Salineville Wastewater Treatment Facility - Energy Audit, Level II

Submitted by: Ohio RCAP

Administered by:

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Section 1.0 – Executive Summary

Representatives from the Ohio Rural Communities Assistance Program (Ohio RCAP) conducted a Level II Energy Audit for the Village of Salineville, Ohio Wastewater Treatment Facility on November 18, 2009. The purpose of the facility Energy Audit is to gain an understanding of the Facility processes and of the major end uses, with an ultimate objective of identifying potential energy conservation opportunities. Local representatives were also present during the site visit.

This Level II Energy Audit, herein referred to as the Audit, is a continuance of technical assistance provided through the USDA Rural Community Development Initiative (RCDI) by Ohio RCAP. The opportunities addressed by this Audit, along with any other energy initiatives you may identify now or in the future, will form the basis of your Energy Action Plan, or EAP. The purpose of the EAP is to prioritize your facility energy projects, establish an implementation plan and schedule, and provide a method for tracking the results. The proposed opportunities will be reviewed with you to determine if they are appropriate for your facility and budget. All acceptable project opportunities should be included in your EAP.

This report presents the findings from the Audit. Each available opportunity is described herein to ensure that our understanding of the affected system is accurate. Estimates of annual energy savings and implementation costs are provided for each project, along with approximate simple payback period. The savings and cost estimates are order-of-magnitude based on limited information gathered during the assessment.

For the time period audited, the total energy costs for operating and maintaining the Facility amounts to $23,745 per year (refer to Table 4.1). For the total energy use of 416,004 kWh per year, the average cost of $0.058 per kWh can be estimated for the total Facility usage. Proper fiscal planning and budgeting would require evaluation and estimating of the future demands and costs for the Facility, as well as industry trends and regulations, and regional planning parameters.

In planning for the future, we must take into account that the United States Environmental Protection Agency (EPA) is projecting a 20% increase in the use of energy for water and wastewater facilities over the next 15 years, as a direct result of population growth and increasing agency regulations and requirements. This will increase the annual energy costs of operations and maintenance for the Facility to approximately $28,494 per year. The Village will need to plan for this increase to the annual budget, either through billing rate increases, or in reductions to energy usage and operations efficiency.

Assuming that the energy conservation opportunities and operational recommendations presented within this report are utilized, the Facility may realize an approximate reduction in energy usage of 61% (254,567 kWh usage reduction, only using 162,233 kWh) per year (refer to Table 1.1).

TABLE 1.1 - SUMMARY OF ENERGY CONSERVATION OPPORTUNITIES:

ECO No.	Opportunity Description	Est. Cost ($)	Annual kWh Savings	Annual kW Savings	Annual Energy Cost Savings	Simple Payback Estimate (years)	Notes
1	Demand Management and Load Shifting						
2	Install Energy-Efficient Interior Lighting	$1040	587	0.66	$34	30.5	1
3	Install Interior Occupancy Sensors	$300	708	0.00	$41	7.3	1
4	Install LED Exit Light Fixtures	$80	491	0.06	$28	2.8	
5	Address Building Envelope / Climate Control Issues						
6	Exterior Lighting Controls	$50	1723	0.00	$100	0.5	
7	Install Premium-Efficiency Motors (50 Hp Blower)	$4500	16026	1.83	$929	4.8	2, 4
8	Install Premium-Efficiency Motors (7.5 Hp Raw)	$1800	919	0.42	$53	34	2
9	Raw Sewage pumps – Install VFDs on pump motors	$6200	5,390	0.00	$310	25	3
10	Modify Process to Fine Bubble diffusion	$16,000	228,723	26.11	$13,265	1.2	3, 4
Total Estimated Implementation Cost		$29,970					
Total Potential Electrical Energy Savings			254,567				
Total Potential Electrical Demand Savings				29.08			
Total Potential Cost Savings					$14,760		
Total Simple Payback						2.03	

Notes:

