



MUNICIPAL WASTEWATER TREATMENT PLANT ENERGY EVALUATION

**SUMMARY REPORT 06-14
MARCH 2006**

**NEW YORK STATE
ENERGY RESEARCH AND
DEVELOPMENT AUTHORITY**





The New York State Energy Research and Development Authority (NYSERDA) is a public benefit corporation created in 1975 by the New York State Legislature. NYSERDA's responsibilities include:

- Conducting a multifaceted energy and environmental research and development program to meet New York State's diverse economic needs.
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- Making energy more affordable for residential and low-income households.
- Helping industries, schools, hospitals, municipalities, not-for-profits, and the residential sector, including low-income residents, implement energy-efficiency measures.
- Providing objective, credible, and useful energy analysis and planning to guide decisions made by major energy stakeholders in the private and public sectors.
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STATE OF NEW YORK
George E. Pataki
Governor

ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
Vincent A. DeIorio, Esq., Chairman
Peter R. Smith, President and Chief Executive Officer

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Prepared for the
**NEW YORK STATE
ENERGY RESEARCH AND
DEVELOPMENT AUTHORITY**

Albany, NY
www.nyserda.org

Kathleen O'Connor
Project Manager

Prepared by

MALCOLM PIRNIE, INC.
Buffalo, NY

Jerry Kleyman, P.E., DEE
Project Manager

Agreement No. 7185

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ABSTRACT

The New York State Energy Research and Development Authority (NYSERDA) sponsored a research program to evaluate submetering at municipal wastewater treatment plants (WWTPs) throughout New York State. The purpose of the program was to obtain detailed electric power use information through submetering various unit processes and equipment and to determine if that information is a cost-effective tool for identifying energy conservation measures. A secondary goal of the program was to identify and evaluate energy cost-savings measures at WWTPs and make the findings available to other facilities in New York State.

NYSERDA selected two project teams to perform submetering evaluations at a total of 19 facilities statewide. A total of eight facilities across the state, varying in sizes from 3.5 MGD to 135 MGD, participated in Malcolm Pirnie / Siemens' part of the submetering program. Submetering at each facility was conducted over a six-to-eight week period, along with a simultaneous process data collection effort for the processes being submetered. The submetering and process data were evaluated to develop an energy usage breakdown by different WWTP processes. Additionally, the data were evaluated to establish benchmarks for energy consumption per MGD of treated wastewater and pound of BOD destroyed.

The data collected were used to identify energy-savings opportunities, including capital and operational modifications, lighting and heating, ventilation, and air conditioning (HVAC) improvements, onsite generation potential, as well as participation in various peak-shaving / peak-load reduction programs. The recommendations aggregated over the eight facilities represent an annual cost savings of approximately \$6.4 million, or 15% of the current total energy costs. The associated energy usage saving is approximately 5,200,000 kilowatt hours (kWh), or 9% of the current total annual energy usage. The payback period ranges from approximately 1 year to 8 years. Based on the outcome of this study, it can be concluded that submetering is an effective tool for identifying energy-savings opportunities at most facilities.

Key words: submetering, energy savings

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The following entities contributed to this report:

Siemens Building Technologies
Albany County Sewer District North Wastewater Treatment Plant
Chemung County Sewer District No. 1 Lake Street Plant
Gloversville-Johnstown Joint Wastewater Treatment Plant
Ithaca Area Wastewater Treatment Facility
Monroe County Department of Environmental Services Frank E. Van Lare Wastewater Treatment Facility
South Fallsburg Wastewater Treatment Plant
Town of Tonawanda Wastewater Treatment Facility
Walkill Wastewater Treatment Facility

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EXECUTIVE SUMMARY

The New York State Energy Research and Development Authority (NYSERDA) sponsored a research program to evaluate submetering at wastewater treatment plants (WWTPs) throughout New York State. The purpose of the program was to obtain detailed electric power usage information through submetering various unit processes and equipment to determine if that information is a cost-effective tool for identifying energy conservation measures. In addition to evaluating the usefulness of submetering, a secondary goal of the program was to identify and evaluate energy cost-savings measures at WWTPs and make the findings available to other facilities in New York State.

Traditionally NYSERDA has provided engineering assistance through FlexTech and Technical Assistance programs, for which detailed information can be found at www.nysesda.org. These programs have been tailored toward supporting customized studies that evaluated energy efficient solutions for site-specific concerns typically based on desktop estimates of energy consumption at these sites. Since 1997, NYSERDA has contributed more than \$1.5 million toward more than 75 such studies across New York State. The submetering study focused on obtaining relatively detailed field data for energy consumption by individual wastewater treatment processes and using that information for developing and evaluating energy saving alternatives.

The goals of the submetering study were:

- To combine real-time WWTP process operating data with submetered energy usage data to identify energy and operating cost-savings opportunities
- To determine if detailed submetering of WWTP processes provides a cost-effective tool for improving plant efficiency
- To disseminate benchmarked process-specific information and energy-savings opportunities to other facilities across New York State

The submetering study was conducted through a Research Team agreement between Malcolm Pirnie and Siemens Building Technologies. Malcolm Pirnie was responsible for process data collection and review, evaluation of energy-savings opportunities through capital or operational modifications, and report preparation, as well as for overall communications between NYSERDA, facility personnel, and Siemens. Siemens was responsible for installing submeters, conducting continuous and instantaneous submetering programs, evaluation of energy-savings opportunities through changes in lighting and heating, ventilation, and air-conditioning (HVAC), in addition to evaluation of on-site generation alternatives.

The submetering program was conducted at eight facilities across New York State that represent a range of flows, state geographic regions, and treatment plant configurations. The facilities that participated in this submetering study are already proactive in identifying and implementing cost-effective energy-saving measures. Despite that, the submetering program was able to identify numerous energy-savings opportunities. Among them are capital improvements and replacement for major process equipment, HVAC and lighting improvements, operational modifications, participation in peak load or demand reduction programs administered by the New York Independent System Operator (NYISO), and use of digester gas for co-generation.

One of the most common recommendations at the eight facilities was installation of more energy-efficient equipment (e.g., premium efficiency motors and variable speed drives), that has the greatest impact on reducing energy usage on equipment that is run constantly for long periods of time. These and other recommendations from the studies, aggregated over the eight facilities, represent an annual cost savings of approximately \$6.4 million, or 15% of the current total energy costs. The associated energy usage savings are approximately 5,200,000 kilowatt hours (kWh), or 9% of the current total annual energy usage. The payback period ranges from approximately one year to eight years. Table ES-1 summarizes the recommendations and associated costs, savings, and payback periods.

Furthermore, the study results and recommendations can be used by other facilities to evaluate if current operations result in typical / benchmarked energy usage for treated wastewater volume, and organic and solids loadings, as well as if current equipment and processes would therefore have the potential to benefit from energy-reducing modifications that were evaluated as part of this study. At the eight facilities submetered, approximately 65% of the energy usage was attributed to wet stream treatment processes, such as wastewater pumping; preliminary treatment, including bar screen and grit removal; secondary treatment, including activated sludge, trickling filter, and rotating biological contactors; advanced treatment; and disinfection. Trends in the submetered data demonstrate that the unit energy usage for treatment decreases as average flows and loadings increase, due to the “economy of scale” for larger facilities operations.

Based on the outcome of the study, it can be concluded that submetering is an effective tool for identifying energy-saving capital improvement measures at most facilities, regardless of facility design capacity. Although many of these evaluations could have been done without actually submetering the processes and equipment, submetering provided more accurate estimates of energy consumption and, therefore, the potential energy savings associated with the recommended improvements. In instances where the initial evaluations were performed prior to this submetering project, submetering and the associated evaluations provided significantly more accurate estimates of the energy savings and financial outcome of the project. Submetering provides the “concrete confirmation” of payback that many facilities want before authorizing projects.

Table ES-1

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Measures, Costs, Savings, and Payback, Recommended from Submetering

Facility	Recommended Measures	Total Project Cost (\$)	Estimated Annual Electric Energy Cost Savings (\$ / yr)	Payback (yr)	Current Annual Electric Energy Cost ⁽¹⁾ (\$ / yr)	Proposed Cost Savings as a Percent of Current Cost (%)	Estimated Annual Electric Energy Usage Savings (kWh / yr)	Current Annual Electric Energy Usage ⁽¹⁾ (kWh / yr)	Proposed Usage Savings as a Percent of Current Usage (%)
Albany North	<ul style="list-style-type: none"> Installation of Premium Efficiency Motors on Select Pumps Installation of Premium Efficiency Motors and Variable Frequency Drives on Plant Water Pumps Enhancements to Energy Control Systems Installation of Variable Frequency Drives on Return Activated Sludge Pumps Reduction of Final Distribution Channel Blower Operating Hours During High Plant Flows Installation of Window Film Modifications to Lighting 	\$463,328	\$62,003	7.5	\$790,281	7.8%	660,011	10,446,539	6.3%
Chemung	<ul style="list-style-type: none"> Installation of Premium Efficiency Motors on Inflow and Trickling Filter Pumps Reduction of Trickling Filter Pumping through Use of Variable Frequency Drives Control of Effluent Aeration Dissolved Oxygen through Use of Variable Frequency Drive Adjusting Effluent Aerator Use Based on Season Modifications to Lighting, Ventilation, and Air Conditioning 	\$95,300	\$30,883	3.1	\$113,828	27%	401,083	1,562,220	26%
Frank E. VanLare	<ul style="list-style-type: none"> Installation of Variable Frequency Drives on Process Water Pumps Conversion of Exit Signs to Light-Emitting Diode Upgrade T-12 Lighting to T-8 Replacement of Mercury Vapor Fixtures with Metal Halides Replacement of Heating, Ventilation, and Air Conditioning Motors 	\$769,100	\$134,493	5.7	\$1,793,563	7.5%	2,204,801	27,350,852	8.1%
Gloversville-Johnstown	<ul style="list-style-type: none"> Replacement of Return Activated Sludge Pumps Replacement of 40-hp Effluent Water Pump Improvements to Lighting Improvements to Heating, Ventilation, and Air Conditioning 	\$241,125	\$29,750	8.1	\$311,237	9.6%	306,072	4,555,760	6.7%
Ithaca	<ul style="list-style-type: none"> Installation of Automatic Controls on Aeration System Blowers Replacement of Heating, Ventilation, and Air Conditioning Controls with Windows-Based Front-End Energy Management System 	\$75,000	\$12,000	6.3	\$212,100	5.7%	168,336	3,484,556	4.8%
South Fallsburg	<ul style="list-style-type: none"> Installation of Controls on Trickling Filter Recycle Pumps Reduction in Operating Hours of Rotating Biological Contactor Blower 	\$9,488	\$10,316	0.9	\$123,812	8.3%	101,137	1,246,050	8.1%
Tonawanda	<ul style="list-style-type: none"> Replacement of Selected Standard Efficiency Motors with Premium Efficiency Motors Replacement of Zimpro Wet Air Oxidation, Decant Thickening, and Vacuum Filtration with High-Speed Centrifuges for Sludge Dewatering 	\$4,829,810	\$154,779	8.0 ⁽²⁾	\$1,003,946	15%	871,121	13,405,921	6.5%
Walkkill	<ul style="list-style-type: none"> Installation of Variable Frequency Drives on Mechanical Aerators Participation in New York Independent System Operator Program 	\$321,203	\$40,281	8.0	\$202,675	20%	495,100	2,495,483	20%
	Total	\$6,804,354	\$474,505	6.0	\$4,551,442	10%	5,207,661	64,547,381	8.1%

Notes:

(1) Current annual electric energy costs and usage based on average of historical data.

(2) Payback of 8.0 years for these recommendations based on electric energy usage savings as well as other savings including labor, chemical, gas, etc.

From the viewpoint of improving facility operations, submetering is a more useful tool for medium and larger sized facilities that have multiple shifts staffed, affording these facilities the flexibility to shift loads that smaller facilities could not implement. However, the true measure of such savings is facility-specific and should consider labor costs as well. A parallel submetering program, conducted by Sterns and Wheler, focused on 11 facilities ranging in capacity from 0.8 MGD to 20 MGD. Additional insight on the effectiveness of submetering in identifying energy-saving measures can be found in the project report available from NYSERDA.

Section 1
INTRODUCTION

1.1 BACKGROUND

Capturing energy data for the purpose of understanding energy usage can be an effective means of identifying potential areas for energy management. Submetering has historically been used by both wastewater and water treatment facilities in a variety of capacities, from load / demand control to process optimization. Current “state of the art” submetering technologies provide real-time data capabilities, integration with facility systems such as the Supervisory Control and Data Acquisition (SCADA) system, and trending of collected data for the purposes of evaluating process control options. The technologies also provide fault and load balancing capabilities that can improve the overall energy efficiency of the facility.

Web-enabled advanced energy monitoring allows facilities to obtain real-time energy usage data via the Internet. This technology may be especially beneficial for smaller facilities or those facilities having remote operations (e.g. pump stations and storage facilities). As further discussed in this report, submetering also can be used for identifying operations modifications, process improvements, energy procurement, equipment sizing, efficiency, and maintenance needs.

Implementing submetering technologies has resulted in many success stories for water and wastewater utilities. For example, the Greater Cincinnati Water Works implemented real-time monitoring in its water distribution system and used the resulting data to effectively reduce its peak energy demand by almost 2,500 kilowatts (kW), resulting in an \$800,000 annual savings (The Evolving Water Utility, 2003). In New York, the Monroe County Department of Environmental Services implemented on-line submetering of its main processes, allowing the plant to make educated real-time decisions on controlling overall plant demand while bringing additional equipment into operation.

One of the objectives of the current submetering project is to determine the effectiveness of submetering at various wastewater treatment facilities (WWTFs) across New York and determine if those results can be used by other similar facilities. The New York State Energy Research and Development Authority (NYSERDA) sponsored a similar submetering program, for which the report was published in 1998. That submetering program involved six municipal wastewater treatment plants (WWTPs). Detailed information on that project is located in the project report, “On-Line Process Monitoring and Electric Submetering at Six Municipal Wastewater Treatment Plants,” Final Report 98-12, July 1998. The conclusion of that report was that combining process audit with electrical submetering data is an appropriate tool for identifying energy conservation opportunities at WWTPs. Process data, equipment performance characteristics, and electrical submetering information provide a good basis for identifying

energy conservation opportunities, quantifying the achievable savings, and predicting the impact of implementation on facility performance. The 1998 study was smaller in scale than the current study, which involves two studies, conducted in parallel, focusing on a total of 19 facilities.

