NYSERDA Submetering Program Summary Report

Final Report 07-01
October 2006

New York State
Energy Research and
Development Authority

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NYSERDA Submetering Program
Summary Report
Final Report

Prepared for the

New York State
Energy Research and
Development Authority

Albany, NY
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and

Participating WWTP Facilities:

Village of Marcellus
Village of Clayton
Village of Heuvelton
South & Center Chautauqua Lake Sewer Districts
Town of Grand Island
Village of Potsdam
Town of Bethlehem
Erie County Sewer District no. 2 Big Sister Creek
Town of Orangetown
Saratoga Sewer District no. 1
Metropolitan Syracuse, Onondaga County

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NOTICE

This report was prepared by Stearns & Wheler, LLC in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority and the following participating municipalities located in the State of New York:

- Village of Marcellus
- Village of Clayton
- Village of Heuvelton
- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Village of Potsdam
- Town of Bethlehem
- Erie County Sewer District No. 2 Big Sister Creek
- Town of Orangetown
- Saratoga Sewer District #1
- Metropolitan Syracuse, Onondaga County

ABSTRACT

Energy evaluations of 11 wastewater treatment plants located in New York State with plant flow rates ranging from 0.5 to 80 MGD were completed to identify and recommend specific process modifications and equipment replacements to save plant energy costs. These studies have been funded by NYSERDA as the Sub-Metering Wastewater Treatment Plant Program and the participating municipalities. Power metering was installed at each plant to accurately determine the energy consumption and savings of the evaluated processes. The energy and process data collected resulted in calculated energy use per unit and assist in making process efficiency comparison between the various monitored plants.

Each treatment plant has existing conditions making each application a unique project. Energy saving measures have been found at each of the evaluated plants. Process performance was evaluated and compared to plant flow rate calculations. Capital improvements were recommended with manageable calculated payback periods. Energy saving trends within specific treatment processes were reported.

The following processes were evaluated as potential energy saving measures: pumping systems, aeration systems, biological treatment systems, polymer injection chemical feed systems, filtration systems, sludge handling systems (i.e., thickening, digestion, dewatering, disposal, etc.), and disinfection systems. Other energy saving measures evaluated included process elimination of processes or conversions, addition of variable frequency drives (VFDs), updated lighting systems, improved heating and ventilation systems, use of alternative fuels, and energy monitoring systems.

In implementing the recommended energy saving alternatives for the participating plants, the total annual energy cost savings that can be achieved is $650,000. Some of the recommended alternatives will also provide operational costs savings totaling of $260,000. Other plants not included in this study and through their review of program study results can consider energy saving measures and implementation to further energy cost savings across the State.

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Section 1

GENERAL

A sub-metering program and energy evaluation studies were completed for eleven (11) wastewater treatment plants located in New York State. Each study was conducted to identify and recommend specific process modifications and equipment replacements which included an evaluation of total plant energy usage, replacement of less-efficient motors, and an energy use evaluation on a process-by-process basis. Improvements were recommended to achieve energy savings by utilizing existing and alternate treatment processes based on sub-metering of existing processes.

In addition to perform individual energy evaluations at various wastewater treatment plants, the program also selected plants that ranged in plant size, flow rate and treatment process. The information collected and reported during the sub-metering program and as presented in the Summary Report has been summarized in the following sections for the purpose of presenting program findings to other New York State wastewater treatment plants in order to encourage them to implement additional energy-efficient alternatives.

The Summary Report will describe the overall evaluation of the participating wastewater treatment plants, address energy efficiency measures identified in the individual studies, compare plant size and flow rates to energy efficiency ratings per treatment process, and recommend to promote and implement identified energy efficiency measures more effectively to further energy savings in this sector. This sub-metering program was funded by the New York State Energy Research and Development Authority (NYSERDA) and the eleven (11) participating municipalities. The following wastewater treatment plants ranging in increasing plant flow rate were included in the sub-metering program.

- Village of Marcellus
- Village of Clayton
- Village of Heuvelton
- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Village of Potsdam
- Town of Bethlehem
- Erie County Sewer District No. 2 Big Sister Creek
- Town of Orangetown
- Saratoga Sewer District #1
- Metropolitan Syracuse, Onondaga County

Section 2

DESCRIPTION OF PARTICIPATING FACILITIES

The participating wastewater treatment plants range in flow rate from 0.5 MGD to 80 MGD. The sub-metering program selected these plants to represent specific size categories ranging in the following average flow rates and plant locations. Plant locations through out New York State were planned to offer a state-wide representation of wastewater treatment. Plant locations are presented on Figure 2-1.

- 0.5 to 1.0 MGD - Small Plant Category
- 1.0 to 4.0 MGD - Small to Medium Plant Category
- 4.0 to 8.0 MGD - Medium Plant Category
- 8.0 to 80.0 MGD - Large Plant Category

The following participating plants and average flow rates are distributed in the size categories.
Small Wastewater Treatment Plant Category

- Village of Marcellus - 0.4 MGD
- Village of Clayton - 0.5 MGD
- Village of Heuvelton - 0.5 MGD

Small to Medium Wastewater Treatment Plant Category

- South & Center Chautauqua Lake Sewer Districts - 2.0 MGD
- Town of Grand Island - 2.1 MGD
- Village of Potsdam - 3.5 MGD

Medium Wastewater Treatment Plant Category

- Town of Bethlehem - 4.9 MGD
- Erie County Sewer District No. 2 Big Sister Creek - 7.5 MGD

Large Wastewater Treatment Plant Category

- Town of Orangetown - 10.0 MGD
- Saratoga Sewer District #1 - 21.0 MGD
- Metropolitan Syracuse, Onondaga County - 80.0 MGD

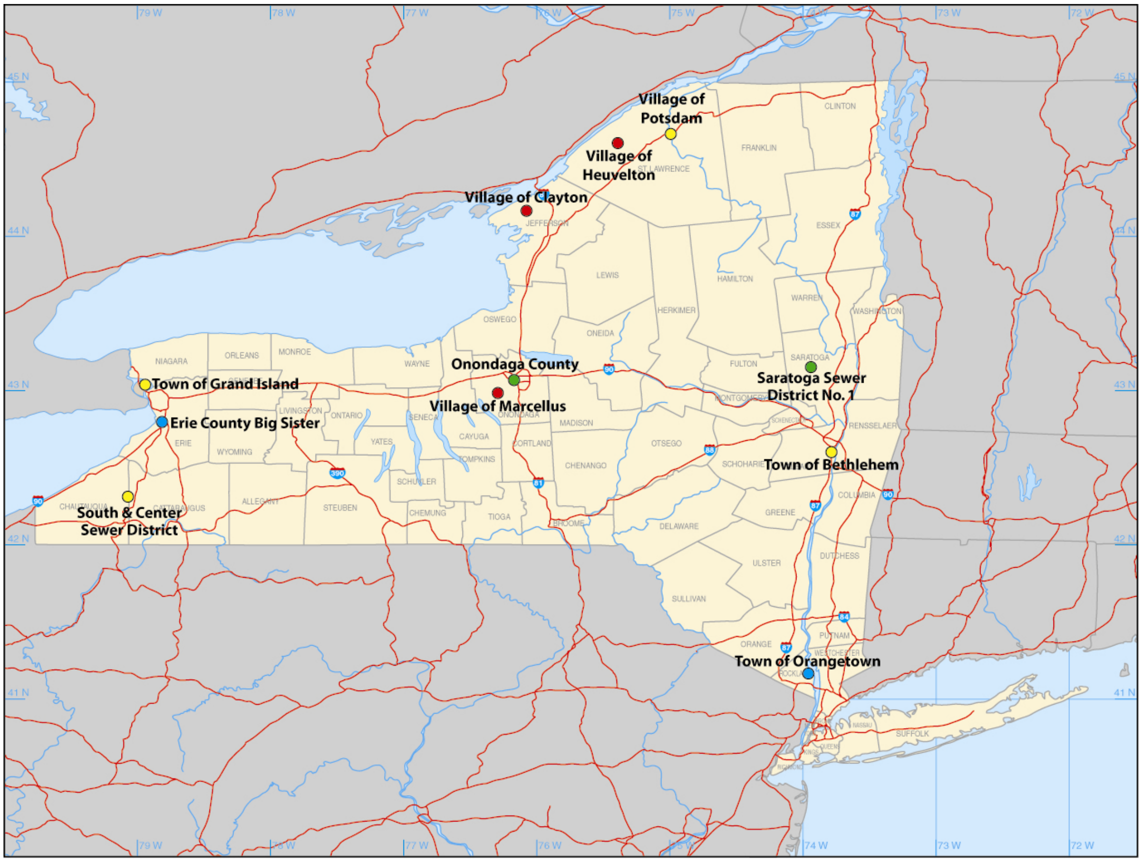

Figure 2-1. New York State Plant Locations

VILLAGE OF MARCELLUS

The Village of Marcellus WWTP is located in Onondaga County with a population of approximately 2,000. The WWTP has an average design flow capacity of 1 MGD with an average flow of 0.3 MGD. Wastewater flows into the WWTP and is filtered through a bar screen and grit chamber. The wastewater then flows by gravity to two (2) contact aeration basins. Air is forced into the mixed liquor in the tank through a series of pipe manifolds and fine bubble diffusers to provide thorough mixing and induction of oxygen for aerobic bacterial conditions. Wastewater then flows by gravity to the base of two (2) clarifiers to settle out suspended solids. The clarifier supernatant then flows by gravity to the chlorine contact tank and finally to the outfall sewer to Nine Mile Creek under a State Pollutant Discharge Elimination System (SPDES) Discharge Permit.

Sludge from the clarifiers is pumped to four (4) re-aeration basins. The aerated sludge is pumped either to two (2) sludge digesters or back to the contact aeration basins where it is mixed with the influent wastewater. The digested sludge is pumped to the solids handling building where it is pressed by a belt press to dewater solids. Supernatant from both the re-aeration tanks and the solids handling building flows by gravity to the two (2) clarifiers and chlorine contact tanks prior to discharge.

VILLAGE OF CLAYTON

The Village of Clayton is located in Jefferson County with a population of approximately 2,100. The plant was originally designed and operated as a contact stabilization plant, but was converted to a sequencing batch reactor (SBR) operation in 2001 with a permitted maximum monthly flow of 1.1 MGD. Current average flow to the WWTP is 0.42 MGD. The WWTP consists of preliminary treatment, secondary treatment, disinfection, and sludge storage and handling.

Preliminary treatment consists of a mechanically cleaned bar screen and a grit chamber. Secondary treatment includes three circular concrete SBR tanks equipped with fine bubble diffusers and decanting arms. Tank Nos. 1 and 2 are 38 feet in diameter with 15-foot liquid depth. They are operated in parallel as a single tank for a total volume of 254,000 gallons. Tank No. 3 is 58-feet in diameter with 15-foot liquid depth and a volume of 296,000 gallons. Disinfection is accomplished by the injection of chlorine gas to the treated effluent in a two-chambered baffled tank prior to discharge to the St. Lawrence River.

Biosolids are pumped from the SBRs and stored in a two-chambered rectangular concrete tank. The sludge holding tank is equipped with fine bubble diffusers for mixing and minimal aeration. Biosolids are removed by tanker truck for off-site disposal.

VILLAGE OF HEUVELTON

The Village of Heuvelton is located in St. Lawrence County with a population of approximately 800. WWTP treats residential and commercial wastewater flows as well as a significant wastewater load generated by Losurdo Foods, a dairy processor. The original treatment plant was built in 1968 and consisted of the Administration Building and lagoons. The treatment plant was upgraded in 1983, during which time a pump building, blower building, bar screen building, and other improvements were added. In 1993, new diffusers were installed in the lagoon, and in 2003, diffuser sleeves were replaced. Major equipment at the plant includes: hydraulically operated grinder, influent pumping, aeration blowers, aeration lagoon, clarifiers, chlorine contact tank, chlorination equipment, sludge holding tank, polymer mixing chamber, sludge pumping, and sludge digestion (aerobic) lagoon.

SOUTH & CENTER CHAUTAUQUA LAKE SEWER DISTRICTS

The South and Center Chautauqua Lake Sewer Districts are located in Chautauqua County with a population of approximately 20,000. It encompasses the Chautauqua Lake area, collecting sewage from areas to the north and south of the lake. The South and Center wastewater treatment facility utilizes an advanced, two stage, activated sludge treatment system with an average daily flow of 4.1 MGD.

The wastewater first passes through the comminutors to grind large particles and then through the aerated grit chambers, which separate and remove sand, and gravel from the influent flow. Primary treatment is accomplished within the primary settling tanks. From the primary settling tanks, wastewater flows to the aeration tanks for the first stage of the activated sludge system. Oxygen transfer within the aeration tanks is accomplished through the mixing of four (4) surface aerators. The wastewater is then transported to the secondary settling tanks for removal of the biological material. From the secondary settling tanks, the wastewater is pumped to the nitrification tanks for the second stage of the activated sludge process. Wastewater flows through the nitrification tanks to the nitrification settling tanks for sludge separation. The nitrification effluent is re-aerated in the re-aeration tanks and disinfected in the chlorine contact tanks prior to discharge to the Chadakoin River.

Waste sludge, including primary and waste activated sludge, is stored in the primary settling tanks. Sludge is pumped to the Jamestown Bureau of Public Utilities (BPU) via a dedicated force main.

TOWN OF GRAND ISLAND

The Town of Grand Island is located in Erie County with a population of over 18,000. The plant was designed to treat an average daily flow of 3.5 MGD. The annual average daily flow rate is 2.5 MGD.

Influent flow is directed through comminutors, which cut large solids and stringy materials into smaller particles. Preliminary treatment consists of two grit chambers, which allow the separation and removal of sand and gravel from the influent sewage flow. The flow is then routed to the pure oxygen activated sludge system, which consists of two reactor trains and two secondary clarifiers. Each reactor train consists of two mechanically agitated tanks in series and utilizes a pure oxygen system (trade name UNOX). Ferrous chloride ($FeCl_2$) is added to the aeration tanks to facilitate phosphorus removal in the secondary clarifiers, and polymer is added to the secondary clarifier influent to enhance flocculation and settling time. Clarifier effluent is disinfected in the chlorine contact tank prior to being discharged to the Niagara River.
Waste sludge is thickened in the gravity thickener. Stabilization of thickened sludge is accomplished through an anaerobic digester system consisting of a mixed and heated primary digester, and a secondary

digester. Although the plant has the capability of dewatering digested sludge with an existing belt filter press, digested sludge is currently hauled off-site for disposal.

VILLAGE OF POTSDAM

The Village of Potsdam is located in St. Lawrence County with a population of over 18,000. The WWTP service area includes the Village of Potsdam and the campuses of Clarkson University and the State University College at Potsdam. The WWTP has a design flow capacity of 3.5 MGD with a daily average flow ranging between 1.5 to 2.2 MGD.

Major treatment equipment and processes at the WWTP include: mechanical bar screen, comminutor, gravity grit chamber, grit cyclone/classifier, mechanically cleaned clarifiers, conventional activated sludge with mechanical surface aerators, and seasonal ultraviolet disinfection. The plant effluent discharges to Raquette River. Waste activated sludge is pumped from the secondary clarifiers to the primary clarifiers. Waste activated sludge is combined with primary sludge in the primary clarifier. The combined primary and waste activated sludge is pumped from the primary clarifier to a circular 40-foot diameter primary anaerobic digester.

Sludge is digested in the primary anaerobic digester, where it is heated and mixed for an average hydraulic residence time (HRT) of 44 days. Digested sludge is transferred to the secondary digester for an average HRT of 41 days. Digested sludge is removed from the secondary digester via gravity or by a portable pumping unit and is piped to a tanker truck for hauling to off-site disposal.

TOWN OF BETHLEHEM

The Town of Bethlehem is located in Albany County with a population of over 31,000 and operates a WWTP with an activated sludge process. Past operations have operated as an activated sludge process with recent modification to a contact stabilization process to accommodate higher flows and solids. The design treatment capacity of the WWTP is 4.9 MGD with a peak hydraulic capacity is 6 MGD.

The treatment process consists of preliminary treatment in two parallel channels, one of which is equipped with a mechanical cleaned bar screen and mechanical grit removal facilities with provisions for equipping the second channel with similar equipment when future flows exceed design flow rates. Flow is then conducted by gravity to two (2) fine bubble aeration tanks. These units are configured and piped to allow them to be utilized as activated sludge and/or contact stabilization processes. Following the aeration tanks, three (3) circular final clarifiers are utilized with a design capacity of 3 MGD each.

Sludge is pumped to the dissolved air flotation (DAF) equipment for sludge thickening. The thickened sludge from the DAF is pumped to the covered 100,000-gallon sludge storage tank that is equipped with an air mixing system. Sludge disposal is by tanker truck hauling to the Albany County WWTP for incineration. The final clarifier effluent is chlorinated in the chamber lying between the clarifiers and conveyed through a 1,600-foot, 48-inch diameter outfall to the Hudson River.

ERIE COUNTY SEWER DISTRICT NO. 2 BIG SISTER CREEK

The Erie County Sewer District (ECSD) No. 2 Big Sister Creek WWTP is located at in Angola. The WWTP has an average design flow capacity of 7.6 MGD with an average flow of 4.5 MGD. Flows in excess of approximately 13 MGD, are directed to the overflow retention facility (ORF).

Wastewater is pumped into an elevated aerated grit chamber. Flows in excess of peak plant design flows are directed into the overflow retention facility (ORF). Once the capacity of the ORF is reached, the ORF overflow is disinfected and discharged into the Big Sister Creek. The wastewater then flows by gravity to two (2) fine bubble aeration basins. Wastewater then flows by gravity to the base of three (3) clarifiers to settle out suspended solids. Sludge is flowed by gravity to the return sludge wells where the return activated sludge (RAS) pumps a portion of the sludge back to the aeration basins for further treatment. After clarification, the wastewater proceeds through sand filtration, chlorination, and re-aeration prior to discharge to Big Sister Creek.

Sludge is pumped to the two dissolved air flotation (DAF) units for sludge thickening. The thickened sludge from the DAFs is pumped to the sludge digestion tanks that are equipped with an air mixing system. The solids are then further processed and dewatered with a recessed plate and frame filter press. Dewatered solids are hauled for landfilling. Existing roofed sludge drying beds are currently not in use unless dewatering equipment is down for repair and remain as a backup dewatering system for the plant.

TOWN OF ORANGETOWN

Orangetown Sewer District No. 1 is located in Rockland County with a population of over 55,000. Forty-three (43) pump stations act as the influent pumping system and convey raw sewage to the WWTP. The Sewer District operates a WWTP with a maximum monthly design flow of 12.75 MGD. Current annual average flow to the WWTP is 10 MGD. Orangetown WWTP is a trickling filter plant that has with the exception of recirculation flow, all wastewater processes flow by gravity through the plant. Wastewater is conveyed to the plant by off-site pump stations.

The treatment process consists of preliminary screening and grit removal (currently not in service), primary clarification, trickling filtration, secondary clarification, and disinfection by gaseous chlorine. Odor control was provided by a wet scrubber system and ozonation system, but neither is in service at this time.

Sludge handling facilities at the WWTP consist of sludge pumping, anaerobic digestion (not in use), sludge holding tanks, and mechanical dewatering of combined primary and secondary sludge using a belt filter press. Prior to dewatering, sludge is conditioned with polymer and potassium permanganate (for odor control). Currently, dewatered sludge is transported to the Rockland County Solid Waste Authority, where it is composted.

SARATOGA SEWER DISTRICT #1

The Saratoga County Sewer District No. 1 is located in southern Saratoga County with a population of approximately 120,000. The Sewer District operates a wastewater treatment plant (WWTP) that consists of influent pumping, preliminary screening and grit removal, primary clarification, secondary activated sludge treatment, and ultraviolet disinfection. The design treatment capacity of the WWTP is 14.5 MGD and the peak hydraulic capacity is 37 MGD. Current annual average flows to the WWTP are approximately 10 MGD.

Sludge handling facilities at the WWTP consist of flotation thickening of waste activated sludge, mechanical dewatering of combined primary and thickened waste activated sludge using belt filter presses, and incineration of dewatered sludge using a fluidized bed incinerator. The WWTP is also equipped with sludge storage tanks and ash dewatering tanks.

METROPOLITAN SYRACUSE, ONONDAGA COUNTY

The METRO wastewater treatment plant located in Syracuse operates an 80 MGD (annual average) facility providing secondary treatment with partial ammonia removal, on a seasonal basis, and phosphorus removal. The wastewater treatment facilities at METRO include preliminary treatment (screenings and grit removal) for wet weather flows up to 240 MGD. Flow from preliminary treatment is pumped by the low lift pumps to the primary clarifiers. The primary clarifiers are designed for a total peak flow of 120 MGD. Primary settled wastewater is distributed to eight aeration tanks which have a fine bubble aeration diffuser aeration system. Aeration tank effluent is fed to four secondary clarifiers. Secondary effluent is chlorinated for disinfection prior to discharge into Onondaga Lake. Sludge from primary and secondary settling is thickened prior to anaerobic sludge digestion, dewatering and stabilization by the N-Viro process.

New facilities for ammonia and phosphorus removal have recently been constructed, and the existing tertiary treatment system has been taken out of service. The ammonia and phosphorus removal system include biological aerated filters (BAF), high-rate flocculated settling (HRFS), and ultraviolet disinfection.

Section 3

PLANT ENERGY COSTS

BASELINE TOTAL ENERGY CONSUMPTION

Nine of the eleven plants in this study provided one or more years of electrical utility data, to aid in characterizing the annual energy distribution inside the plant. One plant (Saratoga) provided a partial year of flow data and an annual electricity data, and one plant (Potsdam) no utility data was provided. Table 3-1, Figure 3-1 and Figure 3-2 presents the annual flow, electricity consumption, and electricity cost for each of the participating plants.