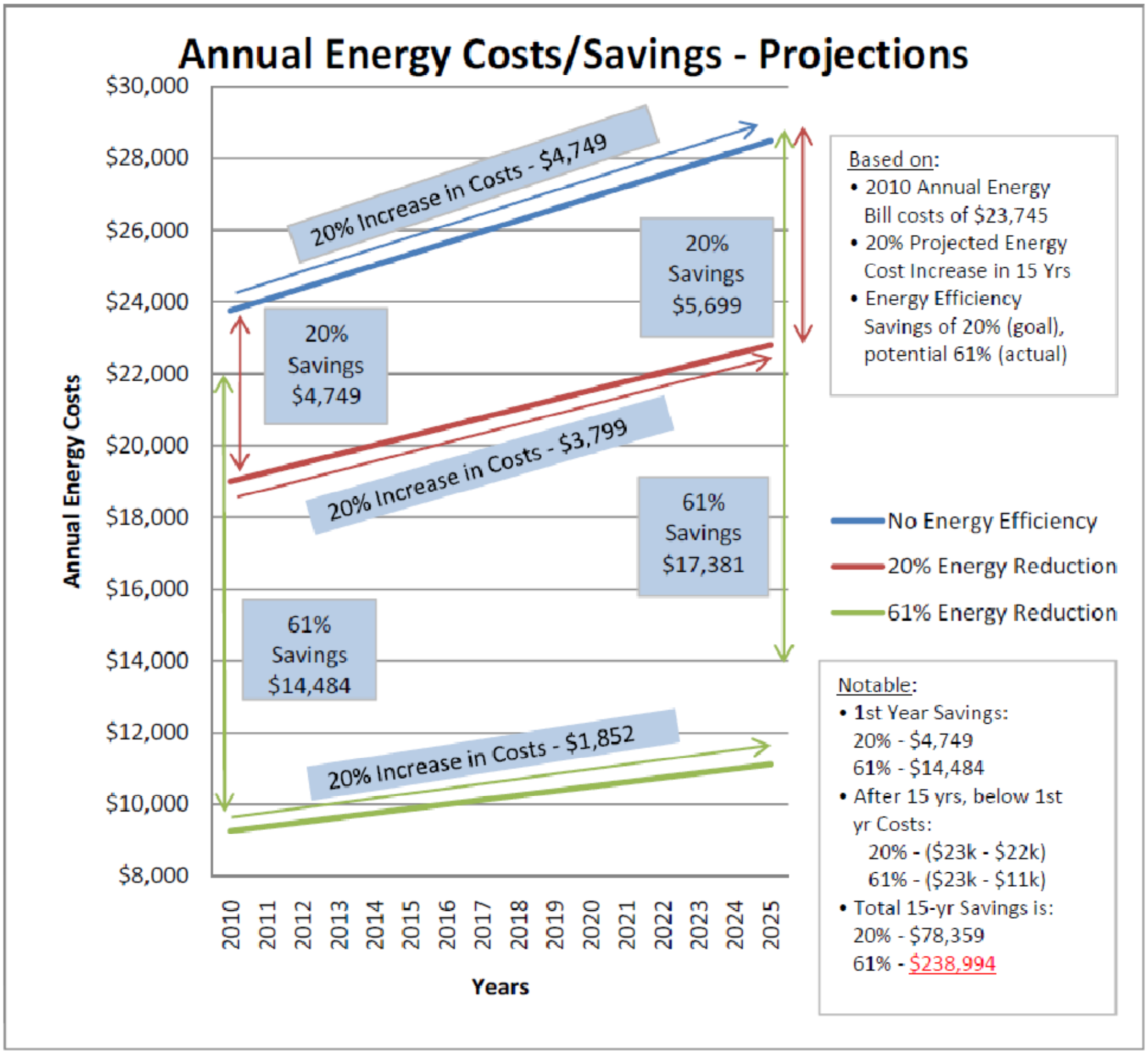
1. Energy savings and simple payback for lighting opportunities depends on lighting retrofits and whether lighting is upgraded on an as-failed basis or all at once. See Section 5.0.
2. Energy savings and simple payback associated with motor replacement depend on the size, operating hours, efficiencies, and quantity of motors involved. See Section 5.0
3. These opportunities require review, design, and implementation by additional design professionals and/or manufacturing representatives.
4. The facility will not select both ECO 7 and ECO 10, as the 50 Hp Blower Motor, Blowers, and the Controls will be oversized for the fine bubble aeration.