1.2 OVERALL PROJECT DESCRIPTION

This report summarizes the current NYSERDA-sponsored research program to evaluate submetering at WWTPs throughout New York State. The purpose of the program is to obtain detailed electric power usage information through submetering various unit processes and equipment and to determine if that information is a cost-effective tool for identifying energy conservation measures. In addition to evaluating the usefulness of submetering, a secondary goal of the program is to identify and evaluate energy cost savings measures at WWTPs and make the findings available to other facilities in New York State.

Traditionally NYSERDA has provided engineering assistance through FlexTech and Technical Assistance programs. Detailed information can be found at www.nysesda.org. These programs have been tailored toward supporting customized studies that evaluated energy efficient solutions for site-specific concerns typically based on desktop estimates of energy consumption at the sites. Since 1997, NYSERDA has contributed more than \$1.5 million toward more than 75 such studies across New York State. The submetering study focused on obtaining relatively detailed field data for energy consumption by individual wastewater treatment processes, and using that information for developing and evaluating energy saving alternatives.

The goals of the submetering study were:

- To combine real-time WWTP process operating data with submetered energy usage data to identify energy and operating cost-savings opportunities
- To determine if detailed submetering of WWTP processes provides a cost-effective tool for improving plant efficiency
- To disseminate benchmarked process-specific information and energy-savings opportunities to other facilities across New York State

1.3 PROJECT TEAM STRUCTURE

The submetering study was conducted through a Research Team agreement between Malcolm Pirnie and Siemens Building Technologies. Malcolm Pirnie was responsible for process data collection and review,

evaluation of energy-savings opportunities through capital or operational modifications, and report preparation, as well as for overall communications between NYSERDA, facility personnel, and Siemens. Siemens was responsible for installing submeters, conducting continuous and instantaneous submetering programs, evaluating of energy-savings opportunities through changes in lighting and heating, ventilation, and air-conditioning (HVAC), and evaluating on-site generation alternatives.

1.4 PROJECT TASKS AND REPORT STRUCTURE

The following tasks were completed in conducting the study:

- Site Selection
- Individual Facility Evaluations
 - Historical Performance and Energy Data Review
 - Submetering and Process Data Collection
 - Identification of Energy-Savings Opportunities (Capital, Operational, and On-Site Generation)
- Knowledge Transfer

This report summarizes the results of these tasks in the following sections:

Section 2 – Selection of Participating Facilities. This section summarizes the site selection process, the development of the potential candidates list, qualifying criteria, and the final participants.

Section 3 – Data Collection Program. This section summarizes the implementation of the continuous submetering program and instantaneous measurements. A submetering location summary, aggregated over participating facilities, is presented. Also summarized is the process performance data collection effort that was conducted simultaneously with the submetering program. Average flows and organic loading (biochemical oxygen demand [BOD]) data are presented as well.

Section 4 – Benchmarks. This section combines the results of the submetering and process data collection programs into a set of benchmarks across the participating facilities. These benchmarks provide an indication of energy usage normalized by plant flow, and organic (BOD) removal, as well as energy consumption distribution by wastewater processes.

Section 5 – Recommendations, Potential Funding Sources, and Findings. This section briefly summarizes the recommendations for each of the participating facilities and the estimated savings. Potential funding sources available to facilities for implementing the recommendations are discussed. This section concludes with a discussion of the applicability of the recommendations to other facilities in New

York State as well as the effectiveness of submetering as a tool for identifying viable, cost-effective energy-savings opportunities at WWTPs.

Section 2
SELECTION OF PARTICIPATING FACILITIES

2.1 QUALIFYING CRITERIA

Because the submetering study was funded through the System Benefits Charge (SBC) program, a participating facility was required to be a customer of one of six utilities in New York State that support the SBC program:

- Central Hudson Gas and Electric Corporation
- Consolidated Edison Company of New York, Inc.
- New York State Electric and Gas Corporation
- Niagara Mohawk Power Corporation
- Orange and Rockland Utilities, Inc.
- Rochester Gas and Electric Corporation

Additionally, qualifying facilities were also required to contribute a 25% cost-share in the form of cash, in-kind services, or equipment purchasing.

2.2 DEVELOPMENT OF CANDIDATE FACILITIES MATRIX

The selection of representative wastewater treatment plants (WWTPs) is essential for the resulting data to be valid for technology transfer to other facilities. Accordingly, a candidate site matrix was developed, based on information regarding over 600 facilities in the New York State Department of Environmental Conservation (NYSDEC) "Descriptive Data of Municipal WWTPs in New York State" database, December 1999. This database contains WWTP design capacity and treatment process information, as well as location and contact information. The database is maintained and updated by NYSDEC. The December 1999 update was the most recently available database at the time facilities were chosen for participation in the submetering study.

The facilities in the database were characterized by three parameters:

- Design Capacity
- Geographic Location (based on energy service provider)

- Treatment Process

The design capacity of a facility may impact a number of parameters, including economies of scale, process technologies, and operational staffing. Therefore, it was important to ensure that the participating facilities fell into a range of design capacities that were representative of the wider range of facility design capacities in New York. Based on these considerations, the following design capacity ranges were established for the purposes of selecting representative participating facilities:

- Less than or equal to 1 MGD
- Greater than 1 MGD to less than or equal to 5 MGD
- Greater than 5 MGD to less than or equal to 10 MGD
- Greater than 10 MGD to less than or equal to 20 MGD
- Greater than 20 MGD

A preliminary number of facilities within each design capacity range was then identified, based on both the total number of facilities and the aggregate design capacity for the facilities within each design capacity range.

Figure 2-1 presents a count of the number of New York State facilities by design capacity, and Figure 2-2 presents aggregate design capacity of the same facilities by design capacity. Although 60% of the facilities in the database are those with design capacities of less than 0.5 MGD, these facilities account for less than 1% of the total treatment capacity in the state. Additionally, while the facilities with design capacities greater than 20 MGD account for only 5% of the total facilities in the state, those same facilities account for 78% of the total treatment capacity in the state.

Based on the potential for impact, it was decided to focus the study on facilities with design capacities greater than 1 MGD and to identify potential facilities in each of the four remaining design capacity ranges. Facilities in these design capacity ranges represent 28% of the total number of facilities in New York State and 97% of the total treatment capacity in the state, as documented in the December 1999 WWTP Database.

WWTP participants were also selected to represent different types of treatment plant wet- and dry-stream processes. The three process areas considered for creating the candidate site matrix were:

<p>Greater than or Equal to 5.0 MGD and Less than or Equal to 10.0 MGD (Total Count = 32) 4%</p> <p>Greater than 20.0 MGD (Total Count = 33) 5%</p> <p>Greater than or Equal to 1.0 MGD and Less than 5.0 MGD (Total Count = 120) 17%</p> <p>Greater than or Equal to 0.5 MGD and Less than 1.0 MGD (Total Count = 87) 12%</p> <p>Less than 0.5 MGD (Total Count = 433) 60%</p> <p>Greater than 10.0 MGD and Less than or Equal to 20.0 MGD (Total Count = 16) 2%</p>	<p>MALCOLM PIRNIE</p>	<p>NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY ENERGY PERFORMANCE EVALUATION THROUGH SUBMETERING MUNICIPAL WASTEWATER TREATMENT PLANTS</p>	<p>FIGURE 2-1 NUMBER OF NEW YORK STATE TREATMENT FACILITIES BY DESIGN CAPACITY GROUPING as of December 1999</p>
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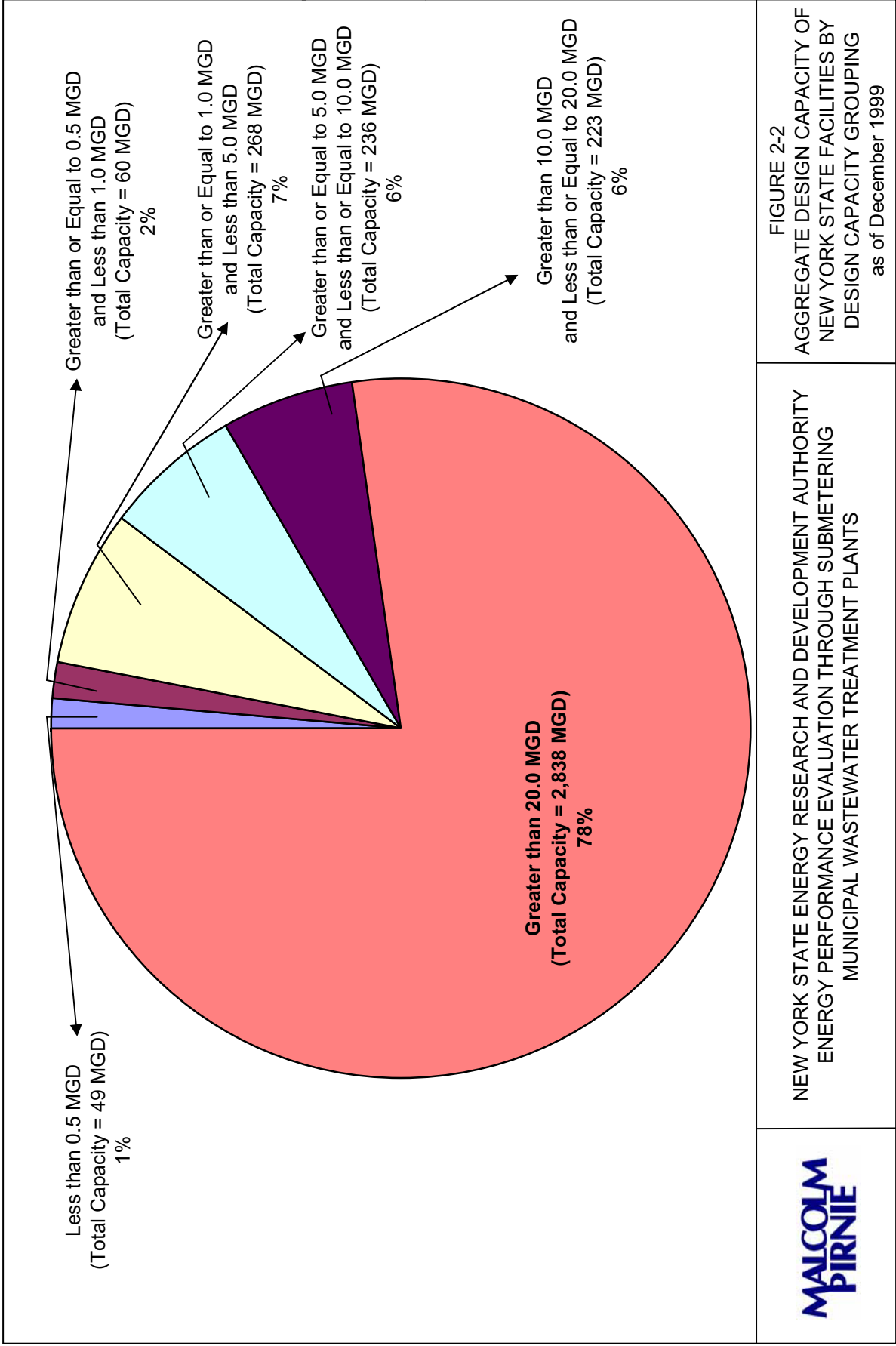


FIGURE 2-2
AGGREGATE DESIGN CAPACITY OF
NEW YORK STATE FACILITIES BY
DESIGN CAPACITY GROUPING
 as of December 1999

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
 ENERGY PERFORMANCE EVALUATION THROUGH SUBMETERING
 MUNICIPAL WASTEWATER TREATMENT PLANTS



- **Secondary Treatment: Suspended Growth versus Fixed Film.** Each type of secondary treatment has a number of variations, each with specific energy requirements. Conventional activated sludge and pure oxygen processes are variations of the suspended growth processes. Major types of fixed film processes include trickling filter and rotating biological contactors. Typically, suspended growth processes have substantially higher energy requirements associated with delivering oxygen into the wastewater as compared to the fixed film processes. At the same time, some fixed film processes, such as trickling filters, may have higher pumping costs associated with lifting wastewater to the top of the filters. Therefore, secondary treatment process types were considered as one of the factors for selecting facilities.
- **Dewatering: Mechanical versus Non-Mechanical.** While larger facilities typically have mechanical sludge dewatering facilities such as presses and centrifuges, sludge dewatering facilities for the smaller plants may include either mechanical dewatering equipment or sludge drying beds. While the sludge drying beds use virtually no energy except for sludge pumping, energy usage for mechanical sludge dewatering equipment could be substantial. Therefore, the configuration of the sludge dewatering facilities was important for selecting facilities with smaller design capacities.
- **Sludge Disposal: Incineration versus Land Application.** Many facilities with larger design capacities in New York State use incinerators for burning sludge, which results in increased energy usage as compared to facilities with similar design capacities that dispose sludge to landfills. Therefore, sludge disposal options utilized by the WWTP facilities were considered for selecting WWTPs with larger design capacities.

2.3 SUMMARY OF PARTICIPATING FACILITIES

Based on the qualifying criteria summarized in Sections 2.1 and 2.2, a number of facilities were identified and contacted to participate in the submetering study. A telephone interview was conducted between the Research Team (Malcolm Pirnie and Siemens Building Technologies) and representatives from each candidate facility interested in participation. The purpose of the telephone interview was to gain insight into the level of interest from facility personnel in participating in the study, identify any potential issues with providing the 25% cost share contribution, establish an overall understanding of the processes at the facility, and decide whether the facility would fit appropriately into the established matrix of qualifying criteria.