TABLE 3-1

ANNUAL FLOW, ELECTRICITY CONSUMPTION AND COST

Size	Site	WWTP Location	Design Flow Rate (MGD)	Annual Flow(MG)	Annual Electricity Use (kWh)	Annual Electricity Cost ($)	Average Cost of Electricity (¢/kWh)
Small	1	Village of Marcellus	0.4	110	580,400	$ 50,495	8.7¢
	2	Village of Clayton	0.5	176	376,830	$ 41,889	11.1¢
	3	Village of Heuvelton	0.5	105	1,046,976	$ 105,745	10.1¢
Small-Med	4	South & Center Sewer District	2	776	1,570,569	$ 59,379	3.8¢
	5	Town of Grand Island	2.1	998	2,168,600	$ 195,174	9.0¢
	6	Village of Potsdam	3.5	803	894,120	$96,005	10.7¢
Medium	7	Town of Bethlehem	4.9	1,755	1,677,573	$ 162,725	9.7¢
	8	Erie County Big Sister	7.5	2,002	3,929,332	$ 381,145	9.7¢
Large	9	Town of Orangetown	10	3,535	1,582,800	$ 150,374	9.5¢
	10	Saratoga Sewer District #1	21	4,222	10,938,375	$ 787,563	7.2¢
	11	Onondaga County	80	26,700	22,443,958	$1,615,965	7.2¢

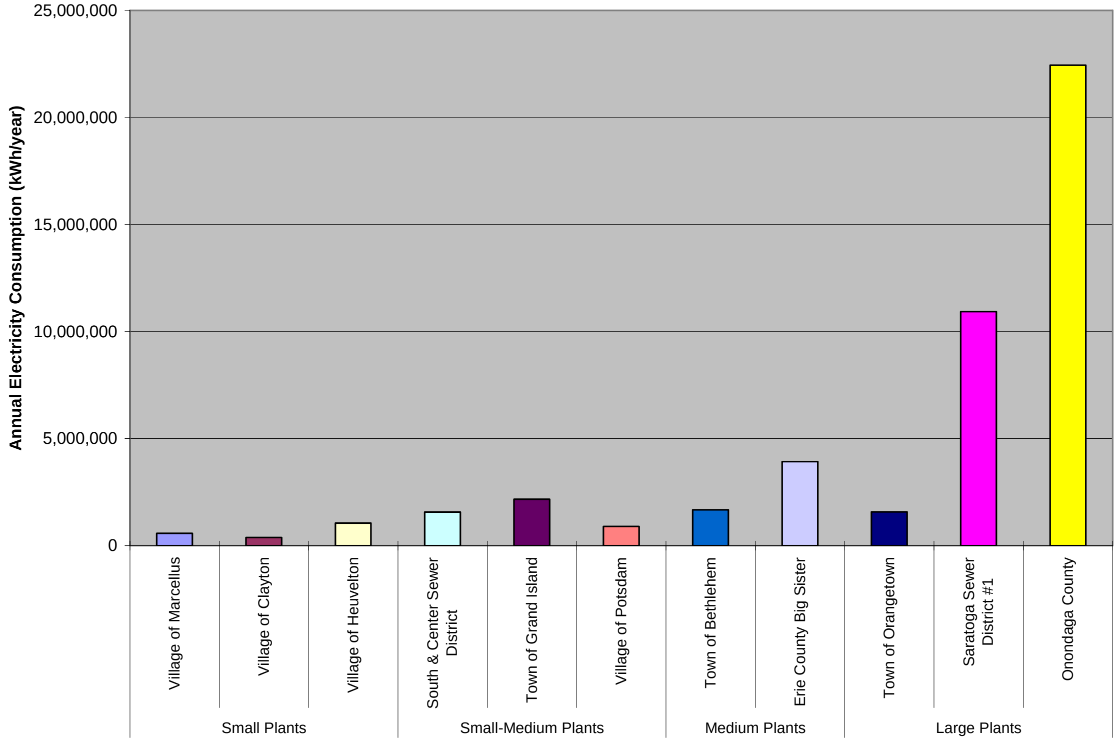

Figure 3-1. Annual Electricity Consumption by Plant

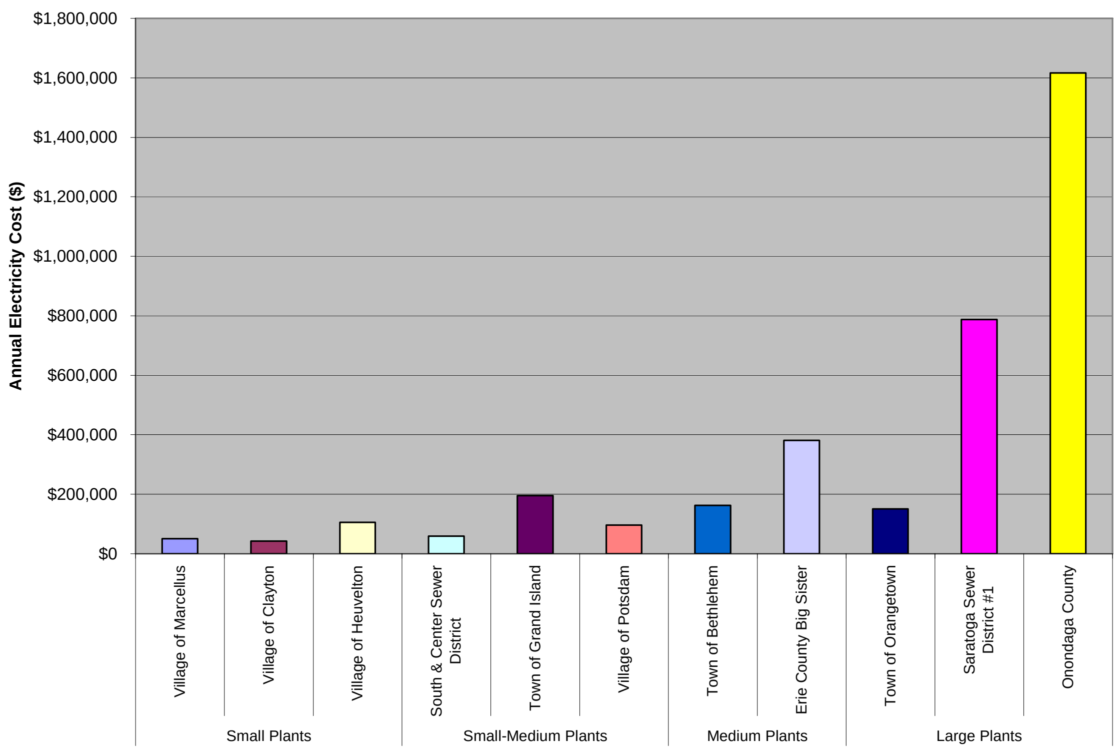

Figure 3-2. Annual Energy Cost by Plant

To further characterize the energy distribution in each plant a series of electrical sub-meters were installed. The electrical sub-meters recorded either the true three-phase power, or a suitable proxy such as current that was correlated to a one-time power reading. Power data was totalized into either 5 or 15-minute energy data and recorded using a datalogger. This energy data was totalized into daily data for comparison to the daily recorded plant flow and loading data.

Figure 3-3. Sub-Meter Installed at Saratoga Sewer District #1 WWTP

The typical duration of sub-metering was between nine and sixteen weeks. A typical sub-meter installation is presented in Figure 3-3. After completion of the sub-metering period, the relation of the monitored energy variation with plant flow was used along with the annual flow relations to provide an estimate of the annual energy consumption by sub-metered load.

In many cases, sub-metered energy data was collected on large portions of the plant pertaining to a particular process, rather than individual pieces of equipment. As each plant configuration and electrical layout is different, the number of sub-meters and level of detail in the sub-metered energy data varied between plants. Typically, the major processes in the plant were monitored, including but not limited to; influent pumping (at plant), aeration, and solids processing. The utility billing data and the sub-metered data were combined to provide an energy consumption and energy cost by process as a percentage of the whole plant annual energy consumption and cost. As the size of the plant increased so does the plant complexity, resulting in an increased number of sub-metered points. The smallest plants had two to three sub-metered loads, while the largest plant (Onondaga County) had 15 sub-metered loads.

The following tables and figures presents the distribution of energy consumption based on the results of the sub-metered data collected and the annual utility consumption. The results are organized first by site, then by plant size to compare and contrast the end-use energy consumption. Energy costs per sub-metered load are based on the average cost of energy as presented in Table 3-1. The sub-metered energy data is also expressed as an energy (and cost) per million gallons of raw sewage treated. This "wire-to-water" efficiency is used to compare different processes and operations between plants.

VILLAGE OF MARCELLUS WWTP ENERGY CONSUMPTION

Four (4) electricity sub-meters were installed at the Village of Marcellus Creek WWTP. The sub-meters were installed on August 13, 2004 and data were collected through October 22, 2004, with over ten weeks of data were collected on these sub-meters.

In addition to the energy sub-meters, two (2) portable current loggers were placed on the remote pump stations at Orange Street and in Marcellus Park. The two (2) energy sub-meters for MCC2 and MCC3 provide a pulse output for every 100 watt-hours, and these switch closures are totalized into 15-minute data on a pulse counting data logger. The meters for the RAS pumps and belt press use a single current CT, and the current reading is correlated to power measurements. Table 3-2 and Figure 3-4 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-2

VILLAGE OF MARCELLUS WWTP ANNUAL ENERGY CONSUMPTION

	RGY CONSUMPTION W/ 109.7 MILLION GALLONS TOTAL FLOW				
	(kWh)	($)	(%)	(kWh/MG)	($/MG)
Aeration	344,227	$29,948	59%	3,138	$273.00
Aerobic Digester	143,392	$12,475	25%	1,307	$113.72
Solids Building	44,341	$ 3,858	8%	404	$ 35.17
Other	48,440	$ 4,214	8%	442	$ 38.42
Total	580,400	$50,495	100%	5,291	$460.30
Remote Pump Stations	1,086	$ 94	N/A	10	$ 0.86

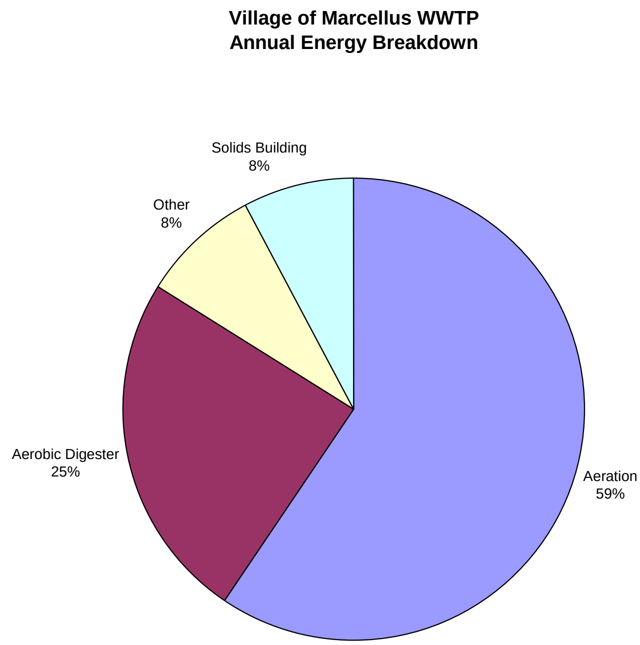

Figure 3-4. Village of Marcellus WWTP Energy Use Breakdown

VILLAGE OF CLAYTON WWTP ENERGY CONSUMPTION

Two (2) electricity sub-meters were installed at the Town of Clayton WWTP on October 26, 2004. Thirteen weeks of data were collected from the sub-meters through January 27, 2005. The sludge blowers (PLC panel) are fed by the WWTP main feed (transfer switch). Table 3-3 and Figure 3-5 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-3

VILLAGE OF CLAYTON WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 176 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Sludge Blowers (PLC panel)	32,522	$ 3,615	9%	184.8	$ 20.54
Control Bldg. (lighting + misc. loads)	121,062	$13,457	32%	687.9	$ 76.46
Centrifugal Aeration Blowers	223,247	$24,816	59%	1,268	$141.00
Total	376,830	$41,889	100%	2,141	$238.01

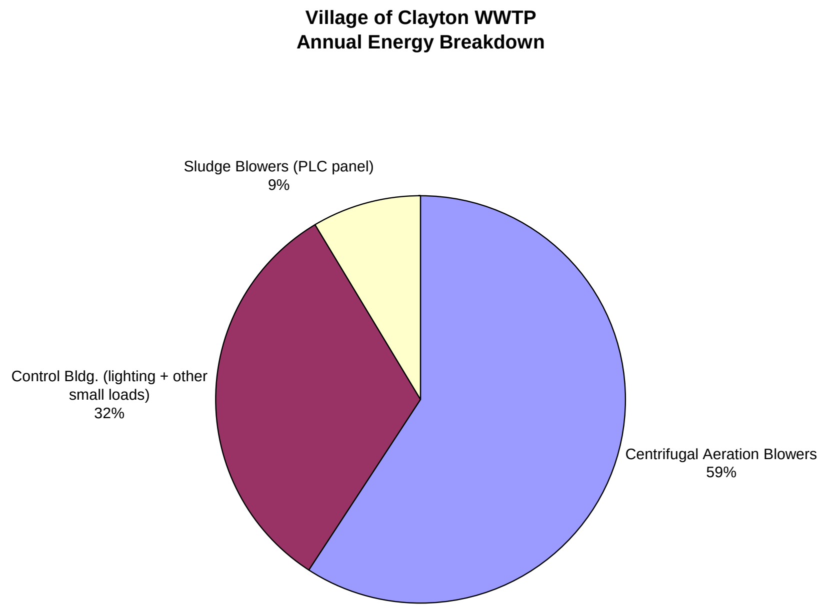

Figure 3-5. Village of Clayton WWTP Energy Use Breakdown

VILLAGE OF HEUVELTON WWTP ENERGY CONSUMPTION

Three (3) electricity sub-meters and one flow logger were installed at the Heuvelton WWTP. The three (3) electricity the sub-meters were installed in mid-January 2004, and the flow logger was installed in mid-March 2004. Table 3-4 and Figure 3-6 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-4

VILLAGE OF HEUVELTON WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 104.8 MILLION GALLONS TOTAL FLOW				
	(kWh)	($)	(%)	(kWh/MG)	($/MG)
Influent Pumps	40,084	$4,048	4%	382	$ 38.63
Sludge Pumps*	25,257	$2,551	2%	241	$ 24.34
Sludge Blowers	210,240	$21,234	20%	2,006	$ 202.62
Centrifugal Blowers	744,441	$75,188	71%	7,103	$ 717.45
Other	26,955	$2,722	3%	257	$ 25.98
Total	1,046,976	$105,745	100%	9,990*	$1,009.01

*Note: Sludge Pumps includes (4) 3-HP Sludge Pumps, (2) ½-HP clarifier rake arms

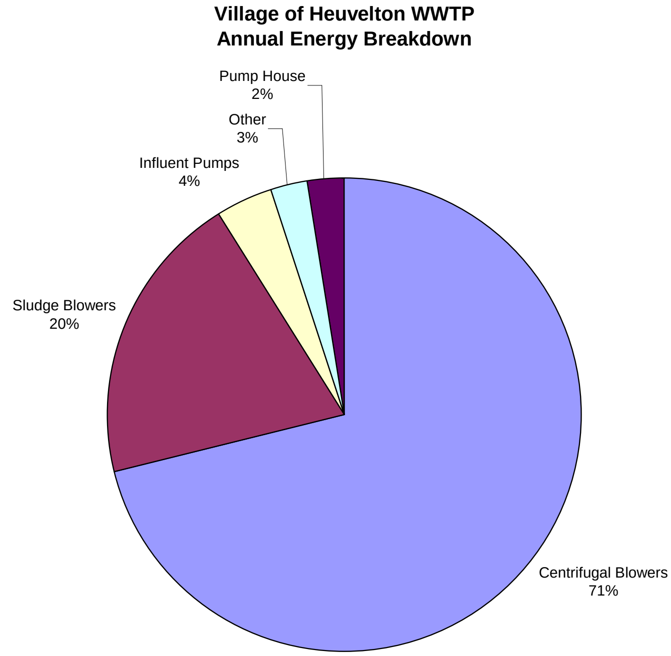

Figure 3-6. Village of Heuvelton WWTP Energy Use Breakdown

SOUTH & CENTER SEWER DISTRICT WWTP ENERGY CONSUMPTION

Several locations around the South and Center Chautauqua Lake WWTP were monitored for approximately ten weeks, starting on August 4, 2003. The sub-metering concentrated on the larger energy consuming portions of the plant including: RAS pumps, piston sludge pumps, primary and secondary aeration, as well as the intermediate lift pumps, which lift the plant flow to the back end of the plant. Also monitored was the energy consumption of a typical remote pump station, the Lakewood pump station, which handles approximately 40% of the total plant flow. Table 3-5 and Figure 3-7 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-5

SOUTH & CENTER SEWER DISTRICT WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 776 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Primary Air Blowers	254,916	$ 9,687	16%	328.5	$ 12.48
RAS/WAS Pumps	49,056	$ 1,864	3%	63.2	$ 2.40
Aerators	346,287	$ 13,159	22%	446.2	$ 16.96
Sludge/Scum Pumps	8,872	$ 337	1%	11.4	$ 0.43
Intermediate Pumps	86,943	$ 3,304	6%	112.0	$ 4.26
Re-Aeration Turbines	85,713	$ 3,257	5%	110.5	$ 4.20
Space Conditioning (Heating/cooling)	266,960	$ 10,144	17%	344.0	$ 13.07
Other	471,822	$ 45,767	30%	608.0	$ 58.98
Total	1,570,569	$152,345	100%	2,023.9	$196.32
Lakewood Pump Station	221,427	$ 8,414	n/a	285.3	$ 10.84

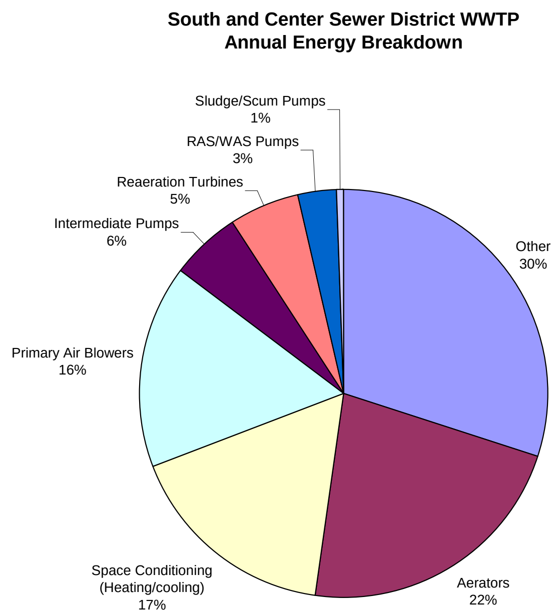

Figure 3-7. South & Center Sewer District WWTP Energy Use Breakdown

TOWN OF GRAND ISLAND WWTP ENERGY CONSUMPTION

Three (3) locations around the Town of Grand Island WWTP were installed and collected data for approximately nine weeks, starting on August 18, 2003. The sub-metering concentrated on the larger energy consuming portions of the plant, namely the influent pump station and the oxygen building. A single sub-meter was collected the energy consumption of the influent pumps, and two sub-meters were collected the energy consumption of the oxygen building.

In the oxygen building, the large air compressor was individually metered, and the other loads (reactor mixers, etc) were characterized using the difference between the oxygen building main feed and the compressor energy. Table 3-6 and Figure 3-8 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-6

TOWN OF GRAND ISLAND WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 998 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Influent Pumps	130,945	$ 11,785	6%	131.2	$ 11.81
Oxygen Building Air Compressor	731,460	$ 65,831	34%	733.1	$ 65.98
Reactor Mixers	402,960	$ 36,266	19%	403.8	$ 36.35
Liquid Oxygen Vaporizing Heater	61,765	$ 5,559	3%	61.9	$ 5.57
Other	841,470	$ 75,732	39%	843.3	$ 75.90
Total	2,168,600	$195,174	100%	2,173	$196.00

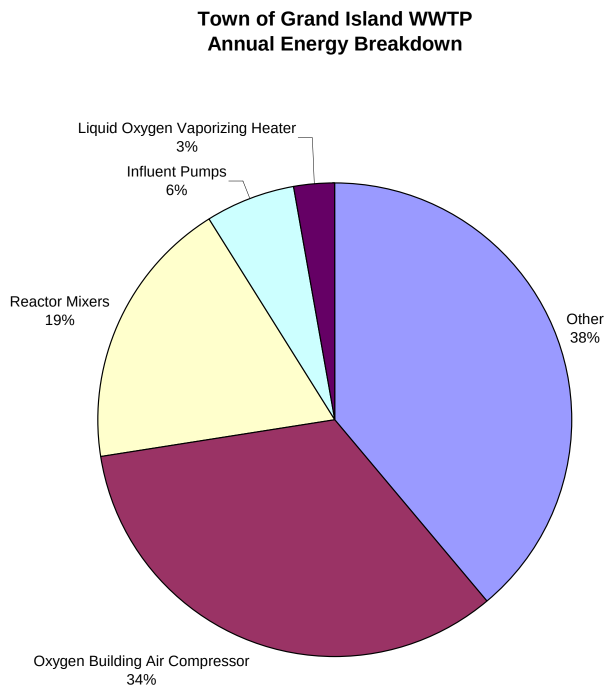

Figure 3-8. Town of Grand Island WWTP Energy Use Breakdown

TOWN OF BETHLEHEM WWTP ENERGY CONSUMPTION

A total of four (4) locations around the Town of Bethlehem WWTP were installed and collected data for approximately 12 to 15 weeks, starting on July 28, 2003. The sub-metering concentrated on the larger energy consuming portions of the plant. Three (3) dedicated sub-meters were collected the energy consumption data of the preliminary building, aeration building, and sludge building. The RAS pumps and sludge dewatering were measured at a sub-panel of MCC-1A in the Main Building.