The goal of Ohio RCAP is to identify a minimum of 20% energy conservation for each Facility that we Audit. The estimated 61% energy cost savings for Salineville is possible with an improvement cost of $29,970, and can be realized with a Simple Payback period of just 2.03 years. The savings of $14,760 per year not only offsets the improvement cost, but there is also a compounding effect that must be taken into consideration.

Chart 1.1 identifies the Facility annual energy costs and potential savings, with the savings based on the minimum 20% reduction goal and the potential 61% reduction. By taking into account the EPA estimated 15-year 20% energy use increase, the energy-efficient Facility model would have a modified

15-year annual energy cost budget decrease from $28,494 to $11,113 per year in the year 2025. This new energy cost amount is not only a fraction of the current operating budget, but will produce a 15-year savings of over $235,000. By subtracting the improvement cost of $29,970, the Facility would see a potential savings of nearly $210,000 during that time period. This savings will allow the Village of Salineville to plan for capital improvements, manage emergency events, and establish a long-term asset for the community.

CHART 1.1 – ANNUAL ENERGY COSTS INCREASE AND SAVINGS PROJECTIONS:



Disclaimer:

The energy conservation opportunities contained in this report have been reviewed for technical accuracy. However, because energy savings ultimately depend on behavioral factors, operational methods, equipment maintenance, the weather, and many other factors outside its control, Ohio RCAP does not guarantee the energy or cost savings estimated in this report. Ohio RCAP shall in no event be liable should the actual energy savings vary from the savings estimated herein.

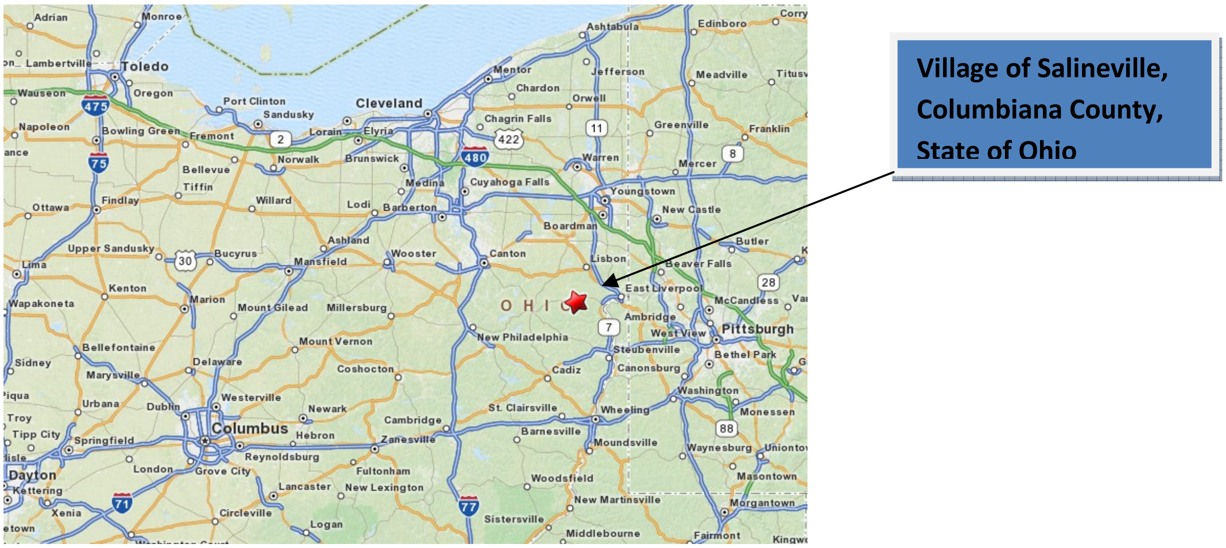
Estimated installation costs are based on a variety of sources, including our own experience at similar facilities, our own pricing research using local contractors and suppliers, and cost handbooks such as RS Means Facilities Construction Cost Data. The cost estimates represent the best judgment of the auditors for the proposed action. The facility owner and staff are encouraged to confirm these cost estimates independently.