Based on the results of the interviews, eight facilities were chosen to participate in the study. These facilities are summarized in Table 2-1. Facilities fell into each of the four design capacity ranges detailed in Section 2.2 (1 MGD to 5 MGD, 5 MGD to 10 MGD, 10 MGD to 20 MGD, and greater than 20 MGD). These eight facilities had the following process characteristics:

- Six facilities used wastewater pumping while two facilities used gravity flow.

Table 2-1

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Matrix of Participating Facilities

Facility	Design Capacity (MGD)	Wastewater Pumping	Secondary Treatment	Dewatering	Disposal	Electric Utility	City
Flow Greater than or Equal to 1.0 MGD and Less than 5.0 MGD							
South Fallsburg Sewer District	3.26	Wastewater Pumping	Trickling Filter / Rotating Biological Contactors	Mechanical and Non-Mechanical	Landfill	New York State Electric and Gas Corporation	Fallsburg
Walkill Sewage Treatment Plant	4	Wastewater Pumping	Oxidation Basin	Mechanical	Landfill	Central Hudson Gas and Electric Corporation	Middletown
Flow Greater than or Equal to 5.0 MGD and Less than or Equal to 10 MGD							
Chemung County Sewer District #1 Sewage Treatment Plant	9.5	Wastewater Pumping	Trickling Filter	Mechanical	Landfill	New York State Electric and Gas Corporation	Elmira
Ithaca Sewage Treatment Plant	10	Wastewater Pumping	Activated Sludge	Mechanical	Landfill	New York State Electric and Gas Corporation	Ithaca
Flow Greater than 10 MGD and Less than or Equal to 20 MGD							
Gloversville-Johnstown Joint Wastewater Treatment Plant	13.1	Gravity Flow	Activated Sludge	Mechanical	Landfill	Niagara Mohawk Power Corporation	Johnstown
Flow Greater than 20 MGD							
Tonawanda Wastewater Treatment Plant	30	Wastewater Pumping	Pure Oxygen Activated Sludge	Mechanical	Incineration	Niagara Mohawk Power Corporation	Tonawanda
Albany North Wastewater Treatment Plant	35	Wastewater Pumping	Activated Sludge	Mechanical	Incineration	Niagara Mohawk Power Corporation	Albany
Frank E. Van Lare Sewage Treatment Plant	135	Gravity Flow ⁽¹⁾	Activated Sludge	Mechanical	Incineration	Rochester Gas and Electric Corporation	Rochester

Note:

(1) Although the Cross Irondequoit Bay Pump Station pumps flow from the eastern portion of the service area to the Frank E. Van Lare Sewage Treatment Plant, the electric energy usage for this pump station is on a separate facility account and therefore is not considered in this evaluation.

- Six facilities had suspended growth while two facilities had fixed film secondary treatment process. These facilities were further subdivided as follows:
 - Suspended growth – four conventional activated sludge, one high purity oxygen activated sludge, one oxidation basin
 - Fixed film – one trickling filter, one rotating biological contactor / trickling filter combination
- Three facilities practiced sludge incineration while five facilities used landfill disposal

Four of the six qualifying power supply utilities were represented, providing a diverse geographic dispersion among the participants. Figure 2-3 presents the locations of the facilities along with their associated power supply companies. These eight facilities represent 6% of the total treatment capacity in New York State.

It should be noted, however, that the final selection of facilities for inclusion in this study was highly affected by the proactiveness and willingness of the facility / community leaders to participate in this research program. Many of the facilities have already implemented a number of energy saving improvements prior to this study. Therefore, although the selected matrix of facilities is representative of different design capacities, geography, and wet and dry stream processes, the study findings in terms of the energy savings may not be completely representative of all facilities in New York.

● Cities

★ Submetered Facilities

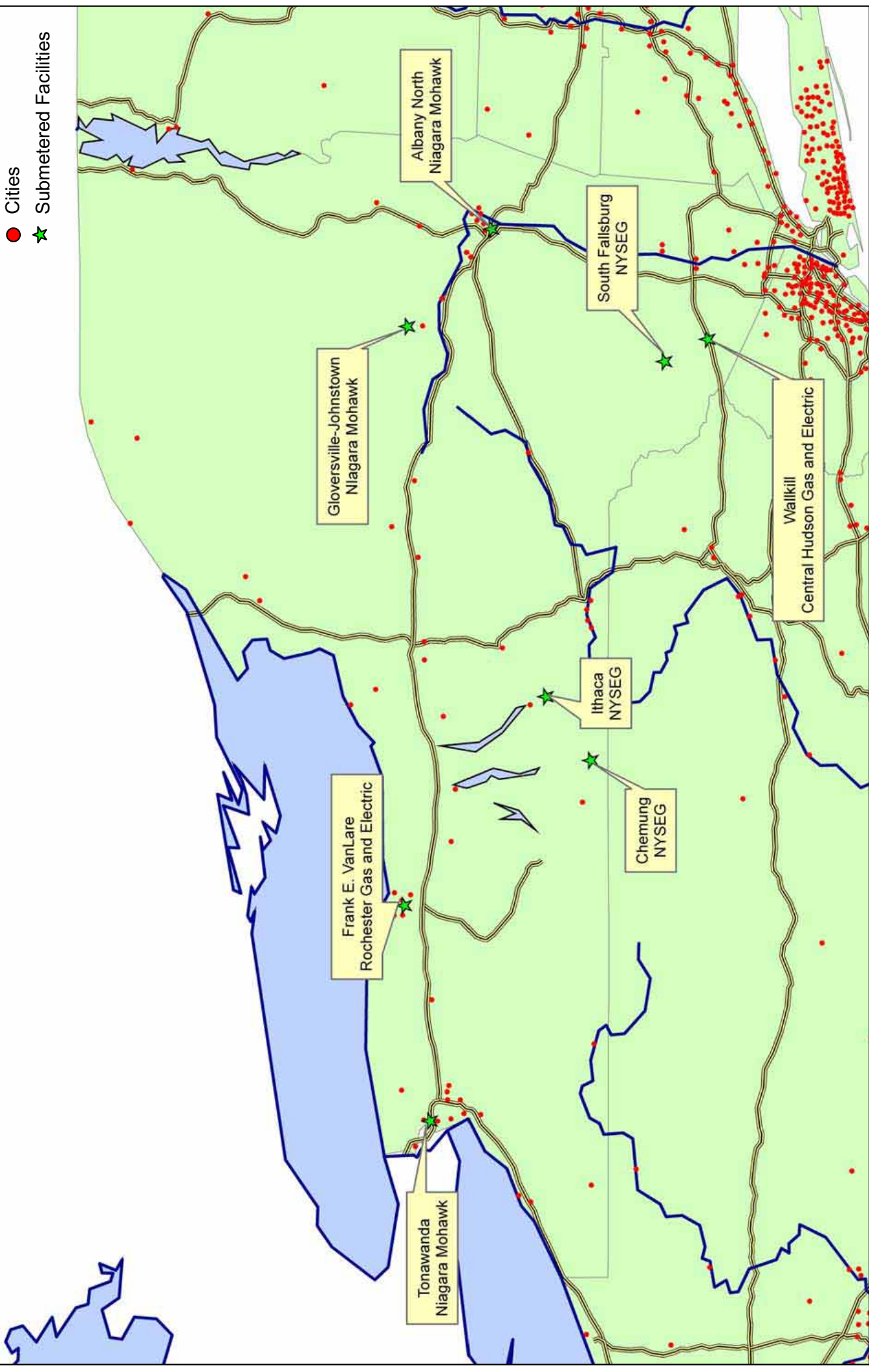


FIGURE 2-3
APPROXIMATE LOCATIONS OF
SUBMETERED FACILITIES WITH
POWER SUPPLY COMPANY
as of November 2005

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
ENERGY PERFORMANCE EVALUATION THROUGH SUBMETERING
MUNICIPAL WASTEWATER TREATMENT PLANTS



Section 3
DATA COLLECTION PROGRAM

The data collection program for the submetering study consisted of three components:

- Historical data review
- Electric and gas energy usage data collection
- Process data collection

3.1 HISTORICAL DATA REVIEW

The historical data review established existing conditions at the facility with respect to influent loading, effluent quality, and operating conditions. The review provided a historical context in which to evaluate the data gathered during the submetering period. The historical data were used to establish a baseline of plant performance and energy usage at each facility, as well as to evaluate changes in energy usage and costs associated with exogenous effects such as changes in influent water quality, seasonal and weekly cycles, and /or energy market changes.

Where applicable, the historical data review included:

- Average, minimum, and maximum daily flow
- Influent, primary effluent, secondary effluent, and final effluent total suspended solids (TSS) and biochemical oxygen demand (BOD₅)
- Activated sludge mixed liquor suspended solids (MLSS) and sludge volume index (SVI)
- Return activated sludge (RAS) flow, TSS, and volatile suspended solids (VSS)
- Solids handling operating records (primary and secondary sludge quantities and solids percentage; thickened, digested, and dewatered sludge quantities and solids percentage; incinerator operation schedule and gas usage)
- Historical energy usage, including available time-of-use monitoring data, two years of utility bills
- Any process changes recently undertaken or contemplated
- Recent energy consumption data for non-electric accounts, including natural gas fuel oil, digester gas, etc.

- Preventative and corrective maintenance records

Historical data were used as a starting point for facility audits, for planning the location of submetering points, and also as a tool for normalizing the data collected during the study. Table 3-1 presents a summary of historical averages, for the main parameters of interest.

3.2 DESCRIPTION OF SUBMETERING DATA COLLECTION PROGRAM

The historical data review gave a sense for overall energy usage and costs at each of the facilities. The next step in the process was to create a list of all the major electric drives (motors) at each facility, identify which motors were potentially the largest energy users that could be made more efficient (either through equipment replacement or operational modifications), and conduct a submetering program to gather energy usage data over a set period, during which process data was also gathered.

The electric energy submetering at each facility was conducted in a series of three steps:

- An energy audit was conducted to finalize submeter locations
- Continuous submetering was conducted over a six-week time period (on average)
- Instantaneous power draw measurements were obtained during site visit(s)

An energy audit was conducted for each facility to finalize locations for submetering. Initially, a list of major motors—typically rated at five horsepower (hp) or greater—was created for each facility, with one exception at the Frank E. VanLare Wastewater Treatment Facility, where the major motor cut-off was increased to 25 hp due to the number of larger motors at the facility. This major motor list, along with information regarding operating schedules, was used during the site visit to finalize locations for continuous metering and instantaneous power draw measurements.

Continuous submetering was conducted through installation of meters with continuous recording electronic data loggers (CREDLs). Due to limitations in the metering equipment as well as safety concerns, the metering locations were limited to a maximum voltage of 480 Volts. Continuous submetering was used to capture diurnal variations in electric demand for major pieces of equipment, to provide a representative sample of energy usage, and to measure electric energy demand as equipment cycled on and off. The following data was recorded at each location:

- Load factor

Table 3-1

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Historical Data

Parameter	Albany North	Chemung	Frank E. VanLare	Gloversville-Johnstown	Ithaca	South Fallsburg	Tonawanda	Wallkill
Average Flow (MGD)	22.9	5.7	96.0	6.7	6.8	2.1	21.4	2.8
Costs								
Billed Annual Usage (kWh)	10,446,539	1,562,220	27,350,852	3,594,400	2,372,400	1,246,050	13,405,921	2,495,483
Co-Generator Production (kWh)	NA	NA	NA	961,360	1,112,156	NA	NA	NA
Annual Usage (kWh)	10,446,539	1,562,220	27,350,852	4,555,760	3,484,556	1,246,050	13,405,921	2,495,483
Rate (\$/kWh)	\$0.0757	\$0.0730	\$0.0650	\$0.0877	\$0.0850	\$0.0995	\$0.0750	\$0.0827
Annual Electricity Costs	\$790,281	\$113,828	\$1,793,563	\$311,237	\$212,100	\$123,812	\$1,003,946	\$202,675
Unit Electricity Usage (kWh/MGD)	1,253	758	782	1,868	1,415	1,634	1,716	2,674
Unit Electricity Cost (\$/MGD)	\$94.47	\$55.29	\$51.33	\$127.55	\$86.02	\$161.56	\$128.79	\$220.09
Annual Usage (therms)	553,163	44,413	1,374,628	86,975	134,263	33,832	653,243	NA
Rate (\$/therms)	\$0.5634	\$0.6900	\$0.6300	\$0.6900	\$0.8850	\$0.8125	\$0.6400	NA
Annual Natural Gas Costs	\$311,856	\$30,778	\$854,271	\$60,177	\$116,160	\$27,542	\$419,959	NA
Unit Natural Gas Usage (therms/MGD)	66	22	39	36	54	44	84	NA
Unit Natural Gas Cost (\$/MGD)	\$37.45	\$15.11	\$24.40	\$24.48	\$47.21	\$35.58	\$53.99	NA
Total Annual Electricity and Natural Gas Energy Costs	\$1,102,137	\$144,605	\$2,647,834	\$371,414	\$328,260	\$151,354	\$1,423,904	\$202,675
Overall Unit Electricity and Natural Gas Energy Cost (\$/MGD)	\$131.92	\$70.40	\$75.73	\$152.02	\$133.23	\$197.14	\$182.78	\$199.09
Wet Stream								
Influent BOD ₅ Concentration (mg/L)	160	85	134	132	186	127	104	140
Influent BOD ₅ Loading (lb/d)	29,361	4,629	101,745	6,982	10,366	2,179	16,918	3,246
Average BOD ₅ Removal (%)	98%	88%	89%	98%	92%	92%	90%	95%
Influent TSS Concentration (mg/L)	239	101	146	189	173	142	99	342
Influent TSS Loading (lb/d)	44,112	5,452	114,208	9,990	9,521	2,414	16,371	7,909
Average TSS Removal (%)	97%	89%	91%	96%	99%	89%	95%	94%
Influent TKN Concentration (mg/L)	23.2	16.9	22.4	NA	NA	25.0	NA	NA
Influent TKN Loading (lb/d)	4,256	928	17,473	NA	NA	44.1	NA	NA
Average TKN Removal (%)	73%	49%	29%	NA	NA	71%	NA	NA
Influent NH ₃ Concentration (mg/L)	NA	17	NA	NA	NA	NA	NA	NA
Influent NH ₃ Loading (lb/d)	NA	928	NA	NA	NA	NA	NA	NA
Average NH ₃ Removal (%)	NA	49%	NA	NA	NA	NA	NA	NA
Solids Handling								
Dewatering Feed Percent Solids (%)	NA	NA	NA	3.0%	NA	2.3%	NA	2.5%
Dewatered Dry Sludge Quantity to Disposal / Landfill (dry tons/yr)	7,757	345	26,046	1,614	2,185	490	4,855	604
Dewatered Cake Percent Solids (%)	22%	NA	30%	22%	22%	21%	NA	15%
Incinerator Natural Gas Usage (therms/yr)	443,085	NA	987,230	NA	NA	NA	NA	NA
Natural Gas Usage per Dry Ton Processed (therms/dry ton)	57	NA	38	NA	NA	NA	135	NA
Heating								
Natural Gas Usage per Facility Footprint (therms / sq. ft)	2.2	0.9	2.1	2.0	2.4	1.4	1.4	NA

- Power factor
- Demand (kW)
- Usage (kWh)

Instantaneous submetering was conducted on pieces of equipment that operated at a constant speed and according to a set schedule. The instantaneous readings and estimated operating hours were used to estimate total energy usage for each piece of submetered equipment. The following data was recorded at each location:

- Volts
- Amperage
- Power factor
- Demand (kW)

Table 3-2 summarizes the major drive motors (five hp or greater for all facilities except Frank E. VanLare WWTF, which lists 25 hp or greater) that were candidate locations for continuous or instantaneous submetering. Based on information regarding the typical energy usage of each process, the operational schedule for the equipment, as well as the location of existing meters, a set of locations was chosen for each facility for both continuous and instantaneous metering. These metering locations are summarized in Table 3-2 as well.