The energy consumption of MCC-1A in the Main Building, as well as the space heating, cooling, and uncharacterized energy consumption was determined by comparing the sum of the sub-meters to the corresponding utility billing period. Table 3-7 and Figure 3-9 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-7

TOWN OF BETHLEHEM WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 1,755 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Preliminary Building	17,155	$ 1,664	1%	9.8	$ 0.95
Aeration Building	1,036,019	$100,494	62%	590.3	$57.26
Sludge Building	157,128	$ 15,241	9%	89.5	$ 8.68
Main Building (MCC1 + MCC1A)	314,436	$ 30,500	19%	179.2	$17.38
Space Heating	102,666	$ 9,959	6%	58.50	$ 5.67
Space Cooling	2,170	$ 210	<1%	1.24	$ 0.12
Other – Non Process	48,000	$ 4,656	3%	27.35	$ 2.65
Total	1,677,573	162,725	100%	955.88	$92.72

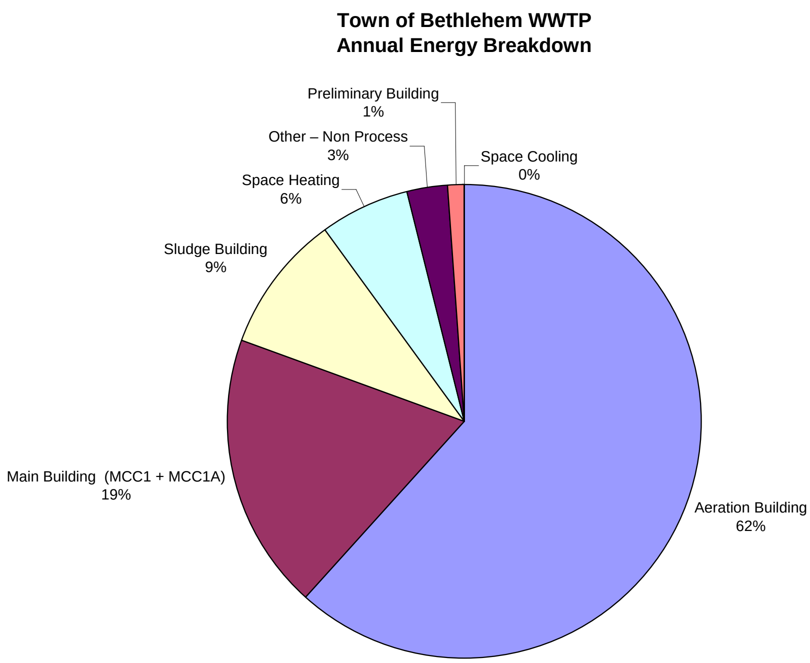

Figure 3-9. Town of Bethlehem WWTP Energy Use Breakdown

ERIE COUNTY BIG SISTER CREEK WWTP ENERGY CONSUMPTION

Four (4) electricity sub-meters were installed at the Big Sister Creek WWTP. The sub-meters were installed and collected data starting on December 23, 2003 through February 27, 2004. In addition to the sub-metered loads, the entire plant energy consumption was measured using a web-enabled billing meter. Table 3-8 and Figure 3-10 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-8

ERIE COUNTY BIG SISTER CREEK WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 2002 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Influent Pump Station	934,959	$ 90,691	24%	467.0	$ 45.30
Aeration	1,146,880	$103,400	29%	572.9	$ 51.65
Aerobic Digester	703,357	$ 68,226	18%	351.3	$ 34.08
Solids Building	617,563	$ 59,904	16%	308.5	$ 29.92
Other	526,573	$ 51,078	13%	263.0	$ 25.51
Total	3,929,332	$381,145	100%	1,962.7	$190.38

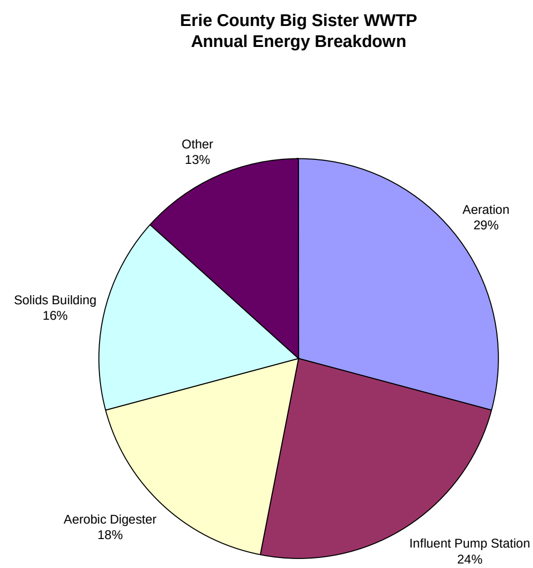

Figure 3-10. Erie County Big Sister Creek WWTP Energy Use Breakdown

TOWN OF ORANGETOWN WWTP ENERGY CONSUMPTION

Four (4) electricity sub-meters were installed at the Town of Orangetown WWTP. The sub-meters were installed and collected data starting on September 1, 2004 through November 30, 2004. Table 3-9 and Figure 3-11 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-9

TOWN OF ORANGETOWN WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 3,535 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Administration	54,750	$ 5,201	3%	15.5	$1.47
Screen & Grit	62,542	$ 5,942	4%	17.7	$1.68
Sewage Pumping (MCCSEP)	266,614	$ 25,328	17%	75.4	$7.17
Sludge Pumping (MCCSLP)	78,347	$ 7,443	5%	22.2	$2.11
Sludge Handling (MCCSH)	206,389	$ 19,607	13%	58.4	$5.55
Space Heating Process Buildings	189,859	$ 18,037	12%	53.7	$5.10
Plant Effluent Water Pumps	282,568	$ 26,844	18%	79.9	$7.59
Garage / Butler Building	39,310	$ 3,734	2%	11.1	$1.06
Control Building Transformer Feed	74,252	$ 7,054	5%	21.0	$2.00
MCC INC	125,403	$ 11,913	8%	35.5	$3.37
Other - Not Characterized	202,846	$ 19,270	13%	57.4	$5.45
Total	1,582,880	$150,374	100%	447.8	$42.54

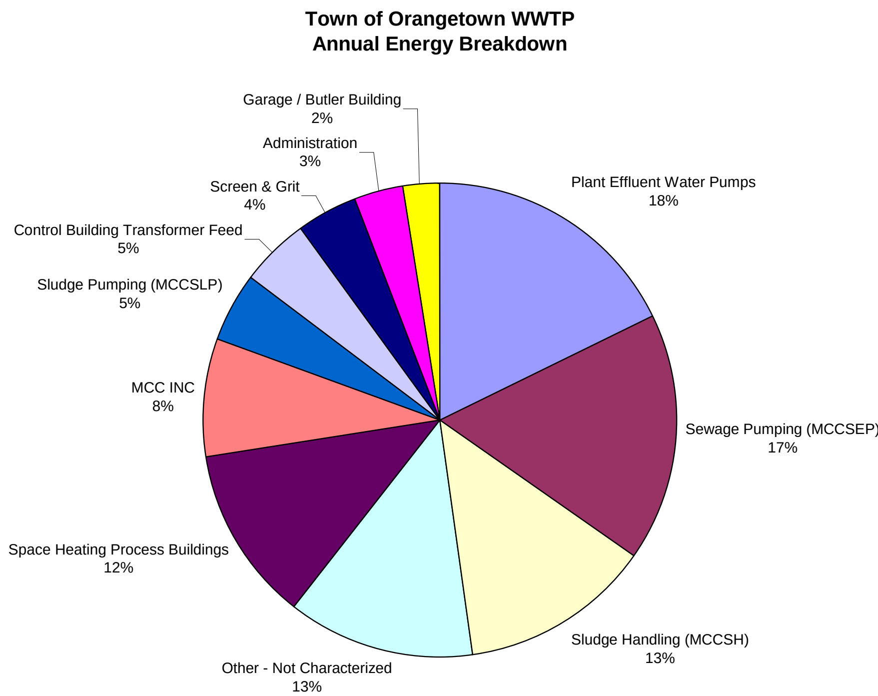

Figure 3-11. Town of Orangetown WWTP Energy Use Breakdown

SARATOGA SEWER DISTRICT #1 WWTP ENERGY CONSUMPTION

Eleven (11) electricity sub-meters were installed and collected data at the Saratoga Sewer District #1 WWTP. Nine (9) of the sub-meters were installed in early August 2003, and the final two were installed in late September 2003. Table 3-10 and Figure 3-12 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-10

SARATOGA SEWER DISTRICT #1 WWTP ANNUAL ENERGY CONSUMPTION

	TOTAL FLOW				
	(KWH)	**($)**	**(%)**	**(KWH/MG)**	**($/MG)**
Primary Sludge Pumping	126,553	$ 9,112	1%	30	$ 2.16
Screen & Grit	189,829	$ 13,668	2%	45	$ 3.24
UV Disinfections	1,168,504	$ 84,132	11%	277	$ 19.93
Other Loads (Not Sub-metered)	1,324,585	$ 95,370	12%	314	$ 22.59
Solids Disposal Building	1,392,080	$100,230	13%	330	$ 23.74
Influent Pumping	1,624,093	$116,935	15%	385	$ 27.70
Thermal Oxidation Reactor	1,944,694	$140,018	18%	461	$ 33.16
Aeration Blowers	3,168,037	$228,099	29%	751	$ 54.03
Total	10,938,375	$787,563	100%	2591	$186.54

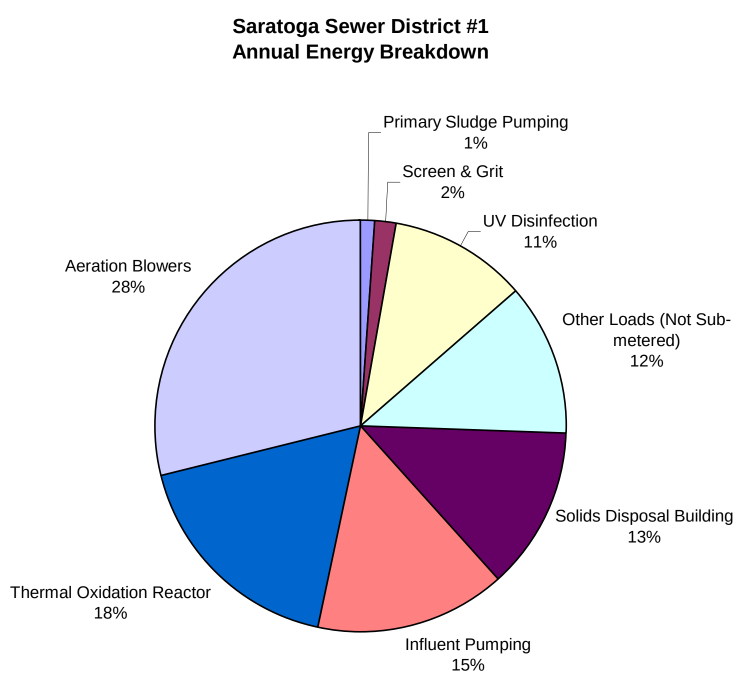

Figure 3-12. Saratoga Sewer District #1 WWTP Energy Use Breakdown

ONONDAGA COUNTY WWTP ENERGY CONSUMPTION

A total of 16 locations at the Onondaga County WWTP were monitored for a minimum of 6-weeks. The sub-metering process was broken down into two phases, with the sub-meters being relocated to different sections of the plant during each phase. Phase one sub-metering consisted of 5 sub-meters, with six to eight weeks of data collected from these sub-meters. Phase two consisted of 11 sub-meters, with six to eight weeks of data collected on all but two of the sub-meters. The two tertiary pump sub-meters were installed only for a ten-day period, to capture operation before the pumps were shut down. Rather than concentrate on individual pieces of equipment, the sub-metering method concentrated collection of data from process and non-process potions of the plant on a per building basis. The exception was the low lift pumps, and the tertiary pumps, which were individually monitored. Table 3-11 and Figure 3-13 presents the annual plant energy consumption and plant energy breakdown percentage.

TABLE 3-11

ONONDAGA COUNTY WWTP ANNUAL ENERGY CONSUMPTION

	ANNUAL ENERGY CONSUMPTION W/ 26,700 MILLION GALLONS TOTAL FLOW				
	(KWH)	($)	(%)	(KWH/MG)	($/MG)
Administration Building	522,564	$ 37,625	2%	19.6*	$ 1.41
Low Lift Pump Station (MCC23 Lights & Small Motors)	265,247	$ 19,098	1%	9.9*	$ 0.72
Plant Maintenance Building	209,448	$ 15,080	1%	7.8*	$ 0.56
Plant Operations Building	1,242,727	$ 89,476	6%	46.5	$ 3.35
Gas Compression Station	260,610	$ 18,764	1%	9.8	$ 0.70
Influent Pumps (Low Lift Pump Station)	2,460,858	$ 177,182	11%	92.2	$ 6.64
New Screen and Grit	924,180	$ 66,541	4%	34.6	$ 2.49
Existing Screen and Grit + Harbor Brook	2,001,127	$ 144,081	9%	74.9	$ 5.40
Sludge Recycle Building A+B Aeration Tanks	7,716,846	$ 555,613	34%	289.0	$20.81
Sludge Recycle Building A+B RAS Pumps (MCC7)	1,517,453	$ 109,257	7%	56.8	$ 4.09
Digester Control House	962,300	$ 69,286	4%	36.0	$ 2.59
Sludge Process Building	332,800	$ 23,962	1%	12.5	$ 0.90
Sludge Dewatering Facility	1,001,805	$ 72,130	4%	37.5	$ 2.70
Tertiary Pumps	2,144,740	$ 154,421	10%	80.3	$ 5.78
Odor Control	881,256	$ 63,450	4%	33.0	$ 2.38
Total	22,443,958	$1,615,965	100%	840.6	$60.52

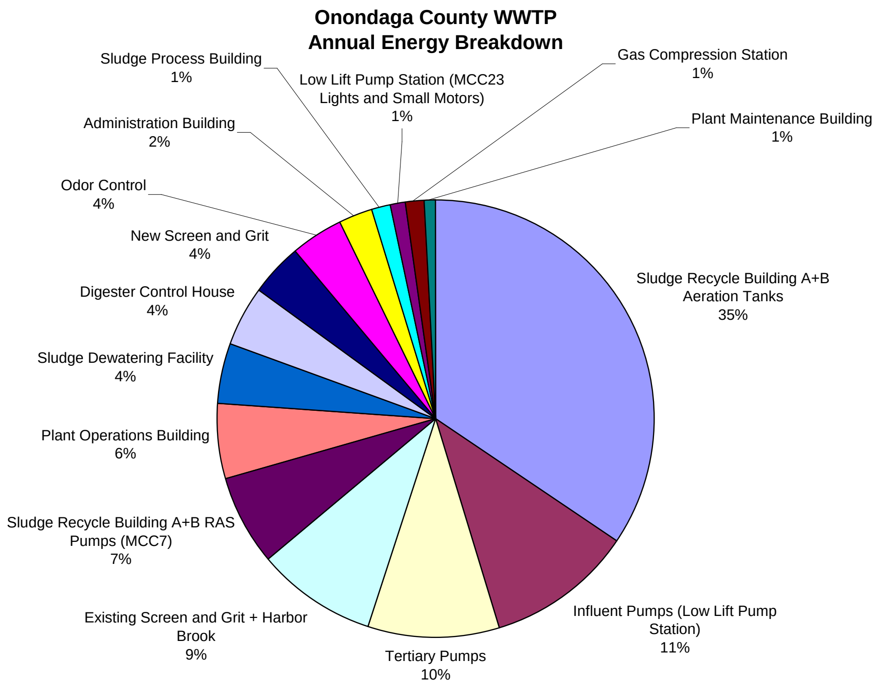

Figure 3-13. Onondaga County WWTP Energy Use Breakdown

ENERGY COMPARISONS BETWEEN PLANT CATEGORIES

The following tables provide comparisons of the energy consumption of each major process sub-metered between plants in each size category. Specific size categories ranging in the following average flow rates have been described in Section 2:

- 0.5 to 1.0 MGD - Small Plant Category
- 1.0 to 4.0 MGD - Small to Medium Plant Category
- 4.0 to 8.0 MGD - Medium Plant Category
- 8.0 to 80.0 MGD - Large Plant Category

SMALL PLANT CATEGORY

Table 3-12 presents the influent pumping energy for the three plants in the small size category (Marcellus, Clayton, and Heuvelton). It is not uncommon for plants of this size not to have on-site influent pumping, as was the case at the Clayton plant. The pumps for the Marcellus plant were not located at the plant, but exist as two remote pump stations located in the Village. The Heuvelton plant utilizes a level control system in the wet well using a two stage pumping system. Table 3-13 presents the aeration energy for these three plants in the small size category. All three plants use conventional centrifugal blowers to provide oxygen for the secondary aeration process. The Heuvelton plant has substantially higher influent contaminant levels than the other two plants due to influent waste from a nearby cheese processing facility.

TABLE 3-12

SMALL PLANT INFLUENT PUMPING COMPARISON

Location	Design Flow (MGD)	Annual Flow(MG)	(kWh)	($)	(kWh/MG)	($/MG)
Village of Marcellus	0.4	109.7	1,086	$ 94	10	$ 0.86
Village of Clayton	0.5	176.0	n/a	n/a	n/a	n/a
Village of Heuvelton	0.5	104.8	40,084	$4,048	382	$38.63

TABLE 3-13

SMALL PLANT AERATION COMPARISON

Location	Design Flow (MGD)	Annual Flow(MG)	(kWh)	($)	(kWh/MG)	($/MG)
Village of Marcellus	0.4	109.7	344,227	$29,948	3,138	$ 273.00
Village of Clayton	0.5	176	223,247	$24,816	1,268	$ 141.00
Village of Heuvelton	0.5	104.8	744,441	$75,188	7,103	$ 717.45

Table 3-14 presents the solids processing energy for the three plants in the small size category. The Marcellus plant uses an aerobic digester for thickening, and then dewaters the sludge. Clayton and Heuvelton aerate the stored sludge, then hauled to another WWTP for further processing and dewatering.

TABLE 3-14

SMALL PLANT BIO-SOLIDS PROCESSING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Village of Marcellus	0.4	109.7	187,733	$16,333	1,711	$148.89
Village of Clayton	0.5	176	32,522	$ 3,615	185	$ 20.54
Village of Heuvelton	0.5	104.8	235,497	$23,785	2,247	$226.96

SMALL - MEDIUM PLANT CATEGORY

Table 3-15 and Table 3-16 presents the influent pumping and aeration comparison for the small to medium sized plants (South and Center Sewer District, Town of Grand Island, Village of Potsdam). All three plants utilized influent pumping at the plant and use some manner of variable speed drive on the influent pumps. The South and Center plant used a hydraulic mechanical transmission to vary the speed of the pump, while the other two plants used a standard variable frequency drive (VFD).

TABLE 3-15

SMALL-MEDIUM PLANT INFLUENT PUMPING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
South and Center Sewer District	2.0	776	308,370	$11,718	397	$15.10
Town of Grand Island	2.1	998	130,945	$11,785	131	$11.81
Village of Potsdam	3.5	646	138,014	$10,350	214	$16.02

South and Center and Potsdam utilized surface aerators for secondary aeration, while the Town of Grand Island plant used a pure oxygen system that incorporates a large air compressor and membrane system to deliver pure oxygen to the reactors. No energy data was collected for solids processing at these three sites since South and Center and Grand Island do not perform much in the way of solids processing.

TABLE 3-16

SMALL-MEDIUM PLANT AERATION COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
South and Center Sewer District	2.0	776	686,916	$ 26,103	885	$ 33.64
Town of Grand Island	2.1	998	1,134,420	$102,097	1,137	$102.30
Village of Potsdam	3.5	646	258,000	$ 19,300	400	$ 30.00

MEDIUM PLANT CATEGORY

Tables 3-17 and 3-18 presents the influent pumping and aeration comparison for the medium sized plants (Town of Bethlehem, Erie County Big Sister). The Erie County Big Sister plant incorporated variable speed influent pumping, while the Bethlehem plant only included screening and grit removal energy at the sewage entrance. Both plants used centrifugal blowers with minimal capacity control for the secondary aeration basins, and had very similar wire-to-water results from the aeration systems.

TABLE 3-17

MEDIUM PLANT INFLUENT PUMPING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Town of Bethlehem (Screen & Grit only)	4.9	1,755	17,155	$ 1,664	10	$ 0.95
Erie County Big Sister	7.5	2,002	934,959	$90,691	467	$45.30

TABLE 3-18

MEDIUM PLANT AERATION COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Town of Bethlehem (Screen & Grit only)	4.9	1,755	1,036,019	$100,494	590	$57.26
Erie County Big Sister	7.5	2,002	1,146,880	$103,400	573	$51.65

Tables 3-19 present both plants utilizing aerobic digesters and sludge dewatering in the solids handling process. The location of the Erie County Big Sister plant required substantially more sludge aeration for odor control due to nearby residential properties. This resulted in a substantially higher solids processing energy per million gallons of sewage at the Erie County Big Sister plant.

TABLE 3-19

MEDIUM PLANT BIO-SOLIDS PROCESSING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Town of Bethlehem (Screen & Grit only)	4.9	1,755	471,564	$ 45,741	269	$26.06
Erie County Big Sister	7.5	2,002	1,320,920	$128,130	660	$64.00

LARGE PLANT CATEGORY

Table 3-20, Table 3-21 and Table 3-22 presents the influent pumping and aeration comparison for the large sized plants (Saratoga Sewer District #1, Onondaga County). The Orangetown plant is a trickling filter plant, and is not suited for per process comparison to a standard activated sludge plant. Comparison between the trickling filter plant and activated sludge plants is included in Section 4.

Both the Saratoga plant and Onondaga County plant utilized variable speed influent pumping. The Town of Orangetown plant did not have on site influent pumping, but relied on an extensive network of remote pump stations. The variable speed pumping at the Onondaga County plant used older DC motors and inverters to vary the pump speed, while the variable speed pumps at the Saratoga plant utilized newer variable frequency AC drives.

TABLE 3-20

LARGE PLANT INFLUENT PUMPING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Town of Orangetown	10	3,535	n/a	n/a	n/a	n/a
Saratoga Sewer District #1	21	4,222	1,624,093	$116,925	385	$27.69
Onondaga County	80	26,700	2,460,858	$177,182	92	$ 6.64

Both plants utilized centrifugal blowers for the secondary aeration system, but with substantially different energy consumption per million gallons of sewage treated. The Saratoga plant used nearly twice the amount of energy per million gallons of sewage compared to the Onondaga County plant. The Saratoga plant used a large incinerator as part of the solids handling process, resulting in significantly higher marginal energy consumption for this process than the Onondaga County plant.