Since actual installed costs can vary widely for a particular installation, and for conditions which cannot be known prior to in-depth investigation and design, Ohio RCAP does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein.

Ohio RCAP will not benefit in any way from any decision by the Owner to select a particular contractor, vendor or manufacturer to supply or install any materials described or recommended in this report.

Section 2.0 – Introduction

The Village of Salineville is a small, rural community located in the Southern portion of Columbiana County in Eastern Ohio. With a total population listed at 1,397 people (2000 Census), there are 535 households and 365 families residing in the Village. The Village has a total median household income of $27,473. The community is served by the Village owned Wastewater Treatment Facility (WWTF).



Map of the State of Ohio, Identifying the Village of Salineville, Ohio

Aerial Map of the Village of Salineville, Ohio, Identifying the Wastewater Treatment Facility

Section 3.0 – Wastewater Facility Description and Operations

The Salineville WWTF finished construction in 1979 and opened with a design flow of 250,000 gallons per day. The current actual loading at the facility is roughly 81,000 gallons per day. At this time, the facility is operating under the Ohio Environmental Protection Agency (Ohio EPA) Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit was effective on March 1, 2008, and expires on February 28, 2013. The Village of Salineville is authorized by the Ohio EPA to discharge, in accordance with the permit conditions, to the North Fork of Yellow Creek. A consultant engineering firm proposed a $6 million facility upgrade in September, 2009, and the proposal was rejected by the Village. There have been many changes with time, including flow capacity, discharge limits, technology, and even energy costs. These items will continue to change in the future, as well, and the Village should remain vigilant of this dynamic portion of the infrastructure.

The existing facility consists of the following equipment:

Headworks: Consisting of an access stairway, a channel type comminutor, a bar-screen by-pass, and a wet well.

Control Building: Approximately 1,320 sq ft and contains a tri-plex pump station, a laboratory, the office, a work shop, blower and stand-by power room (2 – 50 Hp centrifugal blower motors, one primary, one stand-by) (50 kW stand-by power unit), electrical room, chlorine system containment room. (The raw water pumps, blower pumps, and electrical system were noted as fair to poor condition)

Aeration, Final Settling, and Sludge Storage Area: Aeration tanks (2 each) approximately 110,000 gallon (12' deep, 20' wide, and 60' long) fitted with swing air diffusers, Aerobic Sludge Digester (1 each) (12' deep, 14.5' wide, and 28' long) with swing air diffusers, Straight Line Clarifiers (2 each) (12' deep, 12' wide, and 28' long) with a traveling bridge sludge return pump and scraper.

Raw Water Pumping: Allis Chambers Model 300 4x4x12LC (3 each),
2 pumps are original, one has been replaced (date unknown),
7.5 Hp, 236 GPM, 45 TDH, 10.13 Impeller, 1160 RPM, 460 Volt, 12 Amp,
Visual inspection identifies that the impellers are in good shape for age.

Blower Motor: Lamson Centrifugal Direct Drive 510 Series (2 each),
Pumps operated in rotation, with one Primary and one Back Up,
Both pumps are original to the facility,
50 Hp, 3490 RPM, 230/460 Volt, 120/60 Amp, 56 Amp Draw, 14 psi,
Efficiency Index H.