3.3 DESCRIPTION OF PROCESS DATA COLLECTION PROGRAM

Simultaneously with the submetering program, process performance data were collected to obtain information on the flows, loadings, operation, performance, and treatment efficiency for each facility on a process and facility-wide basis. The purpose of collecting process data simultaneously with the submetering data was to identify process parameters along with energy usage of various unit processes at the same time. That information was then used to evaluate if these processes or associated equipment could be improved in terms of energy efficiency. Collecting the process data along with submetering data helped to identify energy-intensive processes and to target potential energy reduction measures.

The process data collected during the submetering program were also compared to the historical data for each facility to determine if operations during the submetering period were typical. In those instances where it was determined that operations during submetering may not have been typical, historical averages were used

Table 3-2

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Submetered Processes

Facility	Total Facility	Wet Stream					Solids Handling					HVAC	Co-Generation		
		Wastewater Pumping	Preliminary Treatment	Primary Treatment	Secondary Treatment	Advanced Treatment	Disinfection	Plant Water Pumping	Solids Pumping and Mixing	Digestion	Thickening			Dewatering	Incineration
Albany North		C	I		I	NA	NM	C/I	I	NA	NA	I	C/I		NA
Chemung	C	C	I		I	NA	NM	I				NA	NA		NA
Frank E. VanLare	E	NA	I		E/I	NA	NM	E/C	E/I	NA	E	E	E	I	NA
Gloversville-Johnstown		NA	I		E/C/I	NA	NM	E/C/I	E/C/I	NA	NA	NA	NA	E/C	NA
Ithaca		C	I		C	NA	NM	I	I	NA	NA	C	NA	I	C/I
South Fallsburg		C/I	NM		C/I	NA	NM	C	C/I	C	NA	NA	NA	I	NA
Tonawanda		C	I	NA	I/E	I	NM	C/I	I	NA	NA	C	C/I	I	NA
Waikill		C	I	NA	C/I	NA	C	I	I	NA	I	NA	NA	NA	NA

Notes:

E = Existing Submeter

C = Continuous Submeter

I = Instantaneous Submeter

NM = Facility does not utilize motor greater than 5 hp for indicated process and therefore, was not submetered at that process

NA = Facility does not utilize process / equipment

Blank Cell = Facility utilizes process but motors were not submetered

in conjunction with submetered and process data to determine benchmarks and to identify energy-savings opportunities.

Typical process parameter data that were collected at the facilities during the submetering period included:

- Influent flow
- Influent, primary effluent, and plant effluent BOD₅ or CBOD₅
- Influent, primary effluent, and plant effluent TSS
- Influent, primary effluent, and final effluent ammonia and / or total kjeldahl nitrogen (TKN)
- Activated sludge process RAS and WAS flow rate and suspended solids
- Secondary treatment process effluent CBOD₅ and dissolved oxygen (DO)
- Primary sludge quantities
- Digester feed sludge quantities and total volatile solids percentage
- Digested sludge quantities and total volatile solids percentage
- Digester gas production
- Plant effluent DO
- Oxygen generation data - flow, oxygen gas purity, and vent gas purity, for high purity oxygen processes
- Plant water flow rate and pressure

Not all the parameters listed were collected at every facility that participated in the study. Rather, the list is exhaustive of parameter data that were collected at one or more of the participating facilities. Typically, data were collected as part of the routine data collection practiced at the facilities as part of compliance activities with the National / State Pollution Discharge Elimination System (N/SPDES) Permit. If additional data were collected for the submetering study, the effort was counted toward the facility's required 25% cost-share requirement.

Section 4 BENCHMARKS

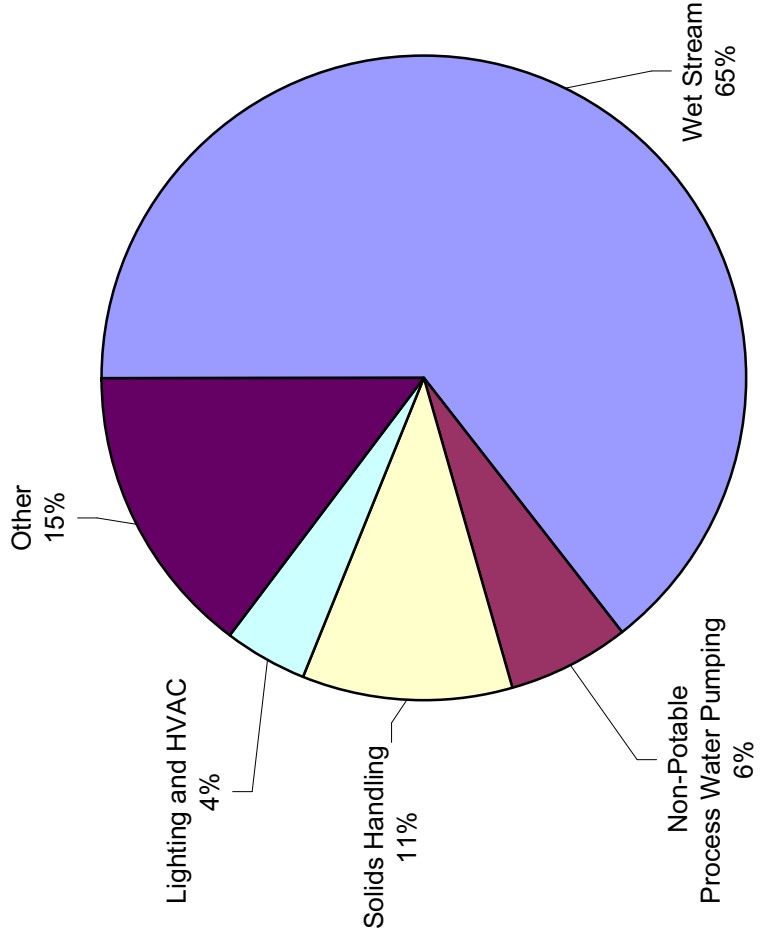
Based on the submetering and process data collected at each of the eight participating facilities, a number of benchmarks were established that relate energy usage to treatment parameters. These benchmarks will allow other New York facilities to determine if energy consumption at their facilities can be considered typical.

4.1 ENERGY USAGE BY PROCESS

The average energy usage by wastewater treatment process was estimated to determine relative distribution of energy consumption at the eight facilities. Figure 4-1 presents the facility-aggregate energy usage percentage by wet stream, solids handling, heating, ventilation, and air conditioning (HVAC) and lighting. Out of all the processes that were submetered, the majority of the energy usage (approximately 65%) was attributable to equipment associated with wet stream treatment. The percentage of energy usage by wet stream processes ranged from approximately 55% to 86% for the eight facilities. The major equipment included in the wet stream processes were:

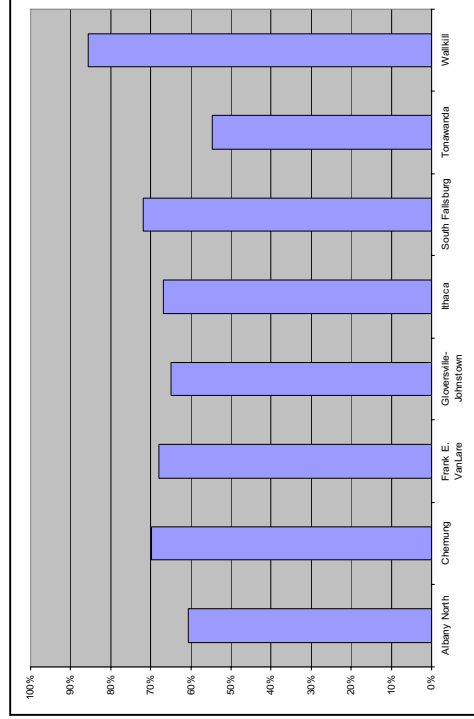
- Wastewater pumping – influent and intermediate wastewater pumps
- Preliminary treatment – mechanical bar screens and aerated grit removal screw conveyors, collectors, blowers, and pumps
- Secondary treatment – conventional activated sludge compressors and blowers, mechanical aerators, high purity oxygen activated sludge cryogenic oxygen generation air compressors and mixers, return activated sludge pumps, trickling filter pumps, and rotating biological contactor drive motors and blowers
- Advanced treatment – filter backwash pumps and air scour blowers, as well as post-aeration mixers
- Disinfection – ultraviolet (UV) light disinfection system

By comparison, solids handling accounted for an average of 11% (ranged 1% to 15%) of energy usage, non-potable process water pumping accounted for an average of 6% (ranged up to 14%) of energy usage, and lighting and HVAC accounted for an average of 4% (ranged up to 21%) of energy usage. The remaining 15% (ranged 3% to 24%), approximately, can be attributed to equipment with motors that are less than five horsepower (hp), which was not metered during this project.



Note: The total percentage represented by the categories presented does not equal 100% due to rounding and the number of decimal points presented in the legend. The actual total is 100%.

Distribution of Wet Stream Energy Usage Percentage by Facility:



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 MUNICIPAL WASTEWATER TREATMENT PLANTS

FIGURE 4-1
 ENERGY USAGE DISTRIBUTION BY
 TREATMENT PROCESS TRAIN
 (Based on Submetered Data)
 as of November 2005

Figure 4-2 shows that in a breakdown of wet stream electric energy usage by treatment process, secondary treatment accounts for 83% of the wet stream electric energy usage. Figure 4-3 shows that in a similar breakdown of solids handling, solids pumping and mixing (41%) and disposal / incineration (34%) are the processes that account for the highest solids handling electric energy usage. It should be noted that the percentages are based on submetered data and that some processes, such as primary treatment and digestion, were not submetered as these processes did not have large motors (greater than five hp).

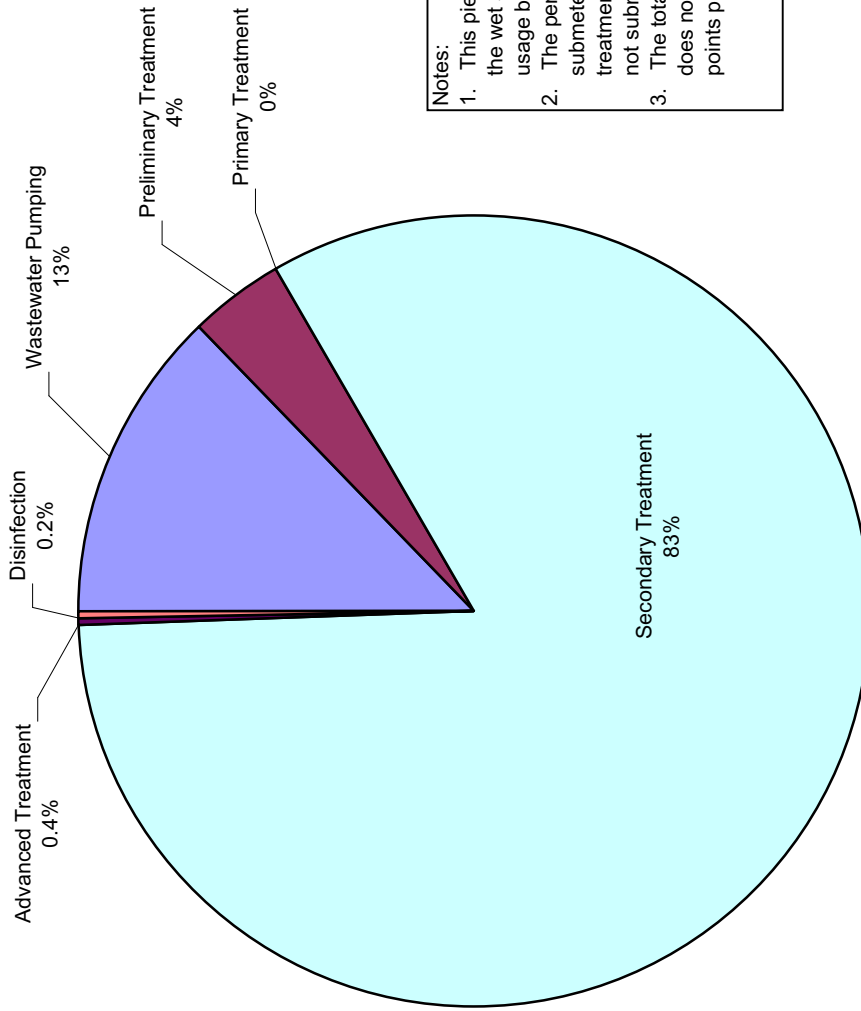
4.2 ENERGY USAGE BENCHMARKS

Using the submetered and process data, a set of benchmarks was estimated to determine typical operating conditions that could be used by other facilities as indicators of how processes at those facilities compare. These benchmarks include:

- Wet stream energy usage per million gallons of treated volume
- Wet stream energy usage per pound of biochemical oxygen demand (BOD₅) removed versus average BOD₅ loading
- Solids handling energy usage per pound of total suspended solids (TSS) removed

Figure 4-4 presents submetered wet stream energy usage per million gallons of total treated volume versus average flow during the submetering period. The facilities have been differentiated in terms of those with wastewater pumping (Albany North, Chemung, Ithaca, South Fallsburg, Tonawanda, and Wallkill) versus those wastewater facilities with gravity flow through the entire plant (Frank E. VanLare and Gloversville-Johnstown) to establish trends for energy usage in terms of total treated volume, with and without wastewater pumping. However, it is difficult to discern a trend between facilities with gravity flow versus wastewater pumping as only two of the facilities had gravity flow. As expected, this figure does reflect the “economy of scale” in unit energy usage. That is, as plant average flow increases, the energy usage per volume of wastewater treated decreases.