TABLE 3-21

LARGE PLANT AERATION COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Saratoga Sewer District #1	21	4,222	3,168,037	$228,099	750	$54.03
Onondaga County	80	26,700	7,716,846	$555,613	289	$20.81

TABLE 3-22

LARGE PLANT BIO-SOLIDS PROCESSING COMPARISON

Location	Design Flow (MGD)	Annual Flow (MG)	(kWh)	($)	(kWh/MG)	($/MG)
Saratoga Sewer District #1	21	4,222	3,463,327	$249,360	820	$59.06
Onondaga County	80	26,700	4,996,798	$359,775	187	$13.47

INFLUENT PUMPING ENERGY COMPARISONS

Seven (7) of the participating plants perform influent pumping within plant bounds. The remaining four plants are fed primarily by remote pump stations. Figure 3-14 presents influent pumping energy to vary from 131 kWh/MG to 467 kWh/MG, with an average pumping energy of 295 kWh/MG. Compared to the annual total plant energy, influent pumping ranged from 4% to 24% of the total plant energy as presented on Figure 3-15.

The differences influent pumping static head and wire-to-water influent pumping energy between plant sizes were evaluated and compared. In taking into consideration the static head differences between plant sizes will provide a better comparison when comparing influent pumping energy between plant sizes. Smaller plants should consume the highest influent pumping energy while the larger plants consuming the lowest influent pumping energy. This hypothesis is evident as presented in Table 3-23.

The Heuvelton Plant (small plant category) has a high influent pumping energy per foot of static head, while the largest plant category (Onondaga Plant) has a low high influent pumping energy per foot of static head. The Big Sister and Saratoga Plants do not exhibit this influent pumping energy trend and can be assumed to be spending a larger than expected amount of energy on influent pumping for the corresponding plant size. The Grand Island and Potsdam Plants appear to be spending a smaller amount of energy on influent pumping for the corresponding plant size.

TABLE 3-23

INFLUENT PUMPING ENERGY COMPARISON TO STATIC HEAD DIFFERENCES

Location	Plant Size Category	Wire-to-Water (kWh/MG)	Energy per Static Head (kWh/MG/FT of Static Head)
Village of Heuvelton	Small	382	16.49
Town of Grand Island	Small-Medium	131	3.48
Village of Potsdam	Small-Medium	214	5.39
Erie County Big Sister	Medium	467	15.08
Saratoga Sewer District #1	Large	385	17.48
Onondaga County	Large	92	4.91

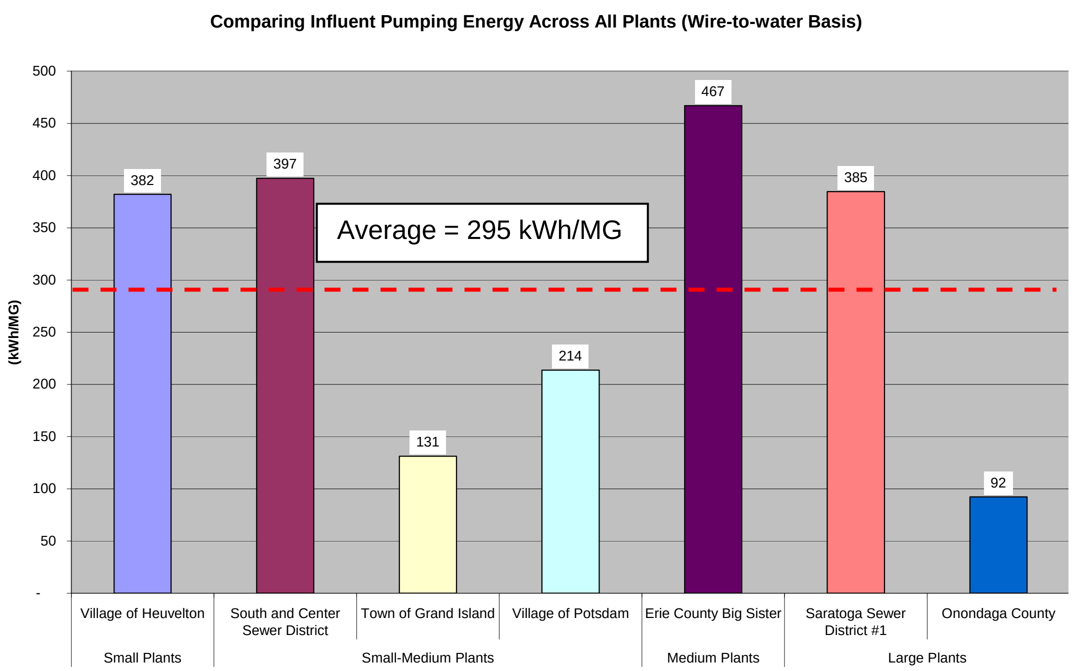

Figure 3-14. Comparing Influent Pumping Energy Across all Sites (Wire-to-Water)

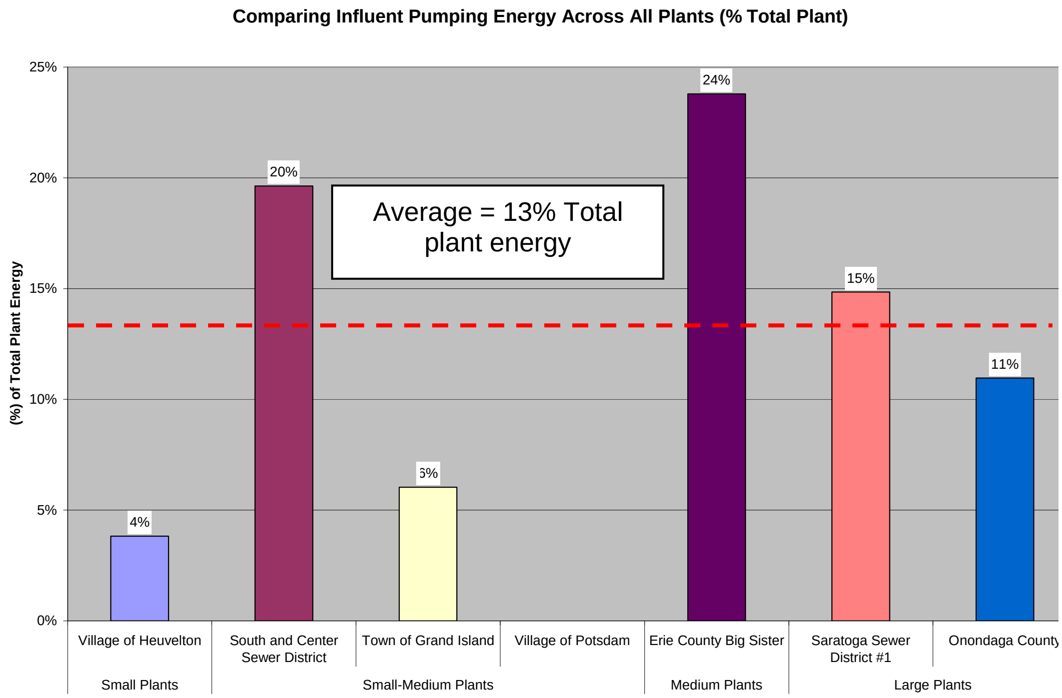

Figure 3-15. Comparing Influent Pumping Energy Across all Sites (% of Total Plant Energy)

AERATION ENERGY COMPARISONS

Ten (10) of the participating plants utilized aeration as the secondary treatment method. The Orangetown plant, being of a trickling filter design, does not use energy for aeration. Figure 3-16 presents aeration energy to vary from 289 kWh/MG to 7,103kWh/MG, with an average pumping energy of 295 kWh/MG. The Heuvelton plant is presently using more than double the next closest plant for aeration energy per million gallons. As the plant size increased, the wire-to-water energy consumption for aeration decreased; implying that the large plants provide more efficient aeration operation.

Figure 3-17 presents aeration is the most significant load at these plants, consuming between 29% and 71% of the total annual energy use at the plant. The larger plants tended to have a lower aeration energy fraction, primarily due to the larger plants operate more processes than the smaller plants, spreading the energy consumption across other treatment processes.

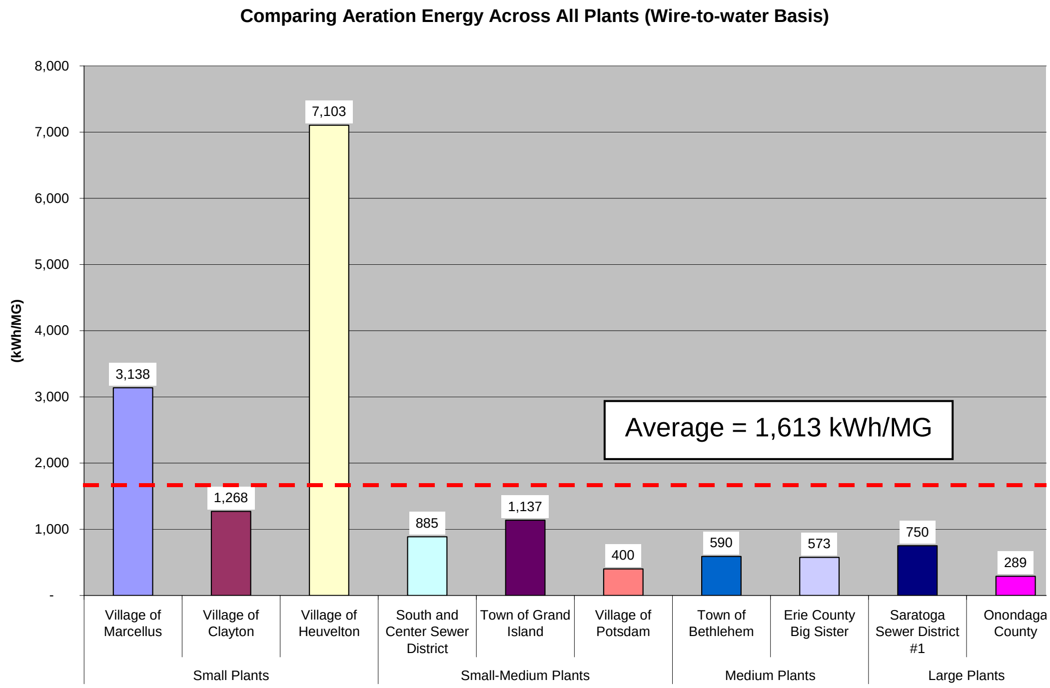

Figure 3-16. Comparing Aeration Energy Across all Sites (Wire-to-Water)

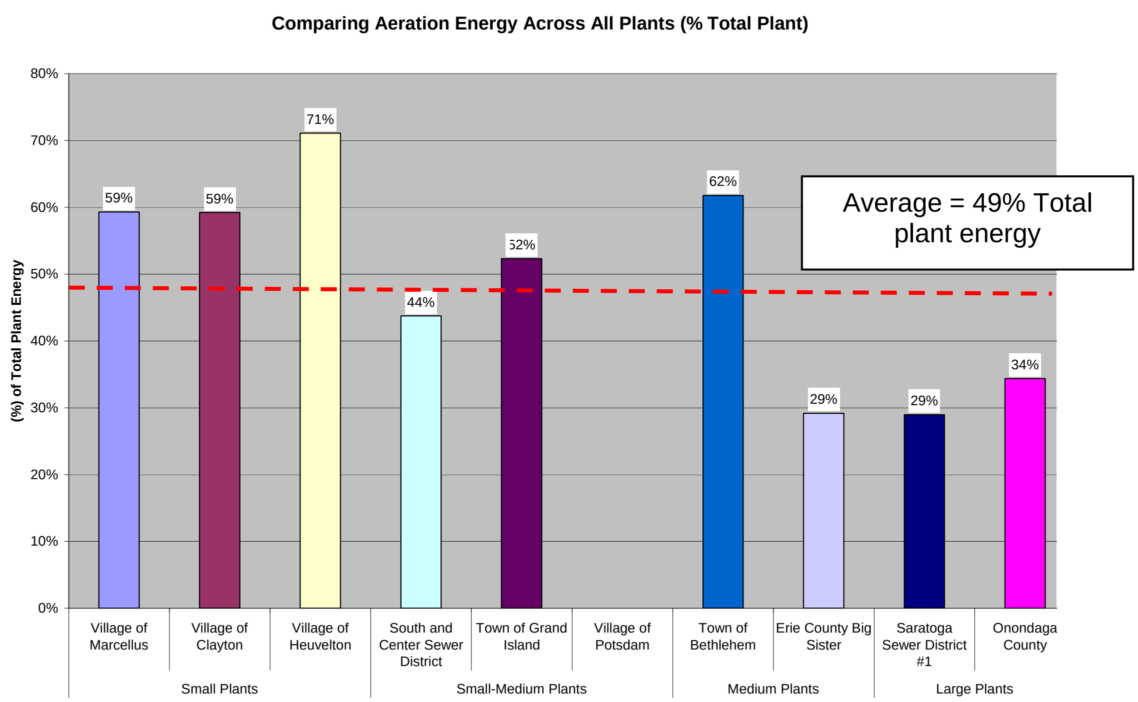

Figure 3-17. Comparing Aeration Energy Across all Sites (% of Total Plant Energy)

BIO-SOLIDS COMPARISONS

The bio-solids processing energy consumption is where the most variation was observed in the collected sub-metered data. The type of bio-solids processing and/or additional sludge aeration required at the plants were responsible for the large differences in sludge processing energy observed in Figure 3-18. Energy consumption ranged from 185 kWh/MG to 2,247 kWh/MG.

At the Clayton and Heuvelton plants, the only sludge processing that occurred was sludge aeration during the sludge storage prior to hauling to another facility for solids dewatering and processing. The Heuvelton plant has a large sludge aeration requirement due to the industrial nature of the loads, whereas the Clayton plant has strictly residential loads. These two plants illustrate how much difference there can be between two plants of similar size.

The other plants performed some type of sludge dewatering. Solids processing averaged 26% of the entire plant energy consumption as presented in Figure 3-19.

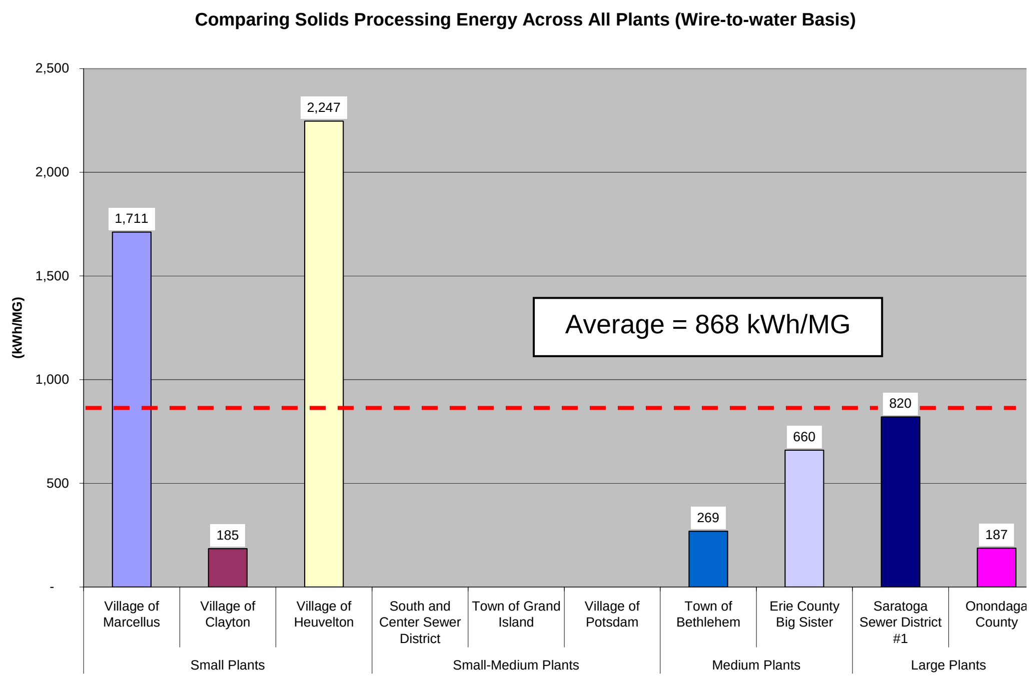

Figure 3-18. Comparing Bio-Solids Processing Energy Across all Sites (Wire-to-Water)

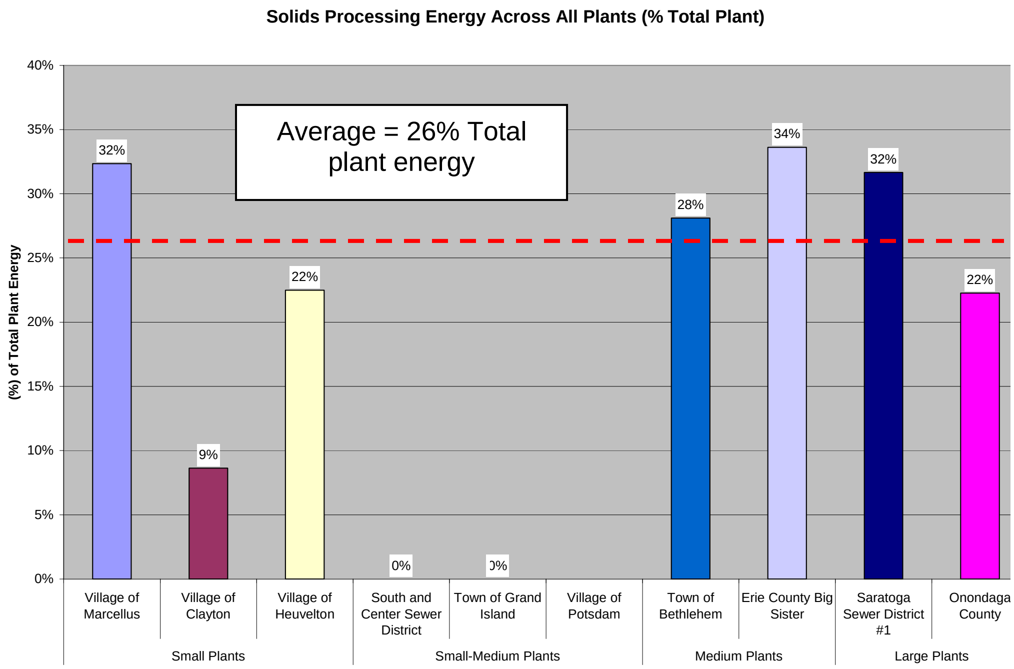

Figure 3-19. Comparing Solids Processing Energy Across all Sites (% of Total Plant Energy)

Section 4

EFFICIENCY RATINGS

OVERALL WIRE-TO-WATER EFFICIENCY

The electric utility data presented in Section 3 was used in conjunction with the corresponding annual flow data to provide an overall "wire-to-water" efficiency data for each plant. Table 4-1 presents the annual electricity consumption of the entire plant, the corresponding annual flow, and wire-to-water efficiency.

TABLE 4-1

ANNUAL PLANT WIRE-TO-WATER EFFICENCY

Size	Site	WWTP Location	Design Flow Rate (MGD)	Annual Flow(MG)	Annual Electricity Use (kWh)	Annual Wire-to-Water Efficiency (kWh/MG)
Small	1	Village of Marcellus	0.4	110	580,400	5,291
	2	Village of Clayton	0.5	176	376,830	2,141
	3	Village of Heuvelton	0.5	105	1,046,976	9,990
Small-Med	4	South & Center Sewer District	2	776	1,570,569	2,024
	5	Town of Grand Island	2.1	998	2,168,600	2,173
	6	Village of Potsdam	3.5	n/a	n/a	n/a
Medium	7	Town of Bethlehem	4.9	1,755	1,677,573	956
	8	Erie County Big Sister	7.5	2,002	3,929,332	1,963
Large	9	Town of Orangetown	10	3,535	1,582,800	448
	10	Saratoga Sewer District #1	21	4,222	10,938,375	2,591
	11	Onondaga County	80	26,700	22,443,958	841

* No utility data provided
** Only 6 months of utility and flow provided, results extrapolated to annual

Overall the annual electricity use increased with the annual flow treated by each plant. The smallest plants (Marcellus and Clayton) consumed approximately 500,000 kWh/year, while the largest plant (Onondaga) consumed nearly 22 Million kWh/year. Comparing the relative change in flow to the relative change in annual energy consumption shows that the largest plant in this study consumes 45 times more energy while treating nearly 175 times more flow than the smallest plants. This indicates that the change in the wire-to-water efficiency with plant flow is an exponential relation, as presented in Figure 4-1.