Coarse Bubble Diffuser: Rotted with age, not functioning as designed. However, the dissolved oxygen (DO) levels are still above the NPDES Permit minimum of 5.0 mg/l. The DO is averaging between 6.8 -7.8 mg/l (measured in July through November of 2009). With no other modifications to the facility, facility maintenance should prepare to replace the diffuser arms.

<u>Thickened Sludge</u>: The thickened sludge is stored on site and transported to a County-owned facility for disposal approximately 2-times per year. The sludge holding capacity is marginal with respect to the facility treatment operations. The facility should plan to either expand the holding area, or plan to provide more frequent transportation opportunities to remove the sludge. It is our understanding that the Village has discontinued its land application practices due to permitting and reporting demands.

<u>Scraper Motors</u>: ½ Hp Motors to power the scrapers on the Clarifiers (2 each), Not analyzed for the purposes of this report.

<u>Chlorine Contact Chamber</u>: 10’ by 30’ tank. Disinfection is achieved with chlorine delivered by underground line to tank. Dechlorination is achieved by the addition of sulfur dioxide. The discharge effluent is transferred by 8 inch vitrified clay pipe to the North Fork of Yellow Creek.

<u>Pump Station (1)</u>: The stand alone pump station services a small cluster of homes containing 15 individual grinder pumps. The pump station details were not available. The electric bill for the pump station totals approximately $50 per month.

The existing facility is operated by local staff, where the operator is on site 2-4 hours each day. The facility does experience minimal Infiltration and inflow from non-wastewater sources, however, the existing excess capacity appears suitable for storm events and water surges. There was only one instance that immediately after a 3” rainfall event, the facility was overwhelmed by flows peaking at 800,000 GPD.

Section 4.0 – Energy Use History and Utility Analysis

Monthly electric utility costs were provided by Salineville for the WWTF. The sole energy provider for the facility is AEP. In a recent 12-month period, the total cost of electricity over this period was estimated to be $23,745.05 (some data was missing from the analysis). The average cost per kWh was $0.058 (including demand charges). The total energy use for the facility in this period was 416,800 kWh.

Based on an estimated annual wastewater load of about 29.6 million gallons (0.081 MGD), energy use indices for electricity is 14098 kWh/MG-yr. The total annual electric cost per million gallons is $817.67.