Figure 4-5 presents submetered wet stream energy usage per pound of BOD₅ removed versus average BOD₅ loading during the submetering period. The facilities have been differentiated in terms of those with fixed film secondary treatment (Chemung and South Fallsburg) versus those with suspended growth secondary treatment (Albany North, Frank E. VanLare, Gloversville-Johnstown, Ithaca, Tonawanda, and Wallkill) to establish trends in energy usage for each type of secondary treatment process. It is difficult to discern a trend in energy consumption between the fixed film and attached growth secondary treatment processes. While facilities with the fixed film processes are generally expected to use less energy, the



Notes:

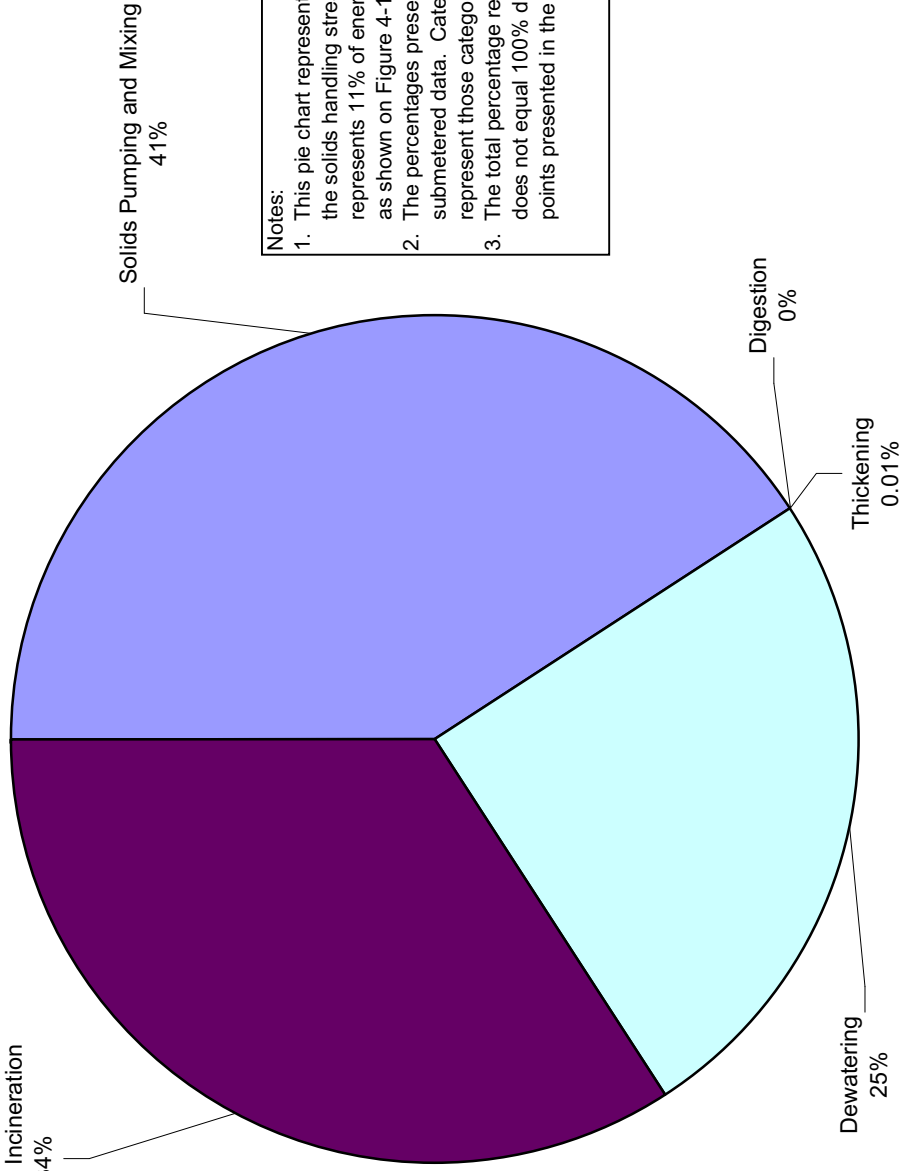
1. This pie chart represents the distribution of energy usage within the wet stream only. The wet stream represents 65% of energy usage by the treatment process train as shown on Figure 4-1.
2. The percentages presented for each category are based on submetered data. Categories listed as 0% (i.e. primary treatment) represent those categories that were not submetered.
3. The total percentage represented by the categories presented does not equal 100% due to rounding and the number of decimal points presented in the legend. The actual total is 100%.



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FIGURE 4-2
ENERGY USAGE DISTRIBUTION
WITHIN WET STREAM
 (Based on Submetered Data)
 as of November 2005

Disposal / Incineration
34%



Solids Pumping and Mixing
41%

Digestion
0%

Thickening
0.01%

Dewatering
25%

Notes:

1. This pie chart represents the distribution of energy usage within the solids handling stream only. The solids handling stream represents 11% of energy usage by the treatment process train as shown on Figure 4-1.
2. The percentages presented for each category are based on submetered data. Categories listed as 0% (i.e. digestion) represent those categories that were not submetered.
3. The total percentage represented by the categories presented does not equal 100% due to rounding and the number of decimal points presented in the legend. The actual total is 100%.



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FIGURE 4-3
ENERGY USAGE DISTRIBUTION
WITHIN SOLIDS HANDLING STREAM
(Based on Submetered Data)
as of November 2005

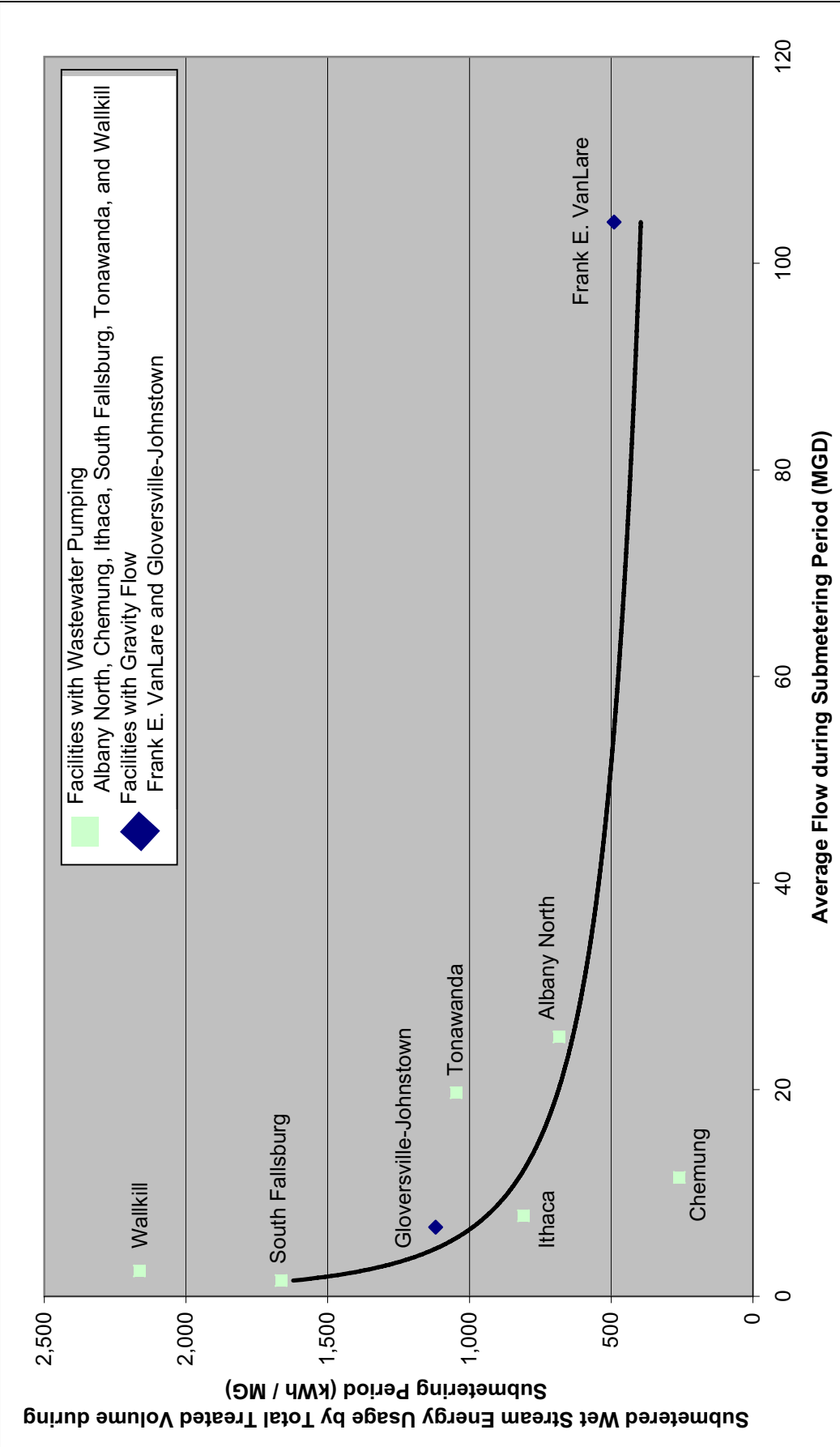


FIGURE 4-4
WET STREAM ENERGY USAGE BY TREATED VOLUME VERSUS AVERAGE FLOW
 (Based on Data Gathered during Submetering Period) as of November 2005

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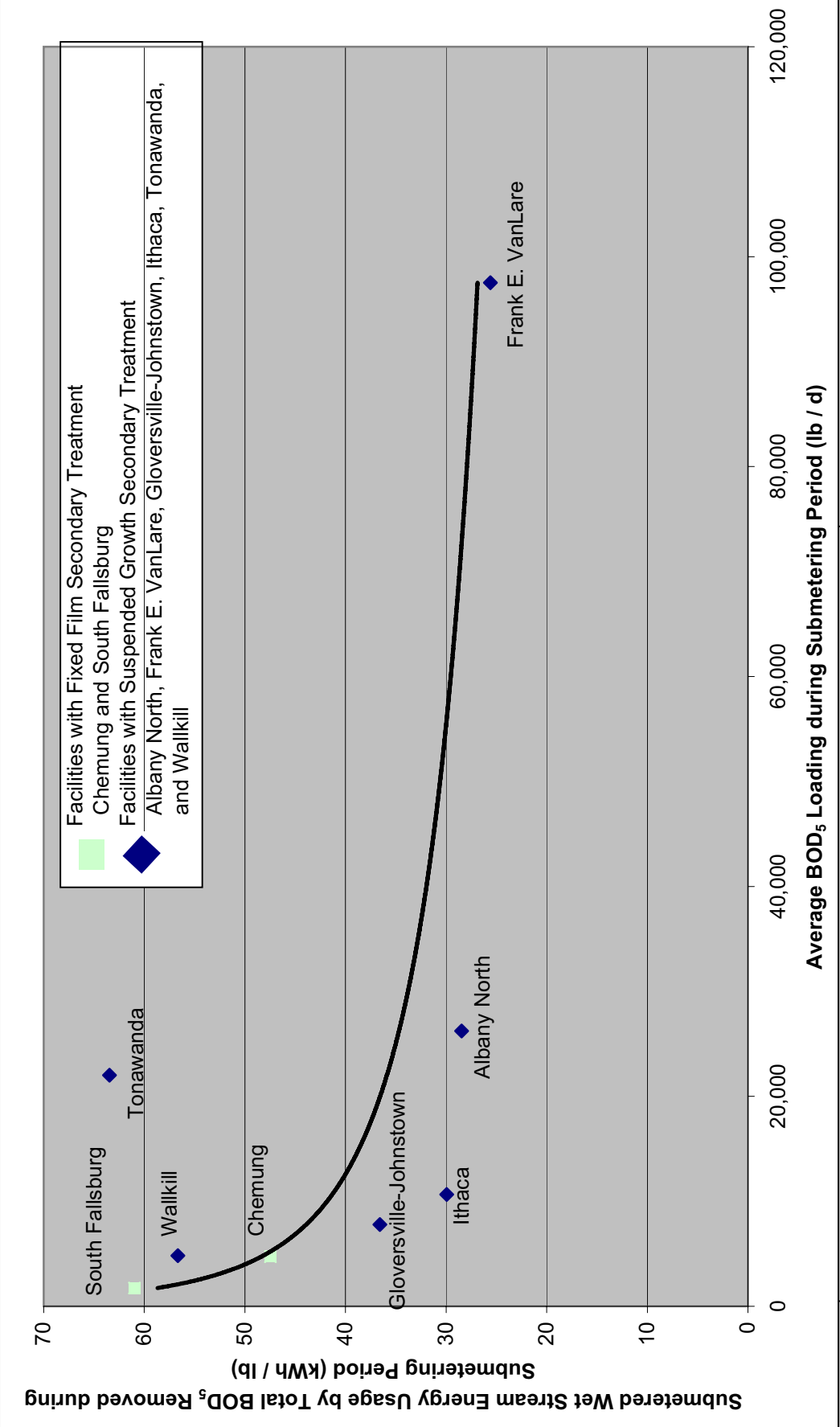


FIGURE 4-5
WET STREAM ENERGY USAGE BY BOD₅ REMOVED VERSUS AVERAGE BOD₅ LOADING
 (Based on Data Gathered during Submetering Period) as of November 2005

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benchmark results do not demonstrate this, most likely due to local facility conditions. For example, although Chemung uses fixed film for secondary treatment and therefore a lower energy usage would be expected, the influent to Chemung is dilute / weak (i.e. has low BOD₅ loading) due to infiltration and inflow in its collection system that results in higher energy usage per pound of BOD₅ removed. Figure 4-5 demonstrates that as the average plant BOD₅ loading decreases, energy usage per pound of BOD₅ removed increases. South Fallsburg also uses fixed film and so would also be expected to consume less energy for BOD₅ removal, but actually has significant energy usage for wastewater pumping due to the plant's layout.