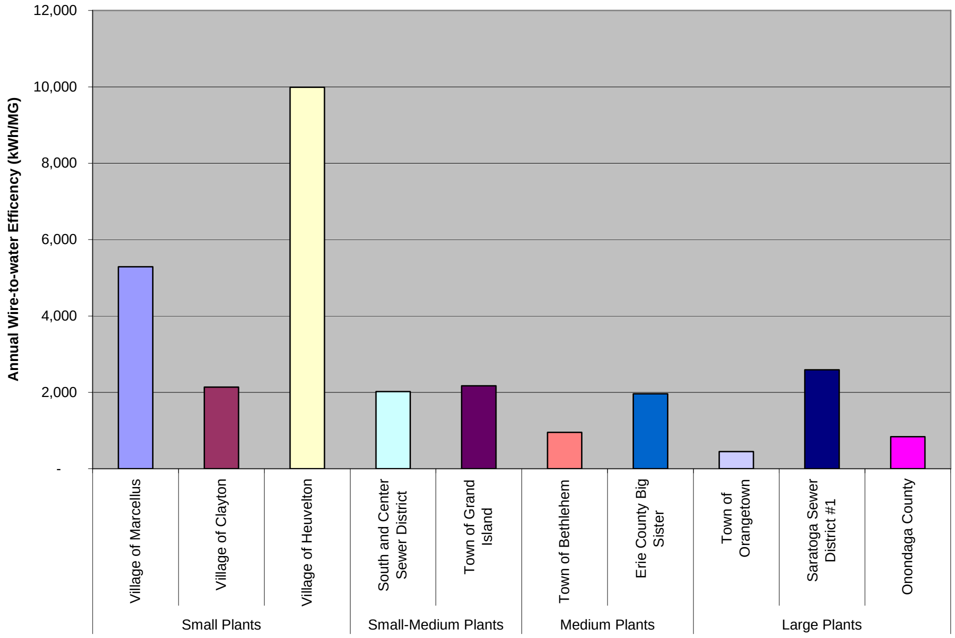

Figure 4-1. Annual Wire-to-Water Efficiency

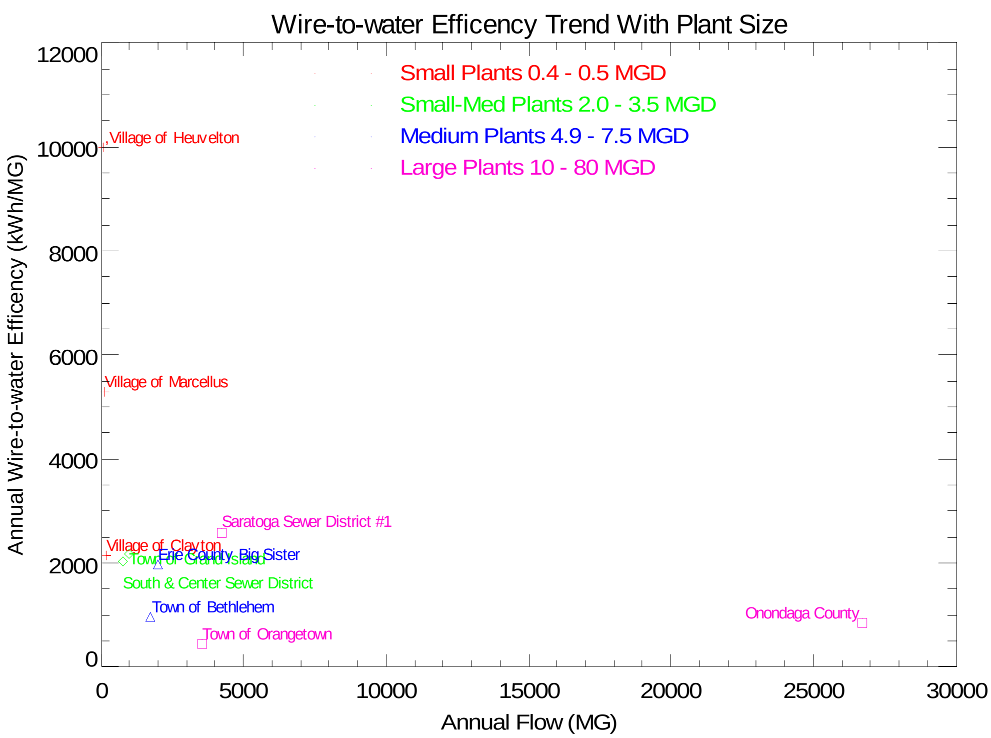

Figure 4-2. Annual Wire-to-Water Efficiency Variation with Annual Plant Flow

The exponential relation between water-to-wire efficiency and annual plant flow presented in Figure 4-2 can be made linear by taking the natural log of both the wire-to-water efficiency and the annual flow as presented in Figure 4-3.

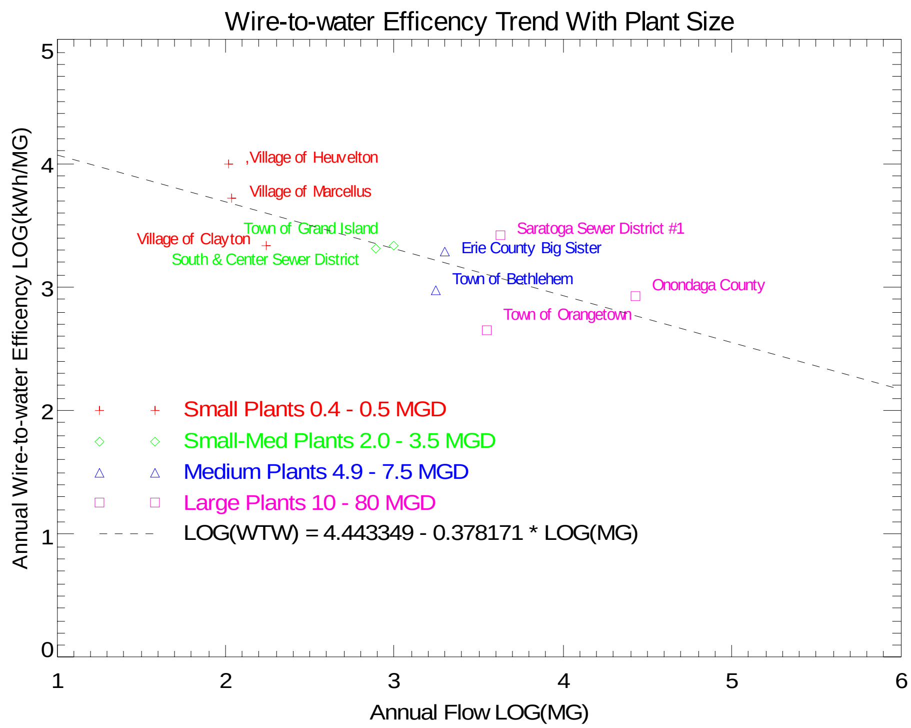

Figure 4-3. Annual Wire-to-Water Efficiency Variation with Annual Plant Flow (Logarithmic Data)

Annual electricity expenditures vary based on not only the size of the plant, but also with the electric utility service territory and corresponding utility tariff. With some exceptions, the annual utility cost per million gallons treated mimics the energy consumption per million gallons. The most notable exception is the South and Center Sewer District plant, which had a very low cost of electricity (3.8¢/kWh), due to electricity being provided by the local municipality. The other plants have a more reasonable cost of energy, with the average energy cost (including demand and other charges) ranging from 7.2¢/kWh to 11.1¢/kWh as presented in Table 3-1.

Table 4-2 presents the annual electrical costs of the entire plant, the corresponding annual flow, and wire to-water costs. The exponential relation between water-to-wire costs and annual plant flow presented can be made linear by taking the natural log of both the wire-to-water efficiency and the annual flow as presented in Figure 4-4.

TABLE 4-2

ANNUAL PLANT WIRE-TO-WATER COSTS

Size	Site	WWTP Location	Design Flow Rate (MGD)	Annual Flow(MG)	Annual Electricity Cost ($)	Annual Wire-to-Water Cost ($/MG)
Small	1	Village of Marcellus	0.4	110	$50,495	$460.30
	2	Village of Clayton	0.5	176	$41,889	$238.01
	3	Village of Heuvelton	0.5	105	$105,745	$1,009.02
Small-Med	4	South & Center Sewer District	2	776	$59,379	$76.52
	5	Town of Grand Island	2.1	998	$195,174	$195.57
	6	Village of Potsdam	3.5	n/a	n/a	n/a
Medium	7	Town of Bethlehem	4.9	1,755	$162,725	$92.72
	8	Erie County Big Sister	7.5	2,002	$381,145	$190.38
Large	9	Town of Orangetown	10	3,535	$150,374	$42.54
	10	Saratoga Sewer District #1	21	4,222	$787,563	$186.55
	11	Onondaga County	80	26,700	$1,615,965	$60.52

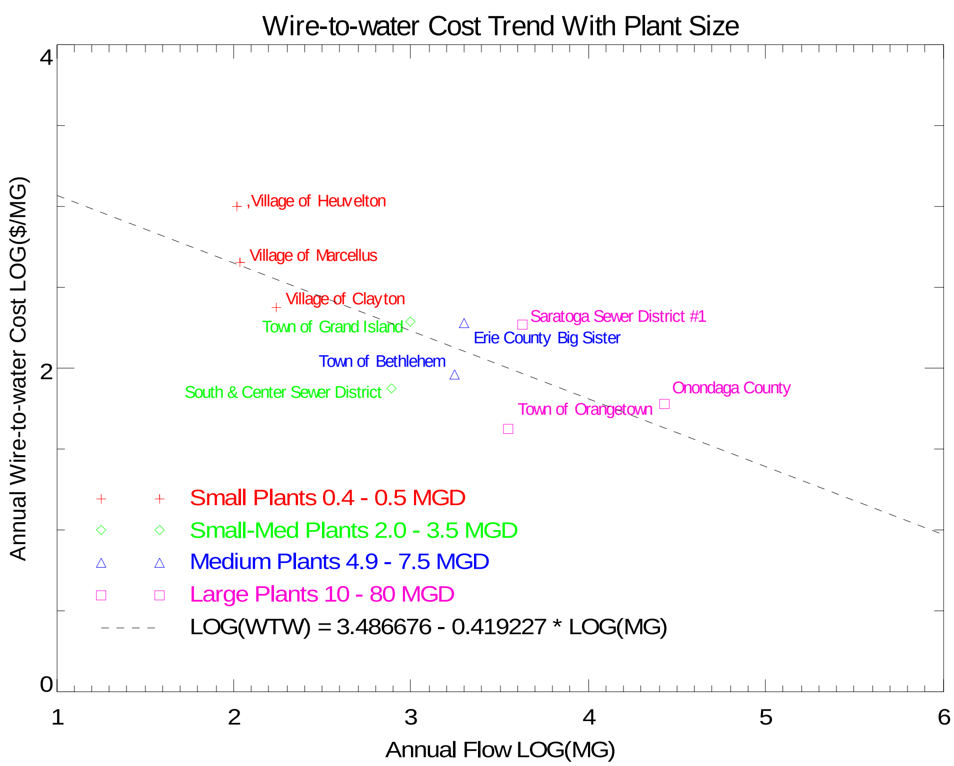

Figure 4-4. Annual Wire-to-Water Cost Variation with Annual Plant Flow (Logarithmic Data)

BOD AND TSS REMOVAL EFFICIENCY

Another method used to compare the efficiency of the plants was to compare the amount of energy required to remove a pound of total suspended solids (TSS) or biological oxygen demand (BOD). These "wire-to-process" numbers are expressed in kWh per pound of contaminant removed and were determined by dividing the total contaminant removal by the corresponding total plant energy consumption.

The BOD wire-to-process numbers for all plants ranged from 0.5 kWh/lb to 2.5 kWh/lb, with an average of 1.7 kWh/lb as presented in Table 4-3 and Figure 4-4. The TSS wire-to-process numbers for all plants ranged from 0.4 kWh/lb to 3.9 kWh/lb with an average of 1.6 kWh/lb as presented in Table 4-3 and Figure 4-5. Typically, the smaller plants use more energy per pound of contaminant removal. Plants with a higher percentage of contaminants removed use more energy than those with lower contaminant removal.

TABLE 4-3

ANNUAL PLANT WIRE-TO-PROCESS EFFICENCIES FOR BOD AND TSS REMOVAL

Size	Site	WWTP Location	Design Flow Rate (MGD)	BOD Wire-to-Process (kWh/LB)	% Total BOD Removal	TSS Wire-to-Process (kWh/LB)	% Total TSS Removal
Small	1	Village of Marcellus	0.4	2.1	99%	1.2	99%
	2	Village of Clayton	0.5	2.5	93%	2.1	98%
	3	Village of Heuvelton	0.5	1.0	99%	3.9	96%
Small-Med	4	South & Center Sewer District	2.0	1.4	95%	1.4	96%
	5	Town of Grand Island	2.1	2.3	93%	2.3	90%
	6	Village of Potsdam	n/a	n/a	n/a	n/a	n/a
Medium	7	Town of Bethlehem	4.9	1.4	94%	1.4	90%
	8	Erie County Big Sister	7.5	2.9	97%	1.3	98%
Large	9	Town of Orangetown	10	0.5	86%	0.4	92%
	10	Saratoga Sewer District #1	21	1.6	94%	1.3	99%
	11	Onondaga County	80	1.1	87%	0.8	90%

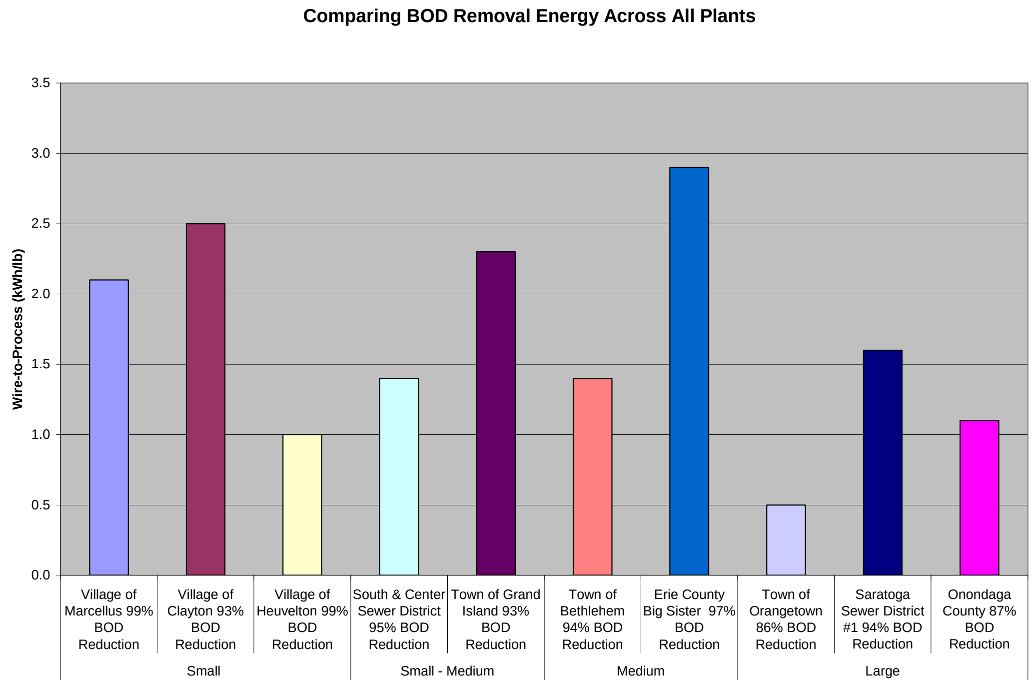

Figure 4-5. Comparing BOD Removal Energy Across all Sites (Wire-to-Process)

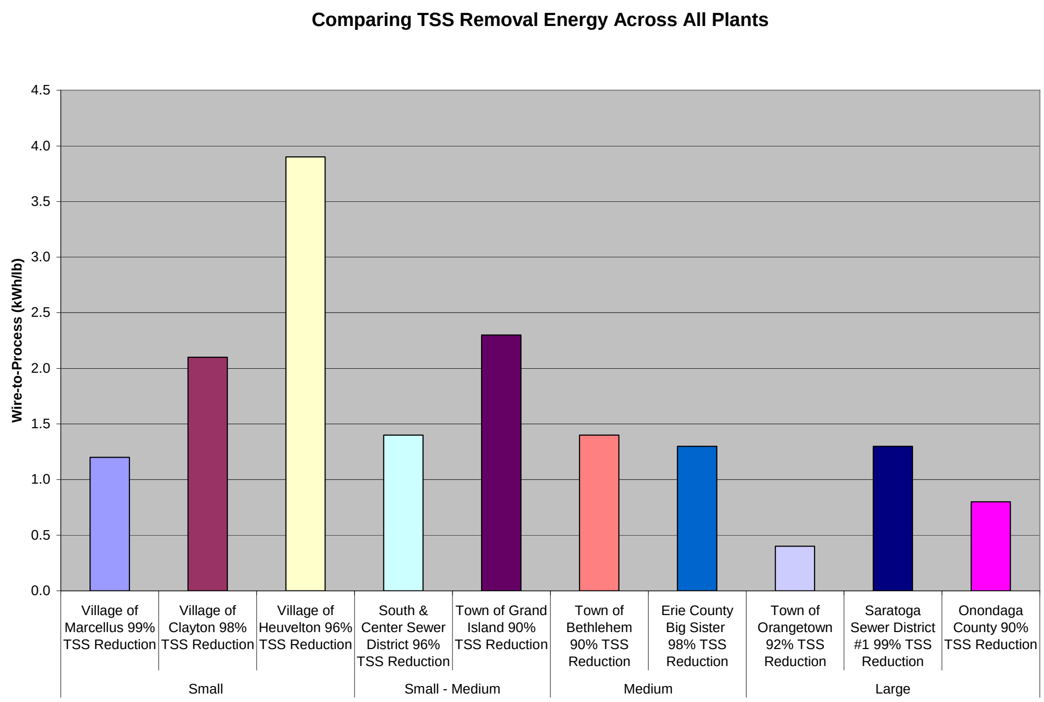

Figure 4-6. Comparing TSS Removal Energy Across all Sites (Wire-to-Process)

Generally, two trends are observed in both wire-to-process trends. As the plant size increased, the amount of energy required to remove one pound of either BOD or TSS decreased. The decrease followed a similar exponential trend to that observed in the wire-to-water efficiency trend. Figure 4-7 and Figure 4-8 presents the relation of BOD and TSS wire-to-process values. Again, the best relation between the flow and water-to-process was described using a LOG-LOG relation.

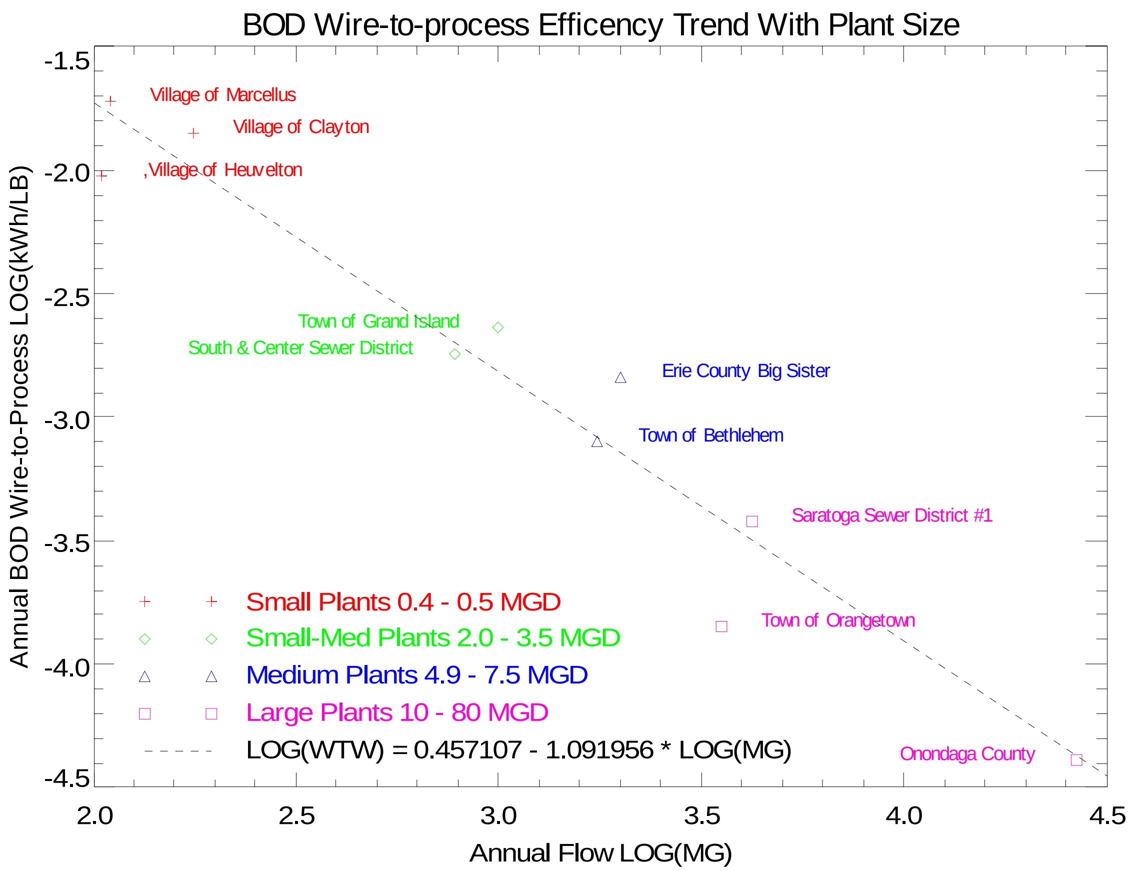

Figure 4-7. Annual BOD Wire-to-Process Variation with Annual Plant Flow (Logarithmic Data)

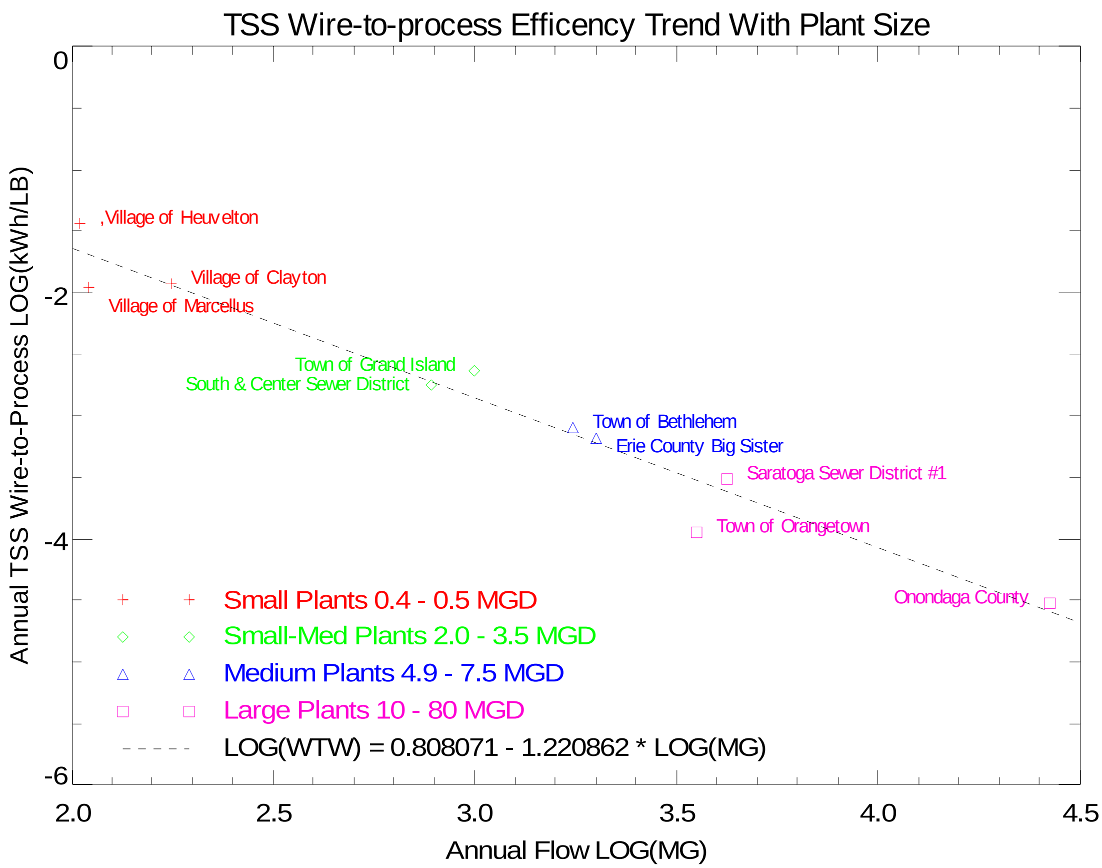

Figure 4-8. Annual TSS Wire-to-Process Variation with Annual Plant Flow (Logarithmic Data)

Section 5

ENERGY EFFICIENT OPPORTUNITIES

The following participating wastewater treatment plants have been categorized by treatment process that includes a listing of each plant study's recommended energy efficient alternatives. Project Summary Tables of each plant study that lists the improvement alternatives, annual energy and costs saved, implementation costs, simple payback periods, and recommended alternatives are presented in Appendix A.