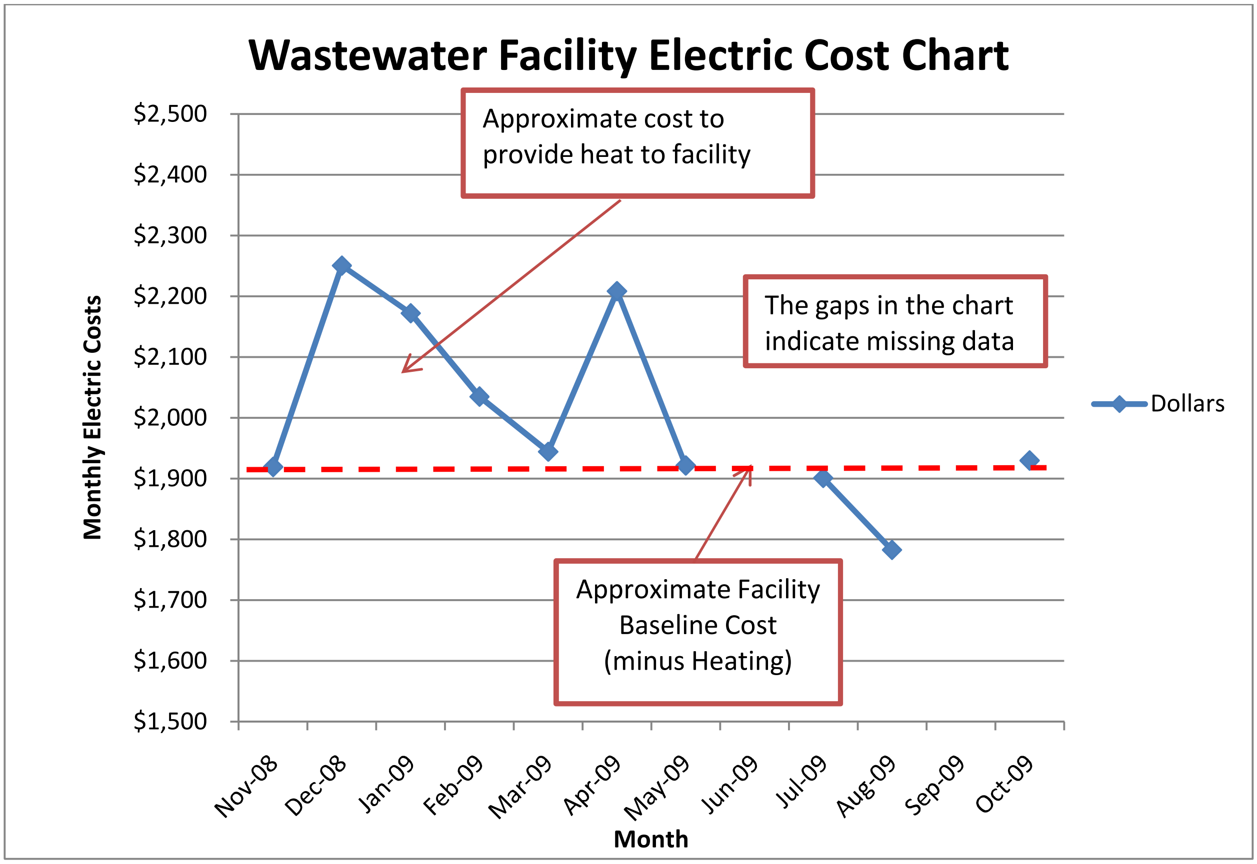
The energy use index and cost per gallon are higher than would be expected for a facility of this size operating far below its peak conditions. As we analyze this facility, please note that the largest energy user at a wastewater facility is typically the aeration treatment, usually between 50-60% of the energy use.

TABLE 4.1 – SALINEVILLE WASTEWATER TREATMENT FACILITY ENERGY USE:

Salineville Wastewater Treatment Facility Energy Use							
Date	Energy Use (kWh)	Billed Demand (kW)	PF	PF Constant	Billed Demand (kVARh)	Energy Cost ($)	Cost/ kWh
2008 Nov	34700	60.7	80.4	1.0209	25700	$ 1,919.26	$ 0.055
2008 Dec	44600	63.3	83.1	1.0079	29800	$ 2,267.84	$ 0.051
2009 Jan	41800	64.3	83.2	1.0078	27900	$ 2,172.15	$ 0.052
2009 Feb	36300	66.1	85.3	0.9987	22200	$ 2,051.83	$ 0.057
2009 Mar	34800	62.8	81.2	1.0768	25000	$ 1,961.07	$ 0.056
2009 Apr	37600	56.4	81.7	1.0143	26500	$ 2,227.06	$ 0.059
2009 May	30400	53.6	77.9	1.0338	24500	$ 1,939.54	$ 0.064
2009 Jun	29500						
2009 Jul	31700	50.5	99.9	0.9512	-1100	$ 1,900.98	$ 0.060
2009 Aug	30200	51.8	79.3	1.0262	23200	$ 1,782.67	$ 0.059
2009 Sep	31300						
2009 Oct	33900	54	80.6	1.0198	24900	$ 1,929.79	$ 0.057
Totals	416800					$ 20,152.19	
Average	34733					$ 2,015.22	$ 0.058

TABLE 4.2 – SALINEVILLE WASTEWATER TREATMENT FACILITY LOADING

Salineville WWTF Loading				
Given:	416800	= Annual Energy Use Average		
	$ 0.058	= Average Cost/kWh		
Avg Flow/Day MGD	Days/ Year	MG/ Year	kWh/Mg/Yr	$/MG/Yr
0.081	365	29.6	14098	$ 817.67