Figure 4-6 presents submetered solids handling energy usage per pound of TSS removed versus average TSS loading during the submetering period. The facilities have been differentiated in terms of those with incineration (Albany North, Frank E. VanLare, and Tonawanda) versus those that landfill (Chemung, Gloversville-Johnstown, Ithaca, South Fallsburg, and Wallkill) to establish trends in energy consumption for those facilities with incineration and those facilities that landfill. While the facilities with incineration are generally expected to use more energy for solids handling, they also, typically, have higher solids quantities. Similar to other benchmarks, it appears that the "economy of scale" governs the unit energy usage, i.e. energy usage per pound of TSS removed decreases as TSS loading increases.

These benchmarks all demonstrate that as flows and loadings increase, unit energy usage for treatment decreases. Essentially, based on this limited dataset, it appears that the size of the facility (design capacity and average flows) is more critical in its energy consumption due to the inherent economies of scale in wastewater treatment at larger facilities.

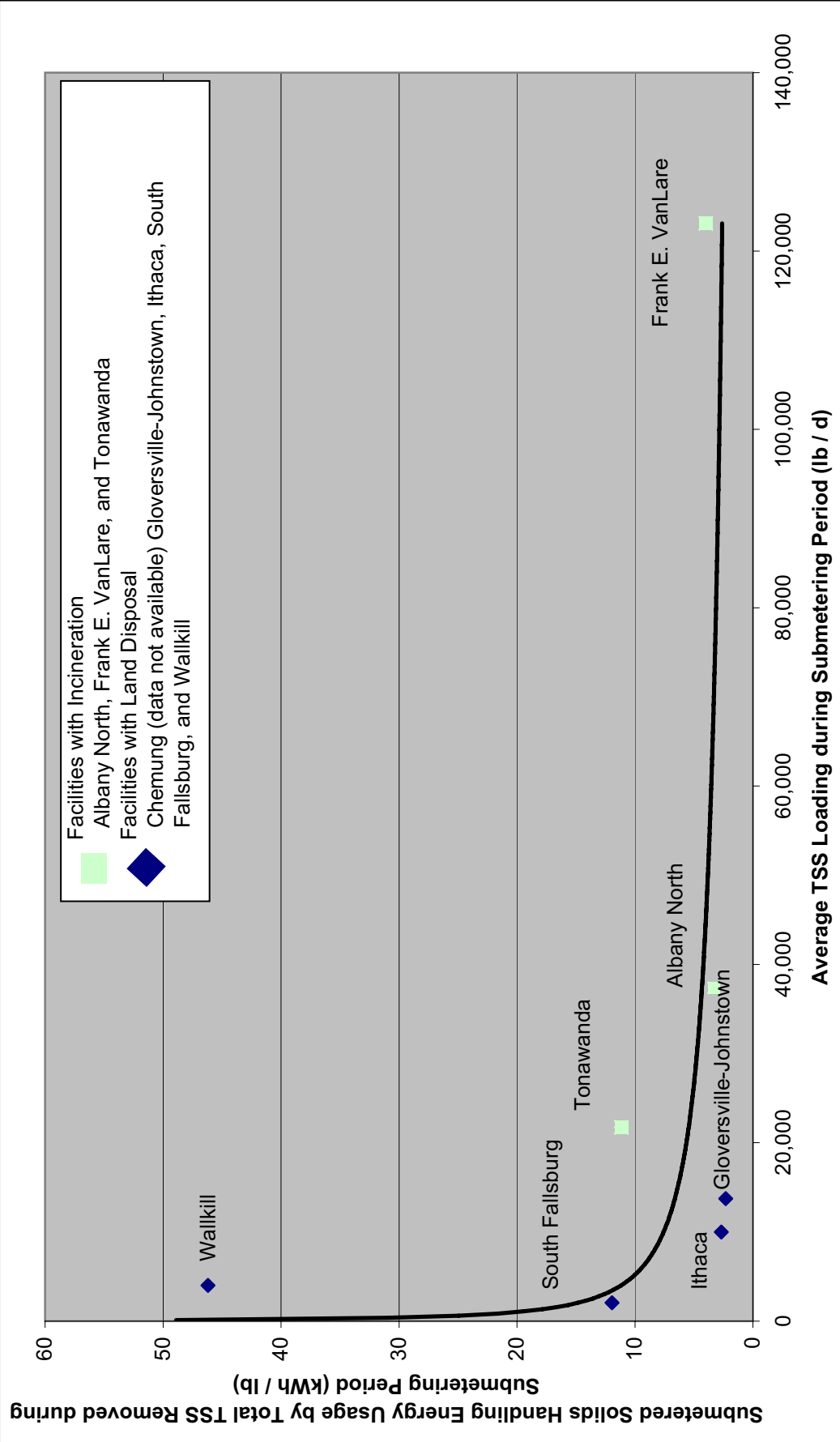


FIGURE 4-6
 SOLIDS HANDLING ENERGY USAGE BY TSS REMOVED
 VERSUS AVERAGE TSS LOADING
 (Based on Data Gathered during Submetering Period)
 as of November 2005

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 ENERGY PERFORMANCE EVALUATION THROUGH SUBMETERING
 MUNICIPAL WASTEWATER TREATMENT PLANTS



Section 5

RECOMMENDATIONS, POTENTIAL FUNDING SOURCES, AND FINDINGS

This section summarizes the recommendations made for each of the facilities as well as the estimated savings associated with those recommendations. Potential funding sources available to the facilities to implement the recommendations are presented, and the applicability of the recommendations to other facilities, as well as the effectiveness of using submetering as a tool to identify energy-savings opportunities at wastewater treatment plants (WWTPs) are also discussed.

Although many of these evaluations could have been done without actually submetering the processes and equipment, submetering provided more accurate estimates of energy consumption and, therefore, the potential energy savings associated with the recommended improvements. In instances where the initial evaluations were performed prior to this submetering project, submetering and the associated evaluations provided significantly more accurate estimates of the energy savings and financial outcome of the project. Submetering provides the “concrete confirmation” of payback that many facilities want before authorizing projects.

5.1 RECOMMENDATIONS

Prior to evaluating energy saving measures for submetered facilities and assessing the effectiveness of this study, it is important to establish the baseline conditions of energy efficiency of each facility’s operations. Most of the facilities that participated in the submetering study have been historically proactive in implementing energy-saving measures. Table 5-1 summarizes past measures implemented at the facilities based on the results of previously completed energy audits. Note that these audits did not include submetering of facility equipment and processes.

The submetering study was able to identify a number of additional energy-saving measures that could be implemented at the facilities, based on the process and energy usage data that was collected at each of the facilities. The collected data was used to evaluate a number of energy-reduction measures, and to develop economically-feasible recommendations for each facility.

Typical energy-reducing measures evaluated for each facility, dependent on the type of equipment and processes at each facility, included:

- Capital improvements and replacement for major process equipment, such as replacing oversized pumps to match demand, upgrading older pumps, replacing standard efficiency motors with premium efficiency motors, installing variable

Table 5-1

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Energy-Saving Measures Implemented Prior to Submetering

Facility	Energy-Saving Measures Implemented	Year
Albany North	*Retrofitted fine-bubble aeration system into each of three aeration basins	1995
	*Replacement of three influent pumps to include VFDs, pump control, SCADA system, and overhead crane modifications, and air conditioning for the MCCs	2000
	*Replacement of existing motors with premium efficiency motors and addition of VFDs on three plant water pumps, three plant air compressors, two incinerator induced draft fans, and two incinerator drives	2003
Chemung	*Replacement of incandescent lighting with fluorescent / metal halide *Installation of energy saving ballasts and lamps	1990
Frank E. VanLare	*Replacement of existing recirculation pump drive systems with slow speed premium efficiency motors driven by VFDs	2000
Gloversville- Johnstown	*Upgrade of aeration facility with ceramic fine bubble diffusers and single stage compressor with automatic DO controls *Installation of new blowers	2002
	*Conversion of the secondary anaerobic digester cover to fixed cover *Installation of new gas meters *Addition of a separate gas holding tank	2004
	*Installation of a fifth influent pump	2001
Ithaca	*Installation of VFDs on three influent pumps, three primary sludge pumps, one heat exchanger pump, two waste sludge pumps, three belt press feed pumps, and one belt press pump	
	*Replacement of primary settling tank chains and flights with plastic and fiberglass	
South Fallsburg	*Installation of high efficiency motors on RBC motors and VFD on intermediate pump motor, and replacement of 30-hp blowers	1993
Tonawanda	*Retrofit of filters with monomedia	1999
Walkill	*Installation of a control system on the RAS pumps to improve blanket control, MLSS control, and attain more consistent sludge wasting rates	2004

speed drives, and improving aeration through use of automated dissolved oxygen (DO) monitoring and aeration equipment control

- Heating, ventilation, and air conditioning (HVAC) and lighting improvements, including installing high efficiency light fixtures, and installing new HVAC units
- Operational modifications, such as load shifting or peak shaving, that would reduce or change equipment run-times to meet variations in loads (e.g. diurnal or seasonal) and reduce dependence on the grid during peak demand
- Participation in peak load or demand reduction programs administered by the New York Independent System Operator (NYISO)
- Use of digester gas for co-generation

One of the most common energy-saving opportunities over the eight facilities is installation of more energy efficient equipment. The installation of premium efficiency motors and variable speed drives results in the largest impact in reducing energy usage on equipment that is run constantly or for long periods of time. Modifications to existing inefficient lighting were also considered at a number of facilities. Table 5-2 summarizes the energy-saving opportunities identified and evaluated for each participating facility under this study. These energy-saving opportunities were further evaluated based on their additional benefits (e.g., process performance improvements, operation and maintenance optimization), as well as the economic merit (i.e., payback period). In general, unless additional process benefits were identified for each measure, an acceptable payback period up to approximately eight years to ten years was used to recommend or not recommend a measure. Based on discussions with municipalities, this payback period appears to be acceptable in most cases, although the situation varies by facility as well as by available and expected funding and budget during the decision making process.

Table 5-3 summarizes the recommendations for each facility, along with the associated implementation costs, annual savings, payback, and estimates of cost and energy savings as a percentage of current annual energy costs and usage. Further detail on the development of the recommendations is provided in the individual facility reports. The recommendations aggregated over the eight facilities represent an annual energy cost savings of approximately \$6.4 million, or 15% of the current total annual energy costs at these facilities. The associated energy usage saving is approximately 5,700,000 kilowatt-hours (kWh), or 9% of the current total annual energy usage. The payback period for the recommended opportunities ranges from approximately one year to eight years.

5.2 POTENTIAL FUNDING SOURCES

A number of funding mechanisms were reviewed to provide facilities with potential sources to implement the recommendations. These funding sources include:

Table 5-2a

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Albany North

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Fuel Energy Saved (mmBtu / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors at Select Pumps	NA	Electric	88,347	NA	\$7,510	\$109,975	15
Installation of Premium Efficiency Motors and Variable Frequency Drives on Plant Water Pumps	Match plant water pressure to other process needs	Electric	376,596	NA	\$32,011	\$96,250	3.0
Enhancements to Furnace Controls	Increase control of furnace operations	Natural Gas	NA	1,005	\$5,900	\$88,400	15
Improvements to Induced Draft Fan	NA	Electric	23,526	NA	\$2,000	\$38,200	19
Installation of Centrifuges	Increase dewatered sludge solids percentage	Electric / Natural Gas	-422,006	13,293	\$37,726	\$4,000,000	106
Installation of Dissolved Oxygen Controls on Aeration Compressors	NA	Electric	18,473	NA	\$1,570	\$71,947	46
Installation of Variable Frequency Drives on Return Activated Sludge Pumps	Match return activated sludge flows to influent wastewater flows	Electric	81,818	NA	\$6,955	\$101,753	15
Reduction of Final Distribution Channel Blower Operating Hours During High Plant Flows	NA	Electric	6,195	NA	\$527	\$0	NA
Installation of Window Film	NA	Electric / Natural Gas	11,765	--	\$1,000	\$14,000	14
Modifications to Lighting	NA	Electric	71,765	--	\$6,100	\$14,750	2.4
Implementation of Peak Shaving Using Existing Generators	Exercise generators for economic incentive	Electric	28,710	--	\$12,000	\$8,047	0.7
Implementation of On-Site Generation	NA	Electric	2,505,882	--	\$213,000	\$6,400,000	30

Notes:

- (1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas
mmBtu = 1,000,000 Btu
Electric = 11,600 Btu / kWh
1 therm = 0.1 mmBtu
1 Dth = 1mmBtu
1 cf Natural Gas = 1,050 Btu
- (2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2b