Pumping Improvements

- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Town of Orangetown
- Metropolitan Syracuse, Onondaga County

Grit Chamber Improvements

- South & Center Chautauqua Lake Sewer Districts Aeration
- Erie County Sewer District No. 2 Big Sister Creek
- Town of Orangetown

Aeration Improvements

- Village of Marcellus
- Village of Clayton
- Village of Heuvelton
- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Town of Bethlehem
- Erie County Sewer District No. 2 Big Sister Creek
- Metropolitan Syracuse, Onondaga County

Clarification Improvements

- Erie County Sewer District No. 2 Big Sister Creek

Sludge Digestion Improvements

- Village of Marcellus
- Village of Heuvelton
- Erie County Sewer District No. 2 Big Sister Creek

Solids Dewatering Improvements

- Village of Marcellus
- Village of Clayton
- Village of Potsdam
- Town of Bethlehem
- Erie County Sewer District No. 2 Big Sister Creek
- Saratoga Sewer District #1
- Metropolitan Syracuse, Onondaga County

Heating & Ventilation Improvements

- Village of Marcellus
- Town of Bethlehem
- Erie County Sewer District No. 2 Big Sister Creek

Lighting Improvements

- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Town of Bethlehem
- Town of Orangetown

INFLUENT AND INTERMEDIATE PUMPING IMPROVEMENTS

Energy efficiency and cost savings related to pumping improvements for the plants studied were accomplished by recommending the replacement of aging and /or oversized pumping equipment. Some plants are under utilized due to population decline leaving a plant with higher design flows than actual flow conditions. Pump replacement designed to accommodate lower flow rates can be down sized to smaller horsepower motors which result in lower demand (kW) costs and provide pump operation at more efficient pumping flow rates. Pump efficiency is defined on pump performance curves identifying the most optimal flow rate for the power consumed. Pump motor efficiency of aging pumps can be improved by replacing pump motors with premium efficient motors. The following pump improvement alternatives were recommended for the listed plants.

South & Center Chautauqua Lake Sewer Districts: Existing 50 HP pumps were recommended to be replaced with two (2) smaller 15 HP submersible pumps to handle the plant flow under low and average flow conditions and two large 35 HP submersible pumps to handle peak flow conditions. Based on plant flow data, the plant does not frequently see high flow periods. One of the 15 HP pumps will be able to handle the majority of average plant flows. During peak flow periods, the two 15 HP pumps will be used in combination with the proposed two 35 HP pumps. Utilizing the smaller pump during normal operating periods will save the plant a significant amount of energy costs.

Town of Grand Island: Existing 40 HP pump was recommended to be replaced with a smaller 7.5 HP submersible pump to handle the plant flow under low and average conditions. Based on plant flow data, the plant does not frequently experience high flow periods. The 7.5 HP pump will be able to handle the majority of plant flows. During peak flow periods it will be used in combination with the other existing 40 HP pumps. Utilizing the smaller pump during normal operating periods will save the plant a significant amount of energy costs.

Town of Orangetown: This report included four of the larger pump stations (303, Nyack, Sparkill, and Hunt Road). Energy savings was recommended by improving the efficiency of these pumps by replacement and reducing the resistance to flow in the force mains. Replacement of aging pumps and installation of VFDs produced an increase in pump efficiency ranging from 10 to 100%.

Metropolitan Syracuse, Onondaga County: The low lift pump is responsible for pumping screened and degritted influent to the primary clarifiers. There are five (5) 600 HP pumps that have a combined peak pumping capacity of 240 MGD. The low lift pumps have been in service for approximately 40 years. The completed pump test concluded that new impellers would represent an annual savings of $17,780. Since the existing low lift pumps are reaching the end of their useful life, it was recommended to replace the pumps.

GRIT CHAMBER IMPROVEMENTS

Energy efficiency and cost savings related to grit removal chamber improvements for the plants studied was accomplished by recommending the replacement of aeration blowers with more efficient, downsized positive displacement blowers and VFDs. The blower motor rpms can be manually adjusted with VFD controls to the desired air supply depending on the influent flow rate and the amount of grit entering the grit chamber. The following are typical design criteria for required air supply to aerated grit chambers:

- 2 to 5 cfm per foot of tank length (TR-16 published by NEIWPCC)
- 0.1 to 0.3 cfm per square foot of tank surface (S&W Tech. Practices)

In addition, since some plants are under utilized due to population decline leaving a plant with higher design flows, grit removal can be less frequent saving energy and matching actual flow conditions with the correctly sized equipment. Plant flow is correlated to grit volume received. Grit removal equipment can be turned down or put on an intermittent removal schedule dependent on flow rate.

Town of Bethlehem: Power reduction can be accomplished by increasing the grit removal interval "OFF" cycle to save energy by adjusting with timer. Received grit volumes and removal are dependent on influent flow rates and vary seasonally.

South & Center Chautauqua Lake Sewer Districts: The study determined that the three (3) 25 HP multistage, centrifugal air blowers that aerated the grit chambers and reaction outlet channels could be downsized based on the required air supply and design criteria. Two (2) of the existing air blowers were recommended to be replaced with one (1) smaller 15 HP positive displacement blower and VFD.

Erie County Sewer District No. 2 Big Sister Creek: The existing 50 HP positive displacement blower was recommended to be replaced with a downsized 20 HP positive displacement blower and VFD. The aerated grit chamber air supply requirements could be reduced based on the design criteria.

Town of Orangetown: The screening/comminutor operation consumes approximately 200 kWh per day and $6,900 per year. This equipment could be replaced by two (2) 1.5 HP climber screens and a 3 HP screen wash press, each of which would operate only intermittently. Power consumption could be decreased to an estimated 20 kWh per day.

DISSOLVED OXYGEN CONCENTRATION TRENDS

Aeration improvements were recommended to eight (8) of the eleven (11) participating plants. Study results revealed that the majority of the plants were over aerating their treatment processes. In most cases, dissolved oxygen (DO) was being maintained at concentrations that could be decreased resulting in downsizing equipment and/or reducing motor speed. The DO concentration used as a target set point was 2.0 mg/l, which maintains biological activity.

Study results also showed that DO concentrations display trends that can be used to manage DO concentrations resulting in a more energy efficient operation. The amount of air produced for aeration processes can be adjusted seasonal since DO was found to vary with temperature variation. The influent and effluent concentrations of DO at the Bethlehem plant were evaluated to demonstrate that DO concentrations varied seasonally. DO concentrations are high in the winter months between January and May and decrease in the summer and fall months between June to November. Effluent DO vary less than influent concentrations, however, does maintain the similar trend as influent DO concentrations.

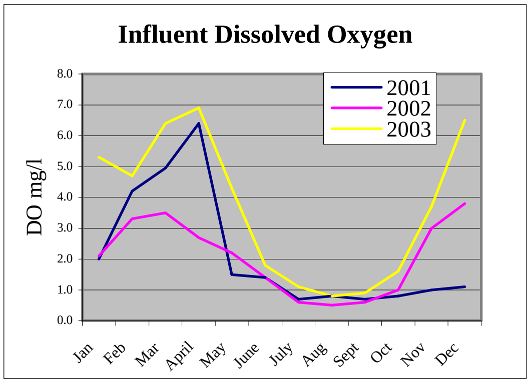

Figure 5-1. Influent Dissolved Oxygen

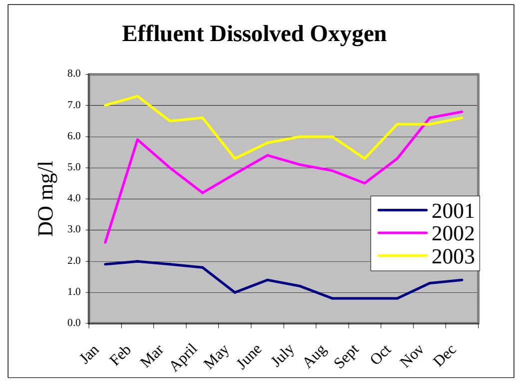

Figure 5-2. Effluent Dissolved Oxygen

It is apparent that similar DO trends are evident at the Bethlehem plant's fine bubble diffuser system aeration tanks. Tank 1 is consistently higher in DO than in Tank 2. Tank 2 presently requires maintenance to the aeration diffusers, which explains the lower DO concentrations. DO concentrations were affected due to the possible short circuiting of aeration that was the result from the accumulation of solids in the aeration tank. This trending shows that a well maintained aeration system will require less aeration and be more energy efficient than a under maintained aeration system.

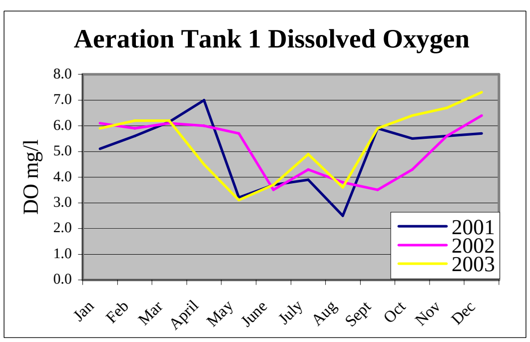

Figure 5-3. Aeration Tank No. 1: Dissolved Oxygen

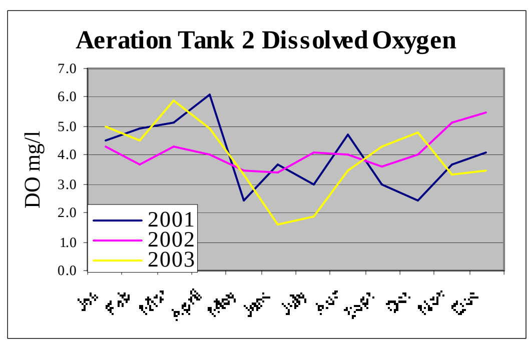

Figure 5-4. Aeration Tank No. 2: Dissolved Oxygen

Other DO concentration trending was evaluated at the Erie County Sewer District No. 2 Big Sister Creek plant. DO concentrations at different locations were sampled downstream of the aeration basins. Sampling results displayed the following DO concentrations in Table 5-1 at different process point locations. DO concentrations increase after the initial aeration process conducted in the aeration basins due to specific drop box falls and natural turbulence.

TABLE 5-1

DO CONCENTRATIONS UPSTREAM FROM FINAL EFFLUENT TANK

Sample Locations	Dissolved Oxygen (mg/L)
Influent DO	8.0
Aeration Basin Effluent	0.8
Secondary Clarifier Effluent	5.1
Solids Contact Clarifier Effluent	6.2
Filter Effluent	6.6
Final Effluent	9.2

When the effluent finally reached the final effluent tank, DO concentrations were recorded at 6.2 mg/L. This level was above the DO concentration discharge requirements for the Big Sister Plant and re-aeration would not be necessary. The Final Effluent Tank was sampled after the re-aeration process showing the increased amount of DO concentration from the re-aeration blower. In this case, significant energy can be saved in shutting down the re-aeration blowing equipment. This trending shows that a DO concentration can be increase through natural turbulence and should be considered for proper aeration management.

AERATION IMPROVEMENTS

Energy efficiency and cost savings related to aeration improvements for the participating plants studied was accomplished by evaluating aeration requirements. All of the following plants were found to be over aerating. Biological activity is enhanced with a DO content of 2.0 mg/l. Reduction in aeration was recommended to include: replacement positive displacement blowers, VFDs, DO monitoring, and aeration system modifications.

Pilot testing with sub-metering equipment at the Big Sister Creek Plant demonstrated that existing centrifugal blowers can be throttled back with intake valves resulting in a power savings of approximately 20% as presented in Figure 5-5.

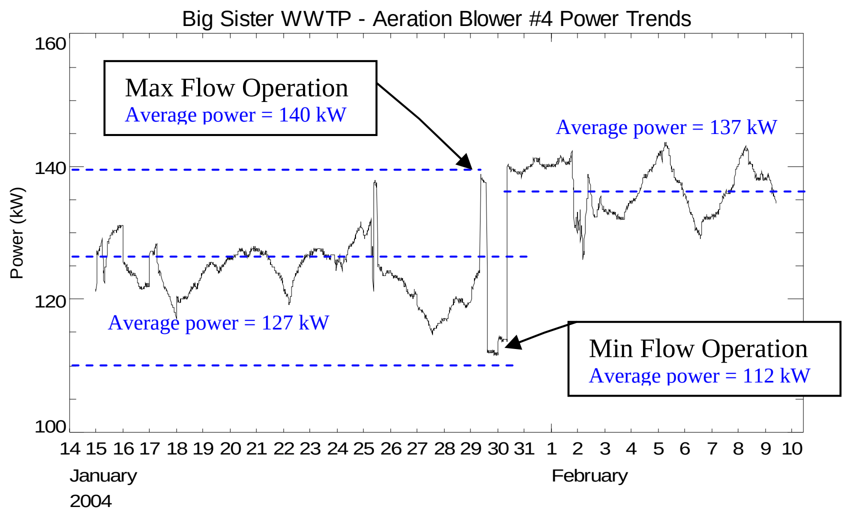

Figure 5-5. Blower Throttling Energy Savings

<u>Village of Marcellus:</u> Aeration is supplied to the fine bubble diffuser aeration basins by either two (2) 25 HP centrifugal blowers or one (1) 60 HP centrifugal blowers. Required aeration can be supplied with one (1) 30 HP positive displacement blower and VFD. DO monitoring will automate and adjust the required aeration to varying conditions with a DO set point of 2.0 mg/l through communication with the blower motor VFD.

<u>Village of Clayton</u>: Reduction of the control set point from 8.0 to 2.0 mg/l during the aeration cycle can save an estimated $6,000 per year with no implementation cost and produce immediate savings. Aeration is supplied to the SBR aeration system by one (1) 75 HP centrifugal blowers. One (1) 50 HP positive displacement blower and VFD was recommended to replace the existing 75 HP blower.

<u>Village of Heuvelton:</u> Projections of increased loading to the plant indicate that current and future peak demand for secondary aeration cannot be met with existing equipment. The current system of manual aeration control can cause unnecessary over-aeration and inefficient use of energy. Based on projected future demands, the existing two (2) 40 HP blowers was recommended to be replaced with two (2) 100 HP blowers. Energy savings can be realized with new, more efficient equipment. Additional savings can be realized through implementation of automated DO monitoring control. Further savings were recommended by reducing aeration through implementation of DO monitoring and control in the aeration lagoon.

<u>South & Center Chautauqua Lake Sewer Districts:</u> This report recommended the replacement of the existing multi-stage 40/22.5 HP surface aerators, including impellers, motors, gears, shafts and skids with new 20 HP motors. The reduction in motor size will provide a significant energy savings and the new aeration system resulting in a 20 to 30% increase in performance of the aeration system.

Town of Grand Island: This report evaluated replacement of the existing 40 HP surface aerator mixers, including impellers, motors, gears, shafts and skids with new 20 HP motors. The reduction in motor size will provide a significant energy savings for the plant, and the new mixing system will provide a 20% to 30% increase in performance of the aeration system.

In addition, the existing backup liquid oxygen generation system was evaluated as the primary oxygen production source and the existing pressure swing adsorption system (PSA) as the back-up oxygen source. The switch between the two systems will incur low capital costs and save the plant a significant amount in energy costs. The annual cost to supply the liquid oxygen is 25% less than the annual cost to operate the PSA system. The high-energy costs of the 200 HP air compressor/blower from the PSA system will be eliminated. The liquid oxygen system includes an electric vaporizer system, a new concrete pad and upgrades to the safety system.

Town of Bethlehem: Significant energy savings were recommended through the replacement of one (1) 100 HP centrifugal positive displacement blower with one (1) 100 HP positive displacement blower controlled by VFD and DO monitoring equipment. DO monitoring will automate and adjust the required aeration to varying conditions with a DO set point of 3.0 mg/l through communication with the blower motor VFD.

Erie County Sewer District No. 2 Big Sister Creek: The existing Biolac fine bubble diffuser aeration system was evaluated to find a constant air draw through system membrane and hosing leaks. The aeration system if repaired could be returned to its original design performance resulting in energy savings. A 43% energy savings was determined if the aeration system was repaired. Pilot testing with sub-metering showed centrifugal blowers can be throttled back with intake valves representing a 20% reduction in air supply.
Metropolitan Syracuse, Onondaga County: New facilities for ammonia and phosphorus removal have recently been constructed to include a biological aerated filter system (BAF). The new biological aerated filters (BAF) system is designed to provide year-round nitrification of the wastewater. With the new BAF system, nitrification was no longer required in the aeration tanks. The amount of air required to maintain seasonal nitrification from June through December was calculated based on historical flows and loads for the past year.

The average amount of air required for seasonal nitrification is 45,800 scfm. With blower design capacity of 2,200 scfm, this results in the need for 21 blowers, and all 8 aeration tanks required to be in operation. The amount of air required for only BOD removal during the same time period is 30,300 scfm. This results in 12 blowers, and 4 aeration tanks required to be in operation. By taking tanks and blowers off-line and reducing the solids retention time (SRT), air requirements are reduced. This process modification resulted in a savings of over 2.3 million kilowatt hours, or $166,000 per year with no implementation costs.

CLARIFICATION IMPROVEMENTS

Energy efficiency and cost savings related to clarification improvements for the plants studied were minimal due to the low energy consumption for this treatment process.

Erie County Sewer District No. 2 Big Sister Creek: The existing Overflow Retention Facility (ORF) is utilized to store and discharge peak flows that cannot be handled by the plant. Clarification appeared to be the critical bottleneck preventing the higher flows during the winter months to be treated resulting in double pumping and increased pumping energy costs. A change in polymer type was jar and pilot tested successfully resulting in an increased fall rate of settable solids. Increased flow through the clarification process resulted in reducing double pumping and lowering energy costs. The selected polymer was less expensive than the currently utilized product resulting in an immediate operational and energy cost savings.

SLUDGE DIGESTION IMPROVEMENTS

Energy efficiency and cost savings related to sludge digestion improvements for the plants studied were accomplished by evaluating aeration and sludge mixing requirements. All of the following plants were found to be over aerating. Reduction in aeration was recommended to include: replacement positive displacement blowers, VFDs, aeration reduction and DO monitoring. Additional energy can be saved in some instances when plants store sludge prior to the dewatering processing. Blower motor speed can be reduced to provide enough aeration for adequate mixing and aerobic activity.

Energy cost savings can result from an adjustment of air supply to the digester tanks in response to sludge level. Figures 5-9 and 5-10 summarize digester performance monitoring data from the Erie County Big Sister Creek Plant study. As shown, the sludge levels in the two digesters varied between 14 and 17-feet. DO concentrations varied from 0 to 2 mg/l with peaks reported at 4 to 5 mg/l. The DO concentrations indicated in the monitoring data generally fall within, or below, the “recommended” operating range of 1 to 2 mg/l published in the 1997 edition of “Recommended Standards for Wastewater Facilities”, better known as “10 States Standards”.

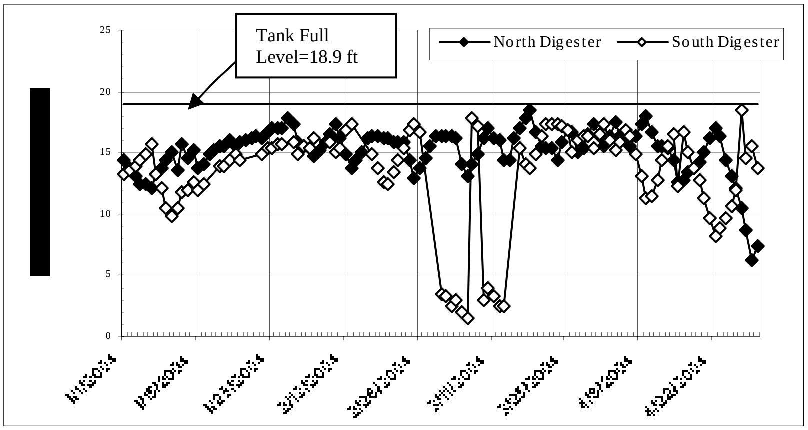

Figure 5-6. Digester Tank Levels

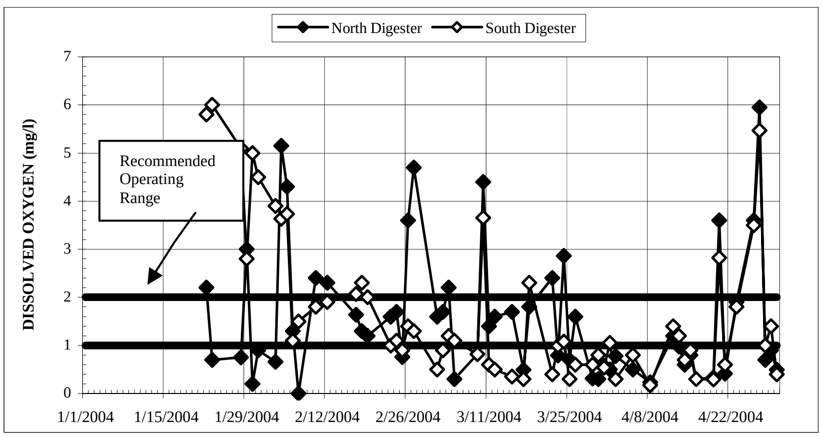

Figure 5-7. Digester Dissolved Oxygen Concentrations

Village of Marcellus: Aeration is supplied to the sludge digester by one (1) 30 HP positive displacement blowers and VFD. Required aeration can be supplied with one (1) 20 HP positive displacement blower and VFD. DO monitoring will automate and adjust the required aeration to varying conditions with a DO set point of 2.0 mg/l through communication with the blower motor VFD. Additional energy can be saved by cycling of aeration equipment for required aeration and sludge mixing during the period of time after sludge has undergone aerobic digestion. Digested sludge is held in storage for a period of time prior to dewatering which occurs every 5 to 6 weeks depending on sludge volumes.