Wastewater Facility Electric Cost Chart
Approximate cost to provide heat to facility
The gaps in the chart indicate missing data
Approximate Facility Baseline Cost (minus Heating)
Monthly Electric Costs
$2,500
$2,400
$2,300
$2,200
$2,100
$2,000
$1,900
$1,800
$1,700
$1,600
$1,500
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Month
Dollars

Section 5.0 – Energy Conservation Opportunities

This section presents a preliminary analysis of quantifiable energy efficiency opportunities identified during the survey. Each opportunity is described to ensure that our understanding of the affected system is accurate. An estimate of annual energy savings and implementation cost is provided for each project, along with approximate simple payback period. The savings and cost estimates are based on limited information gathered during the survey.

Energy conservation can be defined for this report as 'using fewer resources to complete the same work, with no compromise to treatment quality, customer service, facility comfort, or safety'. It is important to evaluate the entire facility operation, from collection to treatment to distribution/discharge. Even small, initial efforts can be rewarding, and may lead to larger, more beneficial projects. However, these opportunities must make economical sense to your community, in both the immediate and the long-term planning goals.

In addition to the opportunities within this section, there are additional opportunities listed in Sections 6 and 7 pertaining to this site. Some of these opportunities are difficult to evaluate due to limitations in testing equipment, research analysis, or questions in the implementation and/or use. Most of them can be evaluated and implemented by facility staff, and a few of them will require the additional study and the assistance of design professionals.

**NOTE: The Energy Conservation Opportunities (ECO's) in this report that are identified as 'Sample Only' are opportunities that have been evaluated as a representative sample, and are not to be reviewed as conclusive. The evaluation should give the client the order of magnitude of the opportunity, and a scale of the simple payback, in order to identify if further study or evaluation is required and/or warranted. All other opportunities are based on the time period of the actual Audit and the data provided to Ohio RCAP for analysis.*

ECO 1 – Evaluate Demand Management with Load Shifting and Shedding

A Time-of-Use (TOU) electric rate schedule, from the AEP utility contract, designates certain hours of the day as being "on-peak" and charges a higher rate for kWh consumed during these time periods. The time period designated as "on-peak" is between 7 am and 9 pm, weekdays Monday through Friday. Those periods designated as "off-peak" are between 9 pm and 7 am weekdays Monday through Friday, all day Saturday and Sunday, as well as all legal Holidays. In addition to the higher energy rates, peak demand charges also increase. Demand management can substantially lower energy costs by reducing and/or avoiding extensive energy use during on-peak periods.

Load Shifting:

Load shifting, the practice of scheduling energy intensive processes for off-peak periods, is a common method of demand management. This not only reduces and/or avoids expensive demand charges, but also lowers the amount of electricity purchased at the higher on-peak rates. Demand management is often achieved by using available storage to accumulate influent during on-peak periods for later treatment, thereby lowering process demand during on-peak periods.

Demand Shedding:

Demand shedding can be used to control peak loads. Demand shedding can be achieved by turning off all non-critical electric equipment during on-peak periods. This practice is not limited to large process equipment, but also applies to lighting, etc. Alarm systems are available to alert facility staff when demand is approaching a pre-set value, allowing them to turn off any non-critical equipment before peak demand is reached.

Currently the electric service at the WWTF is not metered by the AEP on a TOU basis, so there is no opportunity here. However, the Village should be aware of this rate structure and consider it in any future upgrades, improvements, purchases, or contract changes.