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Chemung

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors on Influent and Trickling Filter Pumps	NA	Electric	51,324	\$3,952	\$30,200	7.6
Reduction of Trickling Filter Pumping through Use of Variable Frequency Drives	Vary pumping rates as needed	Electric	182,577	\$14,059	\$35,500	2.5
Control of Effluent Aeration Dissolved Oxygen through Use of Variable Frequency Drive	Increase process monitoring and control flexibility	Electric	113,177	\$8,715	\$14,600	1.7
Replacement of Effluent Aeration with Fine Bubble Diffusers	Increase oxygen transfer efficiency	Electric	72,708	\$5,599	\$56,100	10
Adjustment of Effluent Aerators Use Based on Season	NA	Electric	77,800	\$5,991	\$0	NA
Modifications to Lighting	NA	Electric	30,928	\$2,381	\$10,800	4.5
Modifications to Heating, Ventilation, and Air Conditioning	NA	Electric	11,013	\$948	\$5,500	6.5
Implementation of On-Site Generation	NA	Electric	262,800	\$20,236	\$249,150	12

Notes:

(1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas

mmbtu = 1,000,000 Btu

Electric = 11,600 Btu / kWh

1 therm = 0.1 mmbtu

1 Dth = 1mmbtu

1 cf Natural Gas = 1,050 Btu

(2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2c

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Frank E. VanLare

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors on Process Water Pumps	NA	Electric	26,166	\$1,596	\$37,000	23
Installation of Variable Frequency Drives on Process Water Pumps	Vary pumping rates as needed	Electric	108,080	\$6,593	\$74,100	11
Installation of Sludge Holding Tank Flat Covers	NA	Electric	56,026	\$3,418	\$123,340	36
Installation of Thickener Tank Flat Covers	NA	Electric	293,373	\$17,896	\$328,900	18
Installation of Premium Efficiency Motors on Primary Sludge Pumps	NA	Electric	12,627	\$770	\$78,420	102
Installation of New Wet End Primary Sludge Pumps	NA	Electric	28,690	\$1,750	\$862,100	493
Conversion of Exit Signs to Light-Emitting Diode	NA	Electric	163,934	\$10,000	\$12,650	1.3
Upgrade T-12 Lighting to T-8	NA	Electric	1,147,541	\$70,000	\$350,000	5.0
Replacement of Mercury Vapor with Metal Halide Fixtures	NA	Electric	655,738	\$40,000	\$287,350	7.2
Replacement of 120-ton DX Chiller	NA	Electric	196,721	\$12,000	\$120,000	10
Replacement of Two Hot Water Boilers	NA	Electric	673,771	\$41,100	\$575,000	14
Replacement of Heating, Ventilation, and Air-Conditioning Electric Motors	NA	Electric	129,508	\$7,900	\$45,000	5.7

Notes:

- (1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas
mmBtu = 1,000,000 Btu
Electric = 11,600 Btu / kWh
1 therm = 0.1 mmBtu
1 Dth = 1mmBtu
1 cf Natural Gas = 1,050 Btu
- (2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2d

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Gloversville-Johnstown

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors	NA	Electric	8,831	\$858	\$65,625	7.6
Replacement of Return Activated Sludge Pumps	NA	Electric	253,044	\$24,596	\$199,200	8.1
Replacement of 40-hp Effluent Water Pump	Match plant water pressure to other process needs	Electric	39,849	\$3,873	\$37,500	9.7
Replacement of Waste Activated Sludge Pumps	NA	Electric	38,036	\$3,697	\$75,900	21
Improvements to Lighting and Heating, Ventilation, and Air Conditioning	NA	Electric	13,179	\$1,281	\$4,425	3.5

Notes:

(1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas

mmbtu = 1,000,000 Btu

Electric = 11,600 Btu / kWh

1 therm = 0.1 mmbtu

1 Dth = 1mmbtu

1 cf Natural Gas = 1,050 Btu

(2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2e

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Ithaca

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Installation of Automatic Controls on Aeration System Blowers	Improve process control	Electric	157,680	\$14,700	\$14,400	1.0
Conversion of Ferrous Chloride to Ferric Chloride for Use in Phosphorus Removal in Aeration Basins	NA	Electric	NA	NA	NA	NA
Modifications to On-Site Generation Facilities						
Alternative 1 - Installation of Gas Storage Facilities and New Controls with Continued Operation of Existing Co-Generation Units	NA	Electric	210,240	\$29,114	\$173,500	6.0
Modifications to On-Site Generation Facilities						
Alternative 3 - Installation of Gas Storage Facilities and New Controls with In-Kind Replacement of Existing Co-Generation Units with High Efficiency Reciprocating Engines	NA	Electric	525,600	\$78,006	\$351,000	4.5
Replacement of Heating, Ventilation, and Air Conditioning Controls with Energy Management System and Windows-Based Front End	NA	Electric	168,336	\$12,000	\$75,000	6.3
Improvements to Lighting	NA	Electric	108,000	\$9,300	\$81,000	8.7

Notes:

- (1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas
mmBtu = 1,000,000 Btu
Electric = 11,600 Btu / kWh
1 therm = 0.1 mmBtu
1 Dth = 1mmBtu
1 cf Natural Gas = 1,050 Btu
- (2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2f

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
South Fallsburg

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors	NA	Electric	31,608	\$3,224	\$23,427	7.3
Installation of Hood over Belt Filter Press	Odor Control	Electric	8,698	\$887	\$15,417	17
Installation of Controls on Tricking Filter Recycle Pumps	NA	Electric	35,437	\$3,615	\$11,859	3.3
Reduction in Operating Hours of Rotating Biological Contactor Blower	NA	Electric	65,700	\$6,701	\$0	NA
Addition of Chemical to Belt Filter Press Sludge	Odor Control	Electric	10,848	\$1,106	\$11,400/yr	NA
Improvements to Lighting and Heating, Ventilation, and Air Conditioning	NA	Electric	24,767	\$2,073	\$19,100	9.2

Notes:

- (1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas
mmBtu = 1,000,000 Btu
Electric = 11,600 Btu / kWh
1 therm = 0.1 mmBtu
1 Dth = 1mmBtu
1 cf Natural Gas = 1,050 Btu

- (2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2g

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Town of Tonawanda

Evaluated Measure	Non-Energy Related Benefits	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Replacement of All Standard Efficiency Motors with Premium Efficiency Motors	NA	Electric	70,972	\$5,848	\$76,395	13
Replacement of Zimpro Wet Air Oxidation, Decant Thickening, and Vacuum Filtration with High-Speed Centrifuges	Elimination of costly, outdated processes beyond their useful life; Reduction in plant operator time; Installation of safer, cleaner process	Electric	613,830	\$500,000	\$4,370,000	8.7
Installation of More Efficient Mixers for UNOX Process	NA	Electric	367,224	\$30,277	\$593,400	20
Replacement of Cryogenic Oxygen Generation System with Vacuum-Assisted Pressure Swing Adsorption Oxygen Generation System	NA	Electric	2,199,736	\$175,125	\$1,840,000	11
Modifications to High Pressure Service Water Pump	NA	Electric	234,944	\$19,359	\$2,500	1.3
Replacement of 85-ton Air-Cooled DX Chiller with High Efficiency Unit	NA	Electric	NA	\$5,000	\$43,000	8.5
Replacement of Four Weil-McClain Hot Water Boilers with New High Efficiency Condensing-Type Boilers	NA	Electric	NA	\$18,000	\$375,000	21
Improvements to Lighting	NA	Electric	NA	\$83,000	\$450,000	5.4

Notes:

(1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas

mmbtu = 1,000,000 Btu

Electric = 11,600 Btu / kWh

1 therm = 0.1 mmbtu

1 Dth = 1 mmbtu

1 cf Natural Gas = 1,050 Btu

(2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-2h

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Evaluated Energy Saving Opportunities
Walkkill

Evaluated Measure	Fuel Type Saved ⁽¹⁾	Annual Electric Energy Saved (kWh / yr)	Annual Total Dollars Saved ⁽²⁾ (\$ / yr)	Implementation Costs (\$)	Payback (yr)
Installation of Premium Efficiency Motors	Electric	38,214	\$2,878	\$48,550	17
Installation of Premium Efficiency Motors on Mechanical Aerators	Electric	33,196	\$2,500	\$20,000	8.0
Installation of Smaller Variable Frequency Drives on Mechanical Aerators	Electric	394,200	\$29,683	\$320,203	11
Installation of Larger Variable Frequency Drives on Mechanical Aerators	Electric	596,000	\$44,879	\$320,203	7.1
Replacement of Mechanical Eerators	Electric	315,360	\$23,747	\$399,408	17
Replacement of Ultra Violet Disinfection System	Electric	31,918	\$2,403	\$510,000	212
Improvements to Lighting	Electric	8,539	\$643	\$9,900	15
Participation in New York Independent System Operator Program	Electric	NA	\$3,000	\$1,000	0.3

Notes:

(1) Fuel Type Saved: Electric, Natural Gas, Oil 1, Oil 2, Oil 4, Oil 6, Coal, Liquefied Petroleum Gas

mmbtu = 1,000,000 Btu

Electric = 11,600 Btu / kWh

1 therm = 0.1 mmbtu

1 Dth = 1mmbtu

1 of Natural Gas = 1,050 Btu

(2) Total Annual Dollars Saved based on energy rates for facility during time of study.

Table 5-3

New York State Energy Research and Development Authority
Municipal Wastewater Treatment Plant Energy Evaluation

Summary of Measures, Costs, Savings, and Payback, Recommended from Submetering

Facility	Recommended Measures	Submetering Costs ⁽¹⁾ (\$)	Total Project Cost (\$)	Estimated Annual Electric Energy Cost Savings (\$ / yr)	Payback (yr)	Current Annual Electric Energy Costs ⁽²⁾ (\$ / yr)	Proposed Cost Savings as a Percent of Current Cost (%)	Estimated Annual Electric Energy Usage Savings (kWh / yr)	Current Annual Electric Energy Usage ⁽¹⁾ (kWh / yr)	Proposed Usage Savings as a Percent of Current Usage (%)	
Albany North	<ul style="list-style-type: none"> * Installation of Premium Efficiency Motors on Select Pumps * Installation of Premium Efficiency Motors and Variable Frequency Drives on Plant Water Pumps * Enhancements to Furnace Controls * Improvements to Induced Draft Fan * Installation of Variable Frequency Drives on Return Activated Sludge Pumps * Reduction of Final Distribution Channel Blower Operating Hours During High Plant Flows * Installation of Window Film * Modifications to Lighting 	\$17,054	\$463,328	\$62,003	7.5	\$790,281	7.8%	660,011	10,446,539		6.3%
Chemung	<ul style="list-style-type: none"> * Installation of Premium Efficiency Motors on Influent and Trickling Filter Pumps * Reduction of Trickling Filter Pumping through Use of Variable Frequency Drives * Conversion of Existing Aeration Dissolved Oxygen through Use of Variable Frequency Drive * Adjustment of Effluent Aerator Use Based on Season * Modifications to Lighting * Modifications to Heating, Ventilation, and Air Conditioning 	\$17,054	\$95,300	\$30,883	3.1	\$113,828	27%	401,083	1,562,220		26%
Frank E. VanLare	<ul style="list-style-type: none"> * Installation of Variable Frequency Drives on Process Water Pumps * Conversion of Exit Signs to Light-Emitting Diode * Upgrade T-12 Lighting to T-8 * Replacement of Mercury Vapor Fixtures with Metal Halides * Replacement of Heating, Ventilation, and Air Conditioning Motors 	\$17,054	\$769,100	\$134,493	5.7	\$1,793,563	7.5%	2,204,801	27,350,852		8.1%
Gloversville-Johnstown	<ul style="list-style-type: none"> * Replacement of Return Activated Sludge Pumps * Improvements to Lighting * Improvements to Heating, Ventilation, and Air Conditioning 	\$17,054	\$241,125	\$28,750	8.1	\$311,237	9.6%	306,072	4,555,760		6.7%
Ithaca	<ul style="list-style-type: none"> * Installation of Automatic Controls on Aeration System Blowers * Replacement of Existing Heating, Ventilation, and Air Conditioning Controls with Windows-Based Front End Energy Management System 	\$17,054	\$89,400	\$26,700	3.3	\$212,100	12.6%	326,016	3,484,556		9.4%
South Fallsburg	<ul style="list-style-type: none"> * Installation of Controls on Trickling Filter Recycle Pumps Blower * Reduction in Operating Hours of Rotating Biological Contactor 	\$17,054	\$9,488	\$10,316	0.9	\$123,812	8.3%	101,137	1,246,050		8.1%
Tonawanda	<ul style="list-style-type: none"> * Replacement of Selected Standard Efficiency Motors with Premium Efficiency Motors * Replacement of Zimpro Wet Air Oxidation, Decant Thickening, and Vacuum Filtration with High-Speed Centrifuges for Sludge Dewatering 	\$17,054	\$4,829,810	\$154,779	8.0 ⁽³⁾	\$1,003,946	15%	871,121	13,405,921		6.5%
Wallkill	<ul style="list-style-type: none"> * Installation of Variable Frequency Drives on Mechanical Aerators * Participation in New York Independent System Operator Program 	\$17,054	\$321,203	\$40,281	8.0	\$202,675	20%	495,100	2,495,483		20%
Total			\$6,818,754	\$489,205	5.6	\$4,551,442	11%	5,365,341	64,547,381		8.3%

Notes:

- (1) Submetering costs include installation, removal, and rental of equipment, as well as data download and initial review, based on Siemens' budget for each facility.
- (2) Current annual electric energy costs and usage based on average of historical data.
- (3) Payback of 8.0 years for these recommendations based on electric energy usage savings as well as other savings including labor, chemical, gas, etc.

- Clean Water State Revolving Fund
- New York State Clean Water / Clean Air Bond Act
- New York State Energy Research and Development Authority (NYSERDA) Program Opportunity Notices (PONs)
- New York Independent System Operator (NYISO) Curtailment Programs
- Municipal Bonds
- Commercial Loans
- Lease-to-Own

5.2.1 Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) is administered by the New York State Environmental Facilities Corporation (NYSEFC) and the New York State Department of Environmental Conservation (NYSDEC). The CWSRF provides low interest rate loans for municipalities to construct water quality protection projects. A variety of publicly owned water quality improvement projects are eligible for financing. Eligible projects include point source projects such as wastewater treatment facilities and non-point source projects such as landfill closures and stormwater management projects, as well as certain habitat restoration and protection projects in national estuary program areas. Other examples of point source projects eligible for funding include new, expanded or rehabilitated wastewater treatment plants; sludge treatment and disposal facilities including biosolids reuse; collector, trunk and interceptor sewers; sewer rehabilitation and infiltration/inflow correction; municipally owned sewers and treatment capacity for industrial wastewater including storage, recycling or reclamation. The CWSRF program, in existence since 1990, has provided over \$10 billion in CWSRF financing. Energy efficiency measures may be eligible for funding if the improvements also result in environmental benefits.