Village of Heuvelton: The 450,000-gallon sludge lagoon is operated as an aerobic digester. Two (2) 15 HP blowers supply air continuously to coarse bubble diffusers for oxygen and mixing. Due to the long solids retention time (SRT) in the aeration lagoon, a portion of volatile solids reduction takes place in the aeration lagoon. Based on average solids production, the estimated air requirement for remaining volatile solids destruction is estimated to be 260 cfm. The combined output of the two blowers is estimated to be 1,000 cfm, which is nearly four times the air required for digestion. Since oxygen requirements may be met with less aeration, it may be possible to conserve energy by cycling the blowers. The off cycle should be short enough so that septic conditions are prevented. Energy savings can be immediate with the installation of timers on the existing blower equipment.

Erie County Sewer District No. 2 Big Sister Creek: Dissolved oxygen concentrations and aeration rates to the digester tanks can be lowered as sludge tank levels decrease after sludge draw down for dewatering operations. Tank volumes are approximately reduced by 50% after sludge removal for dewatering. The reduced sludge volume will require less aeration for mixing and aerobic digestion. A VFD can be installed to the existing 125 HP positive displacement blower motor. The new VFD will control blower motor speed from new DO monitoring equipment.

SOLIDS DEWATERING IMPROVEMENTS

Energy efficiency and cost savings related to sludge dewatering improvements for the plants studied were accomplished by evaluating alternate dewatering technologies to include gravity belt pressing, high solids belt pressing and sludge drying beds. Sludge thickening polymers were identified and pilot tested to confirm superior dewatering over existing processes. Significant operational chemicals costs could be eliminated from dewatering processes with the use of sludge thickening polymers. Other dewatering improvements recommendations included: limiting sludge storage, improved tank mixing, and improved WAS pumping efficiency. Recommended dewatering by belt pressing saved hauling and incinerator fuel costs.

Village of Marcellus: This report evaluated the use of a new sludge-thickening polymer that would reduce the use of lime in the sludge dewatering filter press process. The new polymer was jar and pilot tested in the existing system and found to produce an estimated 20% solids concentration without detrimental effects to the other treatment systems. Testing confirmed that lime can be reduced by 50%. The change in polymer does not save energy, however, it saves operational chemical and disposal costs. Operational cost savings can be immediate with no capital costs.

Village of Clayton: Significant savings in sludge disposal costs and fuel used for current sludge hauling can be achieved by thickening the sludge through dewatering with a gravity belt thickener. Fuel savings associated with reduced sludge hauling were estimated to be $3,700 per year. Savings in disposal costs, after operating expenses, were estimated to be $58,000 per year. In addition, the operational practice of storing sludge on site in the aerated sludge holding tank was evaluated. It is estimated that the current practice of maintaining both sludge holding tanks in service simultaneously and retaining a large inventory of sludge incurs an annual electric cost of $3,600 for aeration blowers. Reducing the inventory of sludge and maintaining one of the two sludge holding tanks empty and in standby reduced aeration costs and save $1,800 per year with no implementation costs.

Village of Potsdam: Significant savings in sludge disposal costs and fuel used for hauling can be achieved by the implementation of thickening or dewatering of anaerobically digested sludge. The following alternatives were evaluated:

- Sludge thickening with gravity belt thickener
- Sludge thickening with rotary drum thickener
- Sludge dewatering with belt filter press
- Sludge dewatering with centrifuge

Sludge thickening with gravity belt thickener was recommended for implementation. This alternative had the lowest electrical cost with an estimated operational savings of $49,000 per year in sludge disposal costs. Sludge volume was estimated to be reduced by 61%.

Town of Bethlehem: Significant energy savings and improvements for sludge tank mixing were evaluated. The primary purpose of aerating the sludge tank is to maintain sludge consistency for uniform flow characteristics required by sludge hauling and disposal equipment. Sludge tank aeration mixing was recommended to be replaced with submersible mechanical mixers that provide energy savings and reduce sludge odors.

Erie County Sewer District No. 2 Big Sister Creek: The existing the solids dewatering process can be modified by utilizing the existing sludge drying beds for five (5) summer months per year and dewater with the existing plate and frame press for the remaining seven (7) months. Jar testing and pilot testing was completed to identify a sludge-thickening polymer and test sludge-thickening characteristics, sludge drying and percent solids concentration results. Pilot test results showed sludge pumped into the drying beds at 3% solids concentration and was removed for disposal in two weeks producing with a 28% solids concentration. A 2-week dry time cycle should be sufficient to provide sludge dewatering for the plant during the summer months. This improvement represented an energy savings while filter pressing operations were shutdown.

The currently utilized 92.5 CF recessed plate and frame filter press requires lime and ferric chloride as dewatering chemicals. Jar and pilot testing was completed to replace the lime and ferric chloride chemicals with the same sludge-thickening polymer as identified to dewater sludge at the drying beds. The pilot test resulted in a 24% solids concentration of filter cake. Operational chemical costs totaling $113,750 can be savings by utilizing the identified sludge thickening polymer for dewatering at the drying beds and filter pressing.

Saratoga Sewer District #1: Significant savings in sludge incinerator costs can be achieved by the implementation of sludge dewatering with the recommended high solids belt press. The following alternatives were evaluated:

- Standard belt filter press replacement
- High solids belt filter press replacement
- High solids belt filter press replacement with odor control containment replacement
- High solids centrifuge replacement

The high solids belt press option will use approximately 3 HP more than the standard belt filter press, but would provide 26 to 30% solids concentration as opposed to 20 to 24% solids concentration produced by the standard press. The dryer sludge cake will support autogeneous combustion in the incinerator resulting in a savings of $75,000 per year in fuel oil.

Metropolitan Syracuse, Onondaga County: Six (6) waste activated sludge (WAS) pumps, one for each of four (4) secondary clarifiers, with two WAS pumps in standby were evaluated. Flow control for the pumps is implemented by a manual throttling valve. The pump speed does not change to control flow. Rather, the throttling valve is closed to increase the total pump system head, thereby reducing the pump output. The capacity of each 25 HP, 1160 rpm centrifugal pump is rated at 1,400 gpm at 40 feet of head. However, typically the four (4) pumps operate continuously at an average flow of 140 gpm each and peak flow of 225 gpm. In order to accomplish this, the control valve is closed to add approximately 60 feet of head loss to the pump operation. The pumps were operated at 25% efficiency at average flow. Recommendations were made to replace pump motors and install premium efficiency motors with VFDs resulting in an energy savings of $22,000 per year.

HEATING & VENTILATION IMPROVEMENTS

Village of Marcellus and Erie County Sewer District No. 2 Big Sister Creek: Implementing thermostat set back at the plant will require replacing the existing thermostats with programmable set back thermostats. It is recommended that a simple day/night thermostat be utilized rather than a 7-day programmable version. In buildings where space is unoccupied during the weekends, such as the administration building, a 7-day programmable thermostat is recommended. The cost of programmable set back thermostats is approximately $50 per unit. Set back temperature should be 10°F.

Town of Bethlehem Significant energy savings can be achieved with the proposed replacement of electric unit heaters with oil-fired unit heaters. The annual electric energy saved has been estimated to be 102,650 kWh with 250 kW of demand totaling a saving of $9,500 per year.

LIGHTING IMPROVEMENTS

Typically, the plants that were studied utilized a combination of standard efficiency fluorescent lighting and high intensity discharge (HID) lighting in most areas. HID lighting is used in areas of the buildings with high-bay ceilings. Fluorescent fixtures are used in most other locations. There is minimal use of incandescent lights. Because most of the lighting systems are in good working order, upgrading the lighting systems in this case is best performed on a per fixture basis as the fixtures age and fail. Table 5-2 presents the impact of upgrading various lighting systems to a lower energy alternative. The following plants were evaluated to find in most cases that lighting had not been upgrade and represented origin equipment.

- South & Center Chautauqua Lake Sewer Districts
- Town of Grand Island
- Town of Bethlehem
- Town of Orangetown

TABLE 5-2

LIGHTING UPGRADE SAVINGS ANALYSIS

Upgrade Type	Old Watts	New Watts	Typical Annual Savings Per Fixture (KwH) (10 Hrs/Day Operation)	
Upgrade from T12 to T8 lamp*	68.0	64.0	15	$1.31
Upgrade from T12 to T8 lamp and upgrade ballast*	78.2	57.6	75	$6.77
Upgrade 60 W incandescent to compact fluorescent	60.0	26.0	124	$11.17
Upgrade 125 W metal halide fixture to (4) T8 4-foot lamps	156.6	115.2	150	$13.48
Upgrade 30 W incandescent exit sign to 1 W LED exit sign	30.0	1.0	254	$22.86**

Notes: *Typical two lamp fixture **Exit light savings based on continuous operation

Section 6

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Plant Flow

Plant size categories studied show energy efficiency will increase with plant size. Larger plants can treat higher flow rates more efficiently. In comparing the change in flow to the change in annual energy consumption, the largest plant in this study consumed 45 times more energy while treating nearly 175 times more flow than the smallest plants. This indicates that the change in the "wire-to-water" efficiency with plant flow is an exponential relation. Influent, aeration and bio-solids processes were compared by plant size (flow rate) and category type.

Plant Efficiency

The efficiency of each plant was compared to the amount of energy required to remove one pound of total suspended solids (TSS) or biological oxygen demand (BOD). The BOD "wire-to-process" data for all plants range from 0.5 kWh/lb to 2.5 kWh/lb, with an average of 1.7 kWh/lb. The TSS "wire-to-process" data for all plants range from 0.4 kWh/lb to 3.9 kWh/lb with an average of 1.6 kWh/lb. Smaller plants use more energy per pound for contaminant removal. Two trends can be concluded in both wire-to-process trends. As the plant size increased, the amount of energy required to remove one pound of either BOD or TSS decreased. The decrease followed a similar exponential trend to that observed in the "wire-to-water" efficiency trend.

Influent Pumping

Influent pumping ranged from 4% to 24% of the total plant energy. Influent pumping was performed by seven (7) plants within plant bounds, while four (4) were gravity fed. This does not offer a good comparison between plants which resulted in no clear trend between the plant sizes.

Aeration

Ten (10) of the participating plants utilized aeration as the secondary treatment method. Aeration improvements were recommended to eight (8) of the eleven (11) participating plants, which provided the largest contributor to energy saving opportunities. Aeration energy varied from 289 kWh/MG to 7,103kWh/MG. As the plant size increased, less electrical energy was required to process wastewater per million gallons. The wire-to-water energy efficiency for aeration increased; implying that the large plants provide more efficient aeration operation. Inefficient aeration processes were encountered in mostly every plant which resulted in the highest energy saving opportunities. Over aeration was the result from the use of the following equipment and operational procedures.

- Use of oversized blowers.
- Aeration diffuser and system leaks.
- Centrifugal blowers with less turned down capability than positive displacement blowers.
- Over aeration to higher dissolved oxygen (DO) concentration set points than required.

Study results indicated that DO concentrations displayed trends which can be used to manage more energy efficient aeration operations. In most cases, dissolved oxygen (DO) was maintained at concentrations that could be decreased resulting in equipment downsizing and/or reducing motor speed. The target DO concentration set point used for this study was 2.0 mg/l. The following additional trends in DO concentrations are summarized below:

- Seasonal influent and process tank DO concentrations fluctuations
- DO concentrations increases resulting from drop box falls and natural turbulence.

Bio-Solids Processing and Sludge Digestion

The type of bio-solids processing and/or additional sludge aeration required at the plants varied widely from plant to plant making it difficult to compare energy consumption and savings. Energy consumption ranged from 185 kWh/MG to 2,247 kWh/MG. Variation was due to some plants storing sludge that awaited dewatering and/or hauling sludge to other facilities, while other plants process sludge more frequently.

Energy efficiency and cost savings related to sludge digestion improvements included evaluating aeration and sludge mixing requirements. Reduction in aeration was recommended to include: replacement positive displacement blowers, VFDs, aeration reduction and DO monitoring. Energy savings can be realized when:

- Stored sludge is not allowed to stand in storage for the dewatering process. A quicker turnover by processing the sludge will reduce and/or empty sludge storage tank volumes resulting in a decrease in aeration and mixing requirements.
- Aeration can be reduced to stored sludge for only mixing purposes. Sludge that has undergone digestion can be aerated at reduced rates to keep sludge mixed.
- Sludge levels fluctuate due to tank draw down from the dewatering process. Reduced aeration can be implemented to coincide with lowered tank volumes.

Solids Dewatering

Energy efficiency and cost savings related to sludge dewatering improvements were accomplished by evaluating alternate dewatering technologies to include gravity belt pressing, high solids belt pressing and sludge drying beds. Sludge thickening polymers were identified and pilot tested to confirm superior dewatering over existing processes. Significant operational chemicals costs could be eliminated from dewatering processes with the use of sludge thickening polymers. Other dewatering improvement recommendations included:

- Limiting sludge storage
- Improved tank mixing
- Improved WAS pumping efficiency

RECOMMENDATIONS

1. Future plant evaluations should be considered to include sub-metering. Actual power consumption data can be utilized in energy saving calculations resulting in more accurate estimated energy savings and payback periods of recommended improvements. The circumstances for metering include:

    - When a facility’s demand charge represent a significant portion of the utility bill, to identify which equipment, at which times, contribute to the facility’s peak demand. This will focus alternatives investigations to the most costly equipment and processes.

- When there is a reasonable degree of certainty that a facility is likely to implement recommended energy saving measures (ESM), so that the metering data can be utilized under the NYSERDA CIPP program.
- When a facility is staffed with personnel that are motivated to save energy and will utilize the information collected by the meters to that end.
- To verify that projected savings are actually achieved after an ESM has been implemented.

2. Operation training is recommended for the purpose of transferring \study results to other plants located in New York State. Most plants were found to be over aerating. Significant energy savings can be saved when operations have the knowledge of DO concentration trending and requirements.

3. DO instrumentation installation is recommended. Frequent DO monitoring is required to better define tank aeration requirements and blower adjustments to optimize energy savings. With the addition of DO monitoring, tank aeration requirements can be automated by controlling the blower VFD directly from the DO transmitter. The DO monitoring will send a signal to the blower VFD to raise or lower the blower motor speed (rpms) in accordance with the tank dissolved oxygen requirement sand DO set point. Plants that can utilize this technology to optimize tank aeration include: Village of Marcellus, Village of Clayton, Village of Heuvelton, South & Center Chautauqua Lake Sewer Districts, Town of Bethlehem, Erie County Sewer District No. 2 Big Sister Creek.

4. Annual testing of polymer is recommended as a standard practice to ensure existing polymer usage is the most optimal polymer type available. In general, plant loadings are variable. Loadings to a plant can fluctuate due an ever changing community. Residential usage can be added to a system with new development. Industrial loading can change with production requirements. The polymer that was used in the past can be not as effective as it once was due to an altered influent loading. This was found evident at the Erie County Sewer District No. 2 Big Sister Creek.

5. Development and implementation of energy savings at other plants is recommended by offering:
   - Technology transfer seminars to different parts of the State.
   - NYSERDA funding as a training incentive for the municipality to send WWT personnel.
   - NYSERDA funding as an incentive for the municipality and engineer to provide for an initial plant site trip and screening study designed to explore energy saving possibilities. A preliminary walk through with a preliminary letter report can highlight possible energy savings and show the municipality some projected results prior to entering into a study agreement.
   - The screening study would be a preliminary study designed for the municipality or industry to enter into a FlexTech study after an indication of energy saving could be attained. Screening study costs could be deferred into the FlexTech Study.

- NYSERDA funding as an incentive to the individual operator to provide energy savings through operational adjustments. The plant operator can be the most knowledgeable person available of his specific plant. Incentive funding could be awarded to the municipality to be passed to a specific person.

LESSONS LEARNED

1. Future studies could evaluate specific processes instead of the entire plant. Specific processes to included aeration, solids handling and processing, and pump systems have been identified in the Sub-Metering Program as the largest contributor to energy saving opportunities. Lower study costs with improved plant efficiency would be beneficial to plant owners and NYSERDA.

2. Larger plants can treat higher flow rates more efficiently. Smaller plants when possible can be consolidated into larger plants that can accommodate the increased loading and flow rate. Many variables other than wastewater treatment efficiency rating need to be considered. Some of these variables include: plant location, interconnection costs, sewer rate structure, and maintenance agreements.

3. Sub-metering should include a manageable sampling period. The more sub-meters will result in a more accurate energy profile of the plant energy consumption. Select a reasonable sub-metering sample interval. This study included a sample interval of every 15 minutes. A sampling interval of every one minute is too frequent adding no additional value to the data set. The duration of the sub-metering period at the studied plants ranged from 6 weeks to 3 months. It was found that the shorter sub-metering period was sufficient in defining the existing energy consumption. The longer sub-metering period add some value to data reliability, however, did not include seasonal variations since the period did not extend into the nest season.

4. Plants with existing SCADA systems can benefit from sub-meters being tied into the system producing simultaneous process information with easy access.

5. Installation of sub-meters and collection of data satisfies the first phase of the initial metering for NYSERDA's Commercial and Industrial Performance Incentive Program, which requires pre and post power metering.

APPENDICES

Appendix A

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM OF WASTEWATER TREATMENT PLANTS
RECOMMENDED ALTERNATIVES

Improvement Alternative	Implementation Costs	Total Project Study Costs	Submetering Costs	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Annual Energy Dollars Saved	Operational Dollars Saved	Simple Payback Period (Years)	Percent Cost Savings	Percent Energy Savings
Village of Marcellus		$31,885	$9,000							
Aeration Reduction to Digester and Aeration Tanks	$38,700			152,900	18	$13,400	$0	2.9	25.5	26.3
Sludge Dewatering with New Sludge-Thickening Polymer	$0			0	0	$0	$2,980	0	0	0
Village of Clayton		$28,100	$9,000							
Reduce DO setpoint, replace 75 HP centrifugal blowers with 50 HP PD blowers and VFDs	$200,000			30,000	15	$13,000	0	15.4	31.0	8.0
Sludge thickening with gravity belt thickener (GBT)	$700,000			0	0	$3,700	$58,000	12.1	0	0
Reduce inventory of sludge stored on site	$0			17,000	0	$1,800	0	0	40.5	4.5
Village of Heuvelton		$33,500	$19,640							
Replace 2-40 HP blowers with 2-100 HP blowers, modify aeration lagoon air piping system to reduce pressure loss	$420,000			153,000	35	$21,000	$0	0	19.8	14.6
Reduce Aeration by DO monitoring and automated control in aeration lagoon	$30,000			170,000	0	$17,000	$0	1.8	16.0	16.2
Reduce aeration of sludge lagoon	$1,000			105,000	0	$10,000	$0	0.1	9.4	10.0
South & Center Chautauqua Lake Sewer District		$87,500	$20,570							
Grit Chamber and Outlet Channel Aeration Reduction	$62,000			217,248	25	$9,100	$0	6.8	15.3	13.8
Surface Aerator Replacement	$218,000			67,890	186	$3,175	$0	68.0	5.3	4.3
Intermediate Pump Station Pump Replacement	$87,400			72,240	560	$4,500	$0	19.0	7.6	4.6
Cycling Re-Aeration Tank Operation Time	$6,600			41,400	0	$1,650	$0	4.0	2.7	2.6
Illumination Evaluation	$28,100			63,530	252	$3,170	$0	8.8	5.3	4.0
Town of Grand Island		$57,500	$20,570							
Influent Pump Replacement for Current Capacity	$33,000			67,890	0	$5,550	$0	5.9	2.8	3.1
Surface Aerator Mixer Replacement	$250,000			65,700	90	$7,100	$0	35.0	3.6	3.0
Liquid Oxygen System	$34,000			744,600	1,020	$79,950	($55,000)	1.4	41.0	34.3
Illumination Evaluation	$12,190			36,000	98	$4,490	$0	2.7	2.3	1.7
Village of Potsdam		$25,500	$4,500							
Sludge thickening with gravity belt thickener (GBT)	$420,000			0	$0	$0	$49,000	8.6	0	0
Town of Bethlehem		$59,550	$20,570							
Aeration Blower Replacement with VFD controlled by Dissolved Oxygen Monitoring	$83,000			236,700	325	$22,400	$0	3.7	13.7	14.1
Oil-Fired Heating	$31,100			102,650	250	$9,500	$0	3.2	5.8	6.1
Illumination Evaluations and Alternative	$4,250			17,550	4	$2,000	$0	2.1	1.2	1.1
Erie County Big Sister Creek		$64,050	$20,570							
Influent pumping, ORF Winter Storage Reduction and Clarification Improvements	$0			48,900	0	$4,750	$34,700	0	1.2	1.2
Grit Chamber Aeration Reduction with New Blower/VFD	$24,000			90,225	123	$8,100	$0	3	2.1	2.3
Final Effluent Tank Aeration Reduction with New Blower, VFD and Auto DO Monitoring with Winter Shutdown	$32,000			40,790	60	$3,700	$0	8.6	1.0	1.0
Aeration Basin Diffuser Repair	$101,700			491,510	673	$44,450	$0	2.2	11.7	12.5
Solids Building Air Compressor Replacement	$10,500			10,040	265	$6,725	$0	1.5	1.8	0.3
Sludge Dewatering with Existing Filter Press and Existing Sludge Drying Beds Utilizing Sludge Dewatering Polymer	$20,700			72,900	300	$9,600	$113,750	0.2	2.5	1.9
Building Heating and Thermostat Set Back Evaluation	$500			0	0	$0	$4,100	0.1	0	0
Town of Orangetown		$72,100	$24,430							
Replace remaining 1,000 watt lamps in Butler Building	$3,000			13,000	3.6	$1,200	$0	2.5	0.8	0.8
Upgrade screening equipment	$525,000			65,000	14	$6,200	$0	85.0	4.1	4.1
Implement process controls for recirculating pump ops	$0			490,000	56	$47,000	$0	0	31.2	31.0
Demand-based effluent water system	$75,000			260,000	50	$26,000	$0	2.9	17.2	16.4
Adjust time cycle of primary sludge pumps	$0			0	7.5	$9,000	$0	0	6.0	0
Saratoga Sewer District #1		$87,500	$29,120							
Motor replacement	$46,460			95,920	19	$7,720	$0	6	1.0	0.9
High solids belt filter press	$450,000			0	0	$0	$75,365	6	0	0
Onondaga County		$115,625	$29,120							
Replace screw pump motors	$22,995			30,077	6.5	$2,165	0	10.6	0.1	0.1
Replace belt washwater pump motors	$10,400			15,768	1.8	$1,135	0	9.2	0.1	0.1
Replace gas recycle motors	$22,000			31,798	3.6	$2,289	0	9.6	0.1	0.1
Replace belt wash booster pump motors	$8,800			18,658	2.1	$1,342	0	6.6	0.1	0.1
Replace odor control compressor motors	$8,800			13,227	1.5	$952	0	9.2	0.1	0.1
Replace grit pump motors, New Screen and Grit Building	$9,100			20,000	2.2	$1,440	0	6.5	0.1	0.1
Replace grit pump motors, Existing Screen and Grit Bldg	$6,825			20,000	2.2	$1,440	0	4.9	0.1	0.1
Reduce aeration due to eliminating nitrification in aerator tanks, June to December	$0			2,300,000	945	$166,000	0	0	10.3	10.2
Replace LLP 1, 2, 3, 4, and 5	$1,250,000			665,000	0	$48,000	0	26.0	3.0	3.0
Replace waste activated sludge pump motors; add VFDs	$96,000			260,000	30	$22,000	0	4.4	1.4	1.2

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

VILLAGE OF MARCELLUS, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Total Annual Operational Dollars Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 1 – Aeration Reduction to Digester and Aeration Tanks	Electric	152,900	18	$13,400	$0	$38,700	2.9	X
Alternative No. 2 – Sludge Dewatering with New Sludge-Thickening Polymer	None	0	0	$0	$2,980	$0	0.0	X
Alternative No. 3 – Solids Building Unit Heater Replacement	None	0	0	$0	$0	$8,600	N/A	(1)
Alternative No. 4A – Solids Building Ventilation Option A	None	0	0	$0	$0	$15,500	N/A	(2)
Alternative No. 4B – Solids Building Ventilation Option B	None	0	0	$0	$0	$11,500	N/A	
Building Heating and Thermostat Set Back Evaluation	Natural Gas	350 Therms	0	$315	$0	$50	0.2	X

(1) Alternative 3 is recommended to achieve the appropriate temperature in the solids building with the same energy consumption as the existing equipment. No energy is saved.

(2) Alternative 4A is necessary to bring the solids building in compliance with the Recommended Standards for Wastewater Facilities but does not save energy or operational dollars.

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

VILLAGE OF CLAYTON, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Annual Sludge Disposal Cost Saved ($/year)	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative 1 – Reduce DO setpoint with existing blowers	Electric	70,000	0	$6,000	NA	0	0	X
Alternative 2A – Reduce DO setpoint and replace 75 HP centrifugal blowers with 50 HP PD blowers and VFDs	Electric	30,000	15	$13,000	NA	$200,000	15.4	X
Alternative 2B – Reduce DO setpoint and replace one 75 HP centrifugal blower with one 50 HP PD blower and VFD	Electric	130,000	15	$13,000	NA	$100,000	7.7	
Alternative 3 – Sludge thickening with gravity belt thickener (GBT)	Diesel*	NA	NA	$3,700	$58,000	$700,000	12.1	X
Alternative 4 – Sludge thickening with rotary drum thickener (RDT)	Diesel*	NA	NA	$3,700	$58,000	$730,000	12.6	
Alternative 5 – Reduce inventory of sludge stored on site	Electric	17,000	0	$1,800	NA	0	0	X

*Related to transportation of biosolids.

PROJECT SUMMARY SHEET
SUBMETERING SAVING IMPROVEMENTS
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

VILLAGE OF HEUVELTON, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved[1] (kW)	Total Annual Dollars Saved	Implementation Cost	Simple Payback (Years)	Recommended Alternative
Alternative 1 – Modify aeration lagoon air piping system to reduce pressure loss	Electric	64,000	0	$6,400	$40,000	6.2[2]	
Alternative 2 - Replace three 40 HP blowers with three 150 HP blowers	Electric	0	0	0	$460,000	N/A	
Alternative 3 – Replace two 40 HP blowers with two 100 HP blowers and modify aeration lagoon air piping system to reduce pressure loss	Electric	153,000[3]	35	$21,000[3]	$420,000	Immediate[4]	X
Alternative 4 – Reduce aeration through implementation of DO monitoring and automated control in aeration lagoon	Electric	170,000	0	$17,000	$30,000	1.8	X
Alternative 5 – Reduce aeration of sludge lagoon	Electric	105,000	0	$10,000	$1,000	0.1	X

(1) “Annual Demand Saved” is calculated with the expectation that peak conditions occur for three months and average conditions occur for nine months.
(2) Projected future aeration requirements could not be met with this alternative.
(3) Based on differential energy use and cost of Alternative 2.
(4) Payback is “immediate” because the implementation cost is $40,000 less than Alternative 2, which is the baseline cost.

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NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

SOUTH & CENTER CHAUTAUQUA LAKE SEWER DISTRICTS
CELERON, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 1: Grit Chamber and Outlet Channel Aeration Reduction	Electric	217,248	25	$9,100	$ 62,000	6.8	X
Alternative No. 2A: Cycling Aeration Operation Time *	Electric	210,800	0	$ 8,000	$ 19,250	2.4	
Alternative No. 2B: Surface Aerator Impeller Replacement	Electric	52,560	144	$ 2,425	$ 70,000	28	
Alternative No. 2C: Surface Aerator Replacement	Electric	67,890	186	$ 3,175	$218,000	68	X
Alternative No. 3: Intermediate Pump Station Pump Replacement	Electric	72,240	560	$ 4,500	$ 87,400	19	X
Alternative No. 4: Cycling Re-Aeration Tank Operation Time	Electric	41,400	0	$ 1,650	$ 6,600	4.0	X
Alternative No. 5: Lakewood Pump Station Upgrade *	Electric	105,100	0	$ 7,500	$ 55,000	7.3	
Illumination Evaluation	Electric	63,530	252	$ 3,170	$ 28,100	8.8	X

* Note: Alternative reported for reference purposes. Improvement has been implemented.

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NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

TOWN OF GRAND ISLAND, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kWh)	Total Annual Energy Dollars Saved	Total Annual Operational Cost Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 1A - Influent Pump Station Pump On-Levels	Electric	NA	NA	NA	$0	NA	NA	
Alternative No. 1B - Flow Storage in Equalization Tanks	Electric	NA	NA	NA	$0	NA	NA	
Alternative. No. 1C - Influent Pump Controller Replacement	Electric	NA	NA	NA	$0	$17,800	NA	
Alternative. No. 1D - Influent Pump Replacement In-Kind (Increased Capacity)	Electric	70,847	0	$5,375	$0	$80,000	14.8	
Alternative. No. 1E - Influent Pump Replacement (Current Capacity)	Electric	67,890	0	$5,550	$0	$33,000	5.9	X
Alternative. No. 2 - Oxygen Generation System Air Compressor Replacement	Electric	219,000	300	$23,550	$0	$30,000	1.3	
Alternative. No. 3A - Surface Aerator Mixer Impeller Replacement	Electric	52,560	72	$5,650	$0	$88,000	15.5	
Alternative. No. 3B - Surface Aerator Mixer Replacement	Electric	65,700	90	$7,100	$0	$250,000	35	X
Alternative. No. 4 - Liquid Oxygen System	Electric	744,600	1,020	$79,950	($55,000)	$34,000	1.4	X
Illumination Evaluation	Electric	36,000	98	$4,490	$0	$12,190	2.7	X

PROJECT SUMMARY SHEET
ENERGY SAVING IMPROVEMENTS
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

VILLAGE OF POTSDAM, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Fuel Saved (Gallons)	Annual Fuel Energy Cost Saved ($/Year)	Annual Disposal Cost[(1)] Saved ($/Year)	Implementation Cost ($)	Simple Payback Period (Years)	Recommended Alternative
Alternative 1 – Sludge thickening with gravity belt thickener (GBT)	Diesel[(2)]	150	$380	$49,000	$ 420,000	8.6	X
Alternative 2 - Sludge thickening with rotary drum thickener (RDT)	Diesel[(2)]	150	$380	$49,000	450,000	9.2	
Alternative 3 – Sludge dewatering with belt filter press (BFP)	Diesel[(2)]	220	$550	$56,000	630,000	11	
Alternative 4 – Sludge dewatering with centrifuge	Diesel[(2)]	220	$550	$58,000	1,000,000	17	

(1) Includes fuel cost.
(2) Related to transportation of biosolids.

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

TOWN OF BETHLEHEM, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 1 - Grit Removal Reduction Summer Interval	Electric	490	0	$50	$0	0.0	
Alternative No. 2 - Grit Removal Interval Adjustment	Electric	711-1460	0	$65-$125	$0	0.0	X
Alternative No. 3 - Aeration Blower Reduction with Existing Equipment	Electric	103,200	150	$9,200	$0	0.0	
Alternative No. 4 - Aeration Blower Replacement with VFD	Electric	236,700	325	$22,400	$75,000	3.3	
Alternative No. 5 - Aeration Blower Replacement with VFD controlled by Dissolved Oxygen Monitoring	Electric	236,700	325	$22,400	$83,000	3.7	X
Alternative No. 6 - Sludge Aeration Mixing Replacement by Submersible Mechanical Mixers	Electric	61,300	85	$6,000	$60,000	10.0	
Alternative No. 7 - Sludge Aeration Mixing Enhanced by Piping Modifications	N/A	0	0	0	$12,000	N/A	X
Alternative No. 8: Oil-Fired Heating	Electric	102,650	250	$9,500	$31,100	3.2	X
Illumination Evaluations and Alternative	Electric	17,550	4	$2,000	$ 4,250	2.1	X

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

ERIE COUNTY SEWER DISTRICT NO. 2 - BIG SISTER CREEK, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Total Annual Operational Dollars Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 1 – Influent Pump DC Electrolyte Drive Controllers with VFDs	Electric	0	0	$0	$ 2,500	$56,000	22.0	
Alternative No. 2 – Influent pumping, ORF Winter Storage Reduction and Clarification Improvements	Electric	48,900	0	$4,750	$34,700	$0	0.0	X
Alternative No. 3A – Grit Chamber Aeration Reduction with VFD	Electric	61,600	84	$3,775	$0	$13,000	3.4	
Alternative No. 3B – Grit Chamber Aeration Reduction with New Blower and VFD	Electric	90,225	123	$8,100	$0	$24,000	3.0	X
Alternative No. 4A – Final Effluent Tank Aeration Reduction with New Blower, VFD and Automated Dissolved Oxygen Monitoring	Electric	5,940	8	$500	$0	$32,000	64	
Alternative No. 4B – Final Effluent Tank Aeration Reduction with New Blower, VFD and Automated Dissolved Oxygen Monitoring with Winter Shutdown	Electric	40,790	60	$3,700	$0	$32,000	8.6	X
Alternative No. 5A – Final Effluent Tank Aeration Reduction with Existing Blower, New VFD, Valve Improvements and Manual Dissolved Oxygen Monitoring	Electric	72,000	98	$4,250	$0	$34,000	8.0	
Alternative No. 5B – Final Effluent Tank Aeration Reduction with Existing Blower, New VFD, Valve Improvements and Manual Dissolved Oxygen Monitoring with Winter Shutdown	Electric	112,100	153	$8,375	$0	$34,000	4.0	
Alternative No. 6A – Aeration Basin Diffuser Repair	Electric	491,510	673	$44,450	$0	$101,700	2.2	X
Alternative No. 6B – Aeration Basin System Replacement	Electric	491,510	673	$44,450	$0	$290,000	6.5	

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

ERIE COUNTY SEWER DISTRICT NO. 2 - BIG SISTER CREEK, NEW YORK

Improvement Alternative	Fuel Type Saved	Annual Energy Saved (kWh)	Annual Demand Saved (kW)	Total Annual Energy Dollars Saved	Total Annual Operational Dollars Saved	Implementation Costs	Simple Payback Period (Years)	Recommended Alternative
Alternative No. 7 – Digester Tank Aeration Reduction with Existing Blower, VFD and Automated Dissolved Oxygen Monitoring	Electric	61,320	84	$5,600	$0	$29,000	5.2	
Alternative No. 8 – Solids Building Air Compressor Replacement	Electric	10,040	265	$6,725	$0	$10,500	1.5	X
Alternative No. 9A – Filter Press Sludge Feed Pump Replacement-Air Diaphragm Pumping	Electric	23,100	0	$5,575	$0	$37,700	6.8	
Alternative No. 9B – Filter Press Sludge Feed Pump Replacement – Progressive Cavity Pumping	Electric	18,945	108	$3,000	$0	$45,500	15.1	
Alternative No. 10 – Sludge Dewatering with Existing Sludge Drying Beds	Electric	72,900	300	$9,600	$63,650	$16,200	0.2	
Alternative No. 11 – Sludge Dewatering with Existing Filter Press and Sludge Dewatering Polymer	Electric	0	0	$0	$86,000	$6,000	0.1	
Alternative No. 12 – (Combination of Alternative No. 10 & 11) Sludge Dewatering with Existing Filter Press and Existing Sludge Drying Beds Utilizing Sludge Dewatering Polymer	Electric	72,900	300	$9,600	$113,750	$20,700	0.2	X
Building Heating and Thermostat Set Back Evaluation	Natural Gas	4,650 Therms	0	$4,100	$0	$500	0.1	X

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
WASTEWATER TREATMENT PLANT

TOWN OF ORANGETOWN, NY

IMPROVEMENT ALTERNATIVE	FUEL TYPE SAVED	ANNUAL ENERGY SAVED (KWH)	ANNUAL DEMAND SAVED (KW)	TOTAL ANNUAL ENERGY DOLLARS SAVED	IMPLEMENTATION COST	SIMPLE PAYBACK PERIOD (YEARS)	RECOMMENDED ALTERNATIVE
Alternative 1 – Replace remaining 1,000-watt lamps in Butler Building	Electric	13,000	3.6	$1,200	$3,000	2.5	X
Alternative 2 - Route 303, flow metering, three new pumps and VFDs	Electric	--	--	1,300 [1]	255,000	196[1]	X
Alternative 3 - Nyack, flow metering, four pumps and VFDs	Electric	--	--	58,000 [2]	544,000	9.4[2]	X
Alternative 4 - Sparkill, flow metering, three new pumps and VFDs	Electric	--	--	5,000 [1]	332,000	66[1]	X
Alternative 5 - Hunt Road, flow metering, four new pumps and VFDs	Electric	--	--	14,000 [1]	1,300,000	93[1]	X
Alternative 6 - Upgrade screening equipment	Electric	65,000	14		$525,000	85	X
Alternative 7 – Pace trickling filter fans with VFDs	Electric	56,000	0	$6,200 $5,300	$90,000	17	
Alternative 8 - Review recirculating pump operation. Implement process controls.	Electric	490,000 [3]	56 [3]	$47,000 [3]	$0 [3]	0[3]	X
Alternative 9 - Demand-based effluent water system	Electric	260,000	50	$26,000	$75,000	2.9	X
Alternative 10 - Replace secondary sludge pumps. Implement VFDs and process control	Electric	65,000	0	$6,100	$178,000	29	
Alternative 11 - Adjust time cycle of primary sludge pumps.	Electric	0	7.5	$9,000	$0	0	X

(1) Twenty percent (20%) increase in efficiency assumed
(2) One hundred percent (100%) increase in efficiency assumed
(3) If recirculation is eliminated entirely.

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
SARATOGA COUNTY SEWER DISTRICT NO. 1

SARATOGA COUNTY, NEW YORK

IMPROVEMENT ALTERNATIVE	FUEL TYPE SAVED	ANNUAL ENERGY SAVED (kWh)	ANNUAL DEMAND SAVED (kW)	TOTAL ANNUAL DOLLARS SAVED	IMPLEMENTATION COSTS	SIMPLE PAYBACK PERIOD (YEARS)	RECOMMENDED ALTERNATIVE
Motor replacement(1)	Electric	95,920 kWh	19 kW	$7,720	$46,460	6.0	X
Participation in Emergency Dispatchable Generating Program	Electric	(2)	(2)	(2)	900	(2)	X
MLE denitrification(3)	Electric	-163,375 kWh	-37.3 kW		1,920,000	Infinity	
CNR denitrification	Electric	147,000 kWh	33.5 kW	11,762	1,260,000	107	
Gravity belt thickening	Electric	228,725 kWh	26.1 kW	18,300	280,000 (4)	15.3	(4)
Standard belt filter press	___(5)	___(5)	___(5)	___(5)	380,000(5)	___(5)	
High solids belt filter press	Electric	-12,000 kWh	-2.2 kW	960	450,000(6)	6.04	X
	Fuel oil	94,500 gallons	N/A	75,365			
High solids Winklepress	Electric	-12,000 kWh	-2.2 kW	-960	650,000(6)	8.75	
	Fuel oil	94,500 gallons	N/A	75,365			
High solids centrifuge	Electric	-362,000 kWh	-70.87 kW	28,960	780,000(6)	16.8	
	Fuel oil	94,500 gallons	N/A	75,365			

(1) Summary of all motor replacements. See Section 5 for breakdowns of savings on an individual motor basis. See Appendix M for calculations.
(2) Plant is paid $45 to $50 per 100 kW per hour when called to operate. Total savings depends on the number of times called to run. Minimum run time is four hours. The plant would recover installation costs after one event.
(3) Results in a net increase in energy use.
(4) Implementation costs shown do not include installation costs. Operators report that the existing flotation thickeners are reliable, perform well, require little operator attention, and have not experienced any major maintenance problems. If the flotation thickeners' performance starts to degrade, gravity belt thickeners should be considered over replacement in kind.
(5) Standard belt filter press is the replacement in kind option and is the basis against which the following three sludge dewatering costs are compared.
(6) Equipment costs only.

PROJECT SUMMARY SHEET
NYSERDA SUBMETERING PROGRAM
METROPOLITAN SYRACUSE WASTEWATER TREATMENT PLANT

ONONDAGA COUNTY, NEW YORK

IMPROVEMENT ALTERNATIVE	FUEL TYPE SAVED	ANNUAL ENERGY SAVED (kWh, MMBtu)	ANNUAL DEMAND SAVED (kW)	TOTAL ANNUAL DOLLARS SAVED	IMPLEMENTATION COSTS	SIMPLE PAYBACK PERIOD (YEARS)	RECOMMENDED ALTERNATIVE
Replace return activated sludge pumps with at least 94.5% efficient motors	Electric	58,516 kWh	6.68	$4,208	$54,000	12.83	
Replace aeration blower motors	Electric	157,131 kWh	34.24	9,889	256,000	25.88	
Replace screw pump motors	Electric	30,077 kWh	6.54	2,165	22,995	10.61	X
Replace belt washwater pump motors	Electric	15,768 kWh	1.8	1,135	10,400	9.16	X
Replace grit blower motors	Electric	16,819 kWh	2	1,210	20,800	17.17	
Replace oxidative liquor pump motors	Electric	8,103 kWh	1.85	583	9,000	15.4	
Replace gas recycle motors	Electric	31,798 kWh	3.63	2,289	22,000	9.6	X
Replace belt wash booster pump motors	Electric	18,658 kWh	2.13	1,342	8,800	6.55	X
Replace odor control compressor motors	Electric	13,227 kWh	1.51	952	8,800	9.24	X
Replace grit pump motors, New Screen and Grit Building	Electric	20,000 kWh	2.2	1,440	9,100	6.5	X
Replace grit pump motors, Existing Screen and Grit Building	Electric	20,000 kWh	2.2	1,440	6,825	4.875	X
Replace gas blower motors	Electric	1,511 kWh	0.3	108	4,400	40.44	
Reduce aeration due to eliminating nitrification in aerator tanks, June to December	Electric	2,300,000 kWh	945	166,000	0	Immediate	X
Restore impeller for LLP-4	Electric	--	N/A	1,400	53,600	N/A	
Replace impeller for LLP-1, 2, and 4	Electric	250,000 kWh	N/A	17,780	137,000	7.7	
Replace LLP-1, 2, 3, 4, and 5	Electric	665,000 kWh	N/A	48,000	1,250,000	26	X(1)
Replace motors; add VFDs to waste activated sludge pumps	Electric	260,000 kWh	30	22,000	96,000	4.4	X
Replace four waste activated sludge pumps with smaller pumps and VFDs	Electric	260,000 kWh	30	22,000	59,000	2.7	
Preheat thickened sludge with digested sludge effluent	Natural gas	5,800 MMBtu	N/A	24,000	480,000	20	

(1) Recommended future capital improvement to replace aging existing equipment.

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NYSERDA Submetering Program Summary Report

Final Report 07-01