Two types of funding are available through the CWSRF: short-term and long-term financing. CWSRF interest-free short-term loans allow municipalities to design and initiate construction for water quality projects, without the interest expense associated with bond anticipation notes, etc. These loans, depending on the nature of the financing, may be available for a term of up to three years. Short-term loans also can be used to prefinance costs that will be reimbursed from proceeds of grants and loans from other funding sources. All fees are waived for short-term loans. Short-term loans are processed on a first-come, first-served basis.

NYSEFC also offers two types of long-term funding: "leveraged" (financing from CWSRF bond proceeds) and "direct" (made available from CWSRF resources). NYSEFC issues bonds to "leverage" available state

and federal capitalization dollars, allowing NYSEFC to double or triple the amount of money it can lend under the CWSRF program. The interest earned on the capitalization funds is provided to the recipients as an interest rate subsidy. Elements and fees associated with long-term financing include up to 30-year maximum term, depending on the period of probable usefulness. The interest rate charged most applicants is one-half or two-thirds of the market interest rate at which NYSEFC's bonds are sold. Reduced interest rate financings for sewage treatment works projects serving residential areas are available to communities with demonstrated financial hardship.

5.2.2 New York State Clean Water / Clean Air Bond Act

The New York Clean Water / Clean Air Bond Act (Bond Act) was approved in November 1996. The Bond Act provides \$1.75 billion in funding for projects to protect and restore New York's environment.

The funding is divided into five categories under which projects could qualify:

- Clean Water - \$790 million in funding is available for projects that help implement existing management plans for major water resources. Funds are available for municipal wastewater treatment improvement, pollution prevention, agricultural and non-agricultural non-point source abatement and control, and aquatic habitat restoration.
- Safe Drinking Water - \$355 million in funding is available to economically distressed water systems for upgrading their drinking water facilities. This funding is proportioned at \$265 million for a revolving loan fund and \$90 million for state assistance payments.
- Solid Waste - \$175 million in funding is available for solid waste projects. The funding is proportioned at \$75 million to close the Freshkills Landfill, \$50 million to close rural and Adirondack landfills (including Adirondack Park and landfill management projects), and \$50 million to develop municipal recycling projects.
- Municipal Environmental Restoration - \$200 million is available to investigate and clean up contamination at abandoned sites (brownfields) that are municipally owned. These properties may then be marketed by the municipality for redevelopment or used by the municipality for a variety of activities including industrial, commercial, or public use. Under this category, projects are funded up to 75% of the cost.
- Air Quality - \$230 million is available for investment in clean technologies, including clean fuel buses and cars, helping schools switch from coal-fired furnaces to cleaner fuel, and helping retain jobs at businesses that need to reduce air emissions.

The latest financial information available on the Bond Act shows that approximately \$0.75 billion of the \$1.75 billion approved in November 1996 still remains for future projects.

5.2.3 NYSERDA Program Opportunity Notices (PONs)

NYSERDA offers funding to implement projects that improve energy efficiency or reduce energy usage through PONs. Recently, NYSERDA offered \$1,000,000 in funding through PON 935 for municipal water and wastewater technologies projects that developed, demonstrated, or increased the use of energy efficient water and wastewater technologies and processes that are innovative or underused. The projects must demonstrate quantifiable energy, environmental, and /or economic benefits for a state of New York municipal WWTP or water treatment plant. The projects must also show opportunities for replication at other state of New York facilities. This solicitation is typically offered on an annual basis.

The Peak Load Reduction program offers funding for interval meters that are used in load curtailment. Funding in amounts of \$1,200 or \$2,500 is available, depending on the type of interval meter being used. Additionally, load curtailment equipment, such as energy control systems or similar measures that enable a customer to shed load when called upon, can be funded as well. These measures can receive \$40 per controlled kilowatt in upstate New York and \$180 per kW in Con Edison service area.

The Commercial Industrial Performance Program (CIPP) pays up to \$400,000 per customer for implementation of energy reduction measures. Typically, an Energy Service Company (ESCO) implements an energy-saving project at the customer's facility, documents energy savings through pre- and post-construction monitoring, and then is awarded an incentive based on the type of project implemented as well as the documented energy savings. Incentives are paid for lighting replacements at \$0.06 per kilowatt-hour (kWh) saved, motor replacement at \$0.10 per kWh saved, and HVAC improvements at \$0.20 per kWh saved. Equipment installation is cost-shared at 30%

The Smart Equipment Choice program can be used for smaller projects and pays up to \$10,000 for pre-qualified lighting and motor replacement, as well as replacement of a variety of other electric equipment. Additionally, new programs are anticipated under the third issuance of the System Benefits Charge (SBC 3).

5.2.4 New York Independent System Operator Curtailment Programs

Water and wastewater plants can participate in NYISO curtailment programs, providing a service to the communities they serve and receiving incentives in turn for doing so. The NYISO Special Cases Resources program pays incentives based on the amount of kW shed and its location. The amount of incentive per kW depends on the specific time of year. The time periods include a summer strip from May 1 to Oct. 31 and a winter strip from November 1 to April 30. Customers are paid on a kW-saved basis for the electric load reduced during an emergency event. Typically, these customers have emergency generators that

they need to periodically exercise, and by participating in the SCR they can improve reliability and earn incentives.

5.2.5 Municipal Bonds

The most traditional and common way of funding improvements at WWTPs is through municipal bonds. These bonds are issued by municipalities or authorities for a finite amount of money, usually for a time period of 20 years. Most municipalities have their bonding capacities established by the state.

Additionally, a new provision furnishing low-interest / no-interest bonds for financing bio-fuel generation projects is now available. These Clean Renewable Energy Bonds have been enacted with the new Energy Bill (HR 6.109th Cong. 2005).

5.2.6 Commercial Loans

Commercial loans from private banks can be obtained to finance energy-saving projects with short payback periods. Equipment purchases may qualify for low-interest commercial loans as well.

5.2.7 Lease-to-Own

Lease-to-own options include purchasing equipment through third parties with the intention of leasing the equipment to the end-user. Equipment maintenance and repairs are usually performed by the third party, as well. Lease terms vary and typically span up to 20 years. At the end of the lease, the end-user has an option to purchase the equipment for the residual value established for the equipment at the beginning of the lease. Equipment lease payments can usually be applied to the end-of-lease purchase.

Although most of the recommendations for the eight facilities participating in the submetering project most likely do not warrant the lease-to-own option, the lease-to-own option may be a viable funding option for other facilities implementing energy-reduction measures that require large capital expenditures for equipment purchases and the equipment is maintenance-intensive.

5.3 FINDINGS

This submetering program was conducted over eight facilities across New York State that represent a range of flows, state geographic regions, and treatment plant configurations. The facilities that participated in the study are already proactive in identifying and implementing energy-savings measures. Despite that fact, submetering at these eight facilities resulted in the identification and recommendation of over 5,200,000 kWh in energy usage savings through capital and operational changes to existing equipment and processes,

demonstrating that submetering can be an effective tool for identifying cost-effective energy-savings opportunities. The recommendations aggregated over the eight facilities represent an annual cost savings of approximately \$6.4 million, or 15% of the current total energy costs, with payback periods ranging from approximately one year to eight years. The estimated average cost for conducting submetering at each of the facilities for this project was \$17,000 (based on Siemens' budget for each site), which includes equipment rental, installation, and data collection and initial review. However, the costs for submetering could rise substantially if real-time submetering data were to be integrated with the plant's existing SCADA system, or if high voltage equipment was being submetered (the current submetering program evaluated equipment up to 480 volts; high voltage equipment was not included in the study).

Furthermore, the study results and recommendations can be used by other facilities to evaluate if current operations result in typical / benchmarked energy usage for treated wastewater volume, and organic and solids loadings, and if current equipment and processes would therefore have the potential to benefit from energy-reducing modifications that were evaluated as part of this study.

In general, traditional operational energy-saving measures, such as load shifting and peak shaving, were not recommended at the participating facilities. The smaller facilities that participated in the study are typically staffed in only one shift, and therefore could not implement operational modifications as the facilities lack the required staffing. Although operational modifications may be possible at the larger facilities that participated in the study because those facilities are staffed in more than one shift, most of the operations at these facilities are already evenly distributed over a 24-hour period.

The recommended measures were mainly capital improvements associated with installation of more energy efficient equipment. These measures would not increase the treatment capacity at the facilities, but rather the efficiency with which treatment is accomplished. While many of these evaluations could have been done without actual submetering of the evaluated processes and equipment, submetering did provide more accurate estimates of energy consumption and, therefore, the potential energy savings associated with the recommended improvements. In some instances, when the initial evaluations were completed prior to this submetering project (e.g. Tonawanda centrifuge installation), submetering and subsequent evaluations had resulted in significantly more accurate estimates of the energy savings and financial outcome of the project. Submetering provides the "concrete confirmation" of payback that many facilities want before authorizing upgrades.

Because the facilities that participated in the study are already proactive, these facilities, given the appropriate level of funding, are more likely to implement the recommended measures than less proactive facilities. However, through dissemination of the results of the submetering study, including the recommended measures and the avoided costs that could be expected from implementing those measures, other facilities

may recognize the potential benefit of participation in such studies as well as implementing the energy-saving recommendations.

One of the participating facilities, the Monroe County Frank E. VanLare Wastewater Treatment Facility (WWTF), recently installed a number of permanent submeters and currently monitors energy usage by the submetered processes on a continuous basis on-line. The permanent submetering allows the plant to make educated real-time decisions on controlling overall plant demand while bringing additional equipment into operation. In the long-term, the submetering will also allow the plant to establish energy consumption trends for each piece of submetered equipment and to assist in troubleshooting equipment / processes based on demand information. Submetering allows the facilities to understand the interaction between unit processes and to optimize them in relation to one another.

Based on the outcome of the study, it appears that submetering is an effective tool for identifying energy-saving capital improvement measures at most facilities, regardless of facility design capacity. From the viewpoint of improving facility operations, submetering appears to be a more useful tool to medium and larger sized facilities that have multiple shifts staffed, affording these facilities the flexibility to shift loads that smaller facilities could not implement. Submetering is also of benefit to small-to-medium size facilities when considering equipment replacement and upgrades, as it provides the basis for comparison (i.e., a baseline) with newer equipment. It is recommended that baseline submetering always be undertaken prior to equipment rehabilitation, upgrade, and replacement, and that these data be used to establish energy efficiency performance criteria (i.e., cost savings and payback) for the new equipment.

It should be noted that this study only evaluated energy savings potentials from short-term submetering of equipment at a limited number of facilities. Long-term (permanent) submetering may be beneficial in identifying other areas for potential energy savings. Although not all demonstrated within the scope of this study, these potential areas may include:

- **Operational Savings** – Savings resulting from changes in operational procedures, such as routine, process sequencing, and time-of-use. Long-term submetering could be of benefit in evaluating and documenting these savings, especially at larger facilities.
- **Unit Process Improvements** – Comparison of an existing unit process energy usage with newer, more efficiency technologies. Again, long-term submetering could be of benefit in documenting the savings.
- **Energy Procurement Improvements** – Discussions with a facilities energy supplier can often result in energy savings through discussions of alternative tariffs and billing programs. Long-term submetering could be of benefit here, especially at larger facilities, to provide the background data required to understand operational and load-based flexibility in operations.

- ***Equipment Sizing and Efficiency Evaluations*** – The information obtained through long-term submetering can form the basis for evaluating the efficiency of equipment in terms of diurnal load variations, peak loading efficiency, and sizing. This, in turn, can facilitate decisions about equipment replacement.
- ***Equipment Maintenance and Life Cycle Cost*** – Long-term submetering, especially on larger equipment with significant run times per year, can be used for a variety of beneficial uses, including:
 - Determining maintenance intervals by observing increasing or decreasing energy usage per unit of output (work done).
 - Determining optimal run times or sequences where multiple pieces of equipment can perform the same function.
 - Determining replacement schedules for motors and equipment by comparing, over time, the energy usage per unit of work done in comparison to newer, more energy efficiency equipment.

Although submetering was not directly used to evaluate lighting and HVAC improvements, it was a useful tool in identifying if lighting and HVAC improvements should be evaluated. The submetering data for the major equipment at a facility was used to estimate the energy usage by each process and type of equipment, including lighting and HVAC. If the lighting and HVAC constitute a large percentage of the total facility energy usage, that is typically an indication that they should be further evaluated. Based on the facilities that participated in this study, removal of the recommended lighting and HVAC improvements results in a shorter or longer difference, on average, of six months in payback duration.

In conclusion, submetering can be a cost-effective tool for identifying energy saving measures if the program is implemented with a focus. Not all pieces of equipment at a facility need to be submetered in order to determine the key players in energy usage for that facility. At the onset of the program, the overall objective of the program must be established, whether that be demand / load control, process optimization, or simple trending to identify large energy users. The overall objective of the program will help to establish the level of drill down to which equipment must be monitored, and hence, the cost of the submetering equipment itself. The data collection approach will then follow based on the program objective in terms of collection frequency, required data, and required data evaluations, that will define the level of effort required. The equipment to be monitored and the data to be collected must be in proportion to the objective of the program. The identified energy savings measures will define the benefits.

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toll free: 1 (866) NYSERDA
local: (518) 862-1090
fax: (518) 862-1091

info@nysesda.org
www.nysesda.org

**MUNICIPAL WASTEWATER TREATMENT PLANT
ENERGY EVALUATION**

SUMMARY REPORT 06-14

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GEORGE E. PATAKI, GOVERNOR**

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