ECO 2 – Install Energy-Efficient Interior Lighting

During the site assessment, it was noted there were 20 two-lamp and 6 four-lamp four-foot fluorescent light fixtures containing T12 fluorescent lamps. It is typical for older T12 fluorescent fixtures to utilize inefficient magnetic ballasts, which we will assume for this opportunity. Please note that as of July 1, 2010, the US Department of Energy has prohibited the manufacture of all magnetic ballasts. In addition, no T-12 fluorescent lamps will be manufacture after 2015. All 6 of the existing four-lamp fixtures were only using two lamps per fixture. Both 40-watt and 34-watt lamps were observed on site, so an even mix of 40-watt and 34-watt lamps for the 52 lamps has been assumed for calculation purposes. Hours of operation have been estimated at four hours per day based on information gathered from personnel during the site survey.

The energy conservation opportunity exists by retrofitting all interior T12 fluorescent fixtures with more energy efficient T8 lamps and electronic ballasts. The lamp housing does not require replacement, and both the T12 and T8 lamp pins are the same size and spacing, therefore, both can fit the same plug end. The retrofit is re-wiring the fixture with the new electronic ballast, and installing the new T8 lamps.

This retrofit allows the total lighting energy use to be reduced by approximately 587 kWh per year leading to an annual cost savings of $34. The estimated cost to replace a fixture with energy efficient T8 lamps is about $40 per fixture, or $1040 total. This project is not recommended based on the lengthy projected simple payback. However, the economic return would improve if lamps and ballasts were upgraded by facility staff on an as-failed basis in lieu of all at once.

A sample calculation to illustrate the magnitude of energy savings that may be expected by retrofitting the existing fixtures with electronic ballasts and 32-Watt T8 lamps is in the Appendix.

Retrofit of All 26 Fixtures:
Electric Energy Savings: 587 kWh
Annual Cost Savings: $ 34
Estimated Project Cost: $ 1040
Simple Payback: 30.5 years

ECO 3 – Install Interior Occupancy Sensors

This opportunity considers the application of occupancy sensors to control lighting in areas of the facility that are intermittently occupied. Occupancy sensors monitor motion in a room and keep lights on while someone is in the room. After a specified amount of time when no motion is detected, the sensor shuts the lights off. The length of time for this delay can typically be adjusted to fit the needs of the space.

Occupancy sensors are suitable for a wide range of lighting control applications and should be considered in every upgrade decision. The amount of savings depends on the number and type of fixtures controlled and the length of time the fixtures would be on without a person in the space. They should provide reliable operation when properly specified, installed, and adjusted.

Two motion-sensing technologies are commonly used in occupancy sensors: passive infrared and ultrasonic. Either technology can be housed in ceiling-mounted or wall-mounted sensors. Some manufacturers combine these two technologies into a hybrid or dual-technology sensor.

Passive infrared (PIR) sensors respond to motion between horizontal and vertical cones of vision defined by the faceted lens surrounding the sensor. Most PIR sensors are sensitive to hand movement up to a distance of about 10 feet. They sense arm and upper torso movement up to 20 feet, and are more sensitive to motion occurring perpendicular to the line-of-site of the sensor. Because infrared sensors require direct line-of-sight to the moving object, obstructions impair their performance. For example, they will not operate properly in spaces with furniture, partitions or other objects between the sensor and occupant.

Ultrasonic sensors emit and receive high-frequency sound waves. These waves reflect off people, objects and room surfaces and the sensor measures the frequency of the waves that return to the receiver. If motion occurs within the space, the frequency of the reflected waves will shift. The receiver detects this change, and lights are turned on. Ultrasonic sensors are much more sensitive to movement directly toward or away from the sensor compared to lateral movements. To ensure accuracy, the sensor should have a clear view of the area controlled. High partitions, especially those over 48 inches, can block its ability to detect people. Additionally, plush carpet and fabric partitions may absorb the sound waves and decrease effectiveness.

Lighting may operate continuously in many low-occupancy areas of the wastewater treatment facility. For example, lights probably remain on in break areas that are used infrequently as well as areas that require only an occasional inspection of process equipment. Lighting energy costs can be reduced dramatically in these and other similarly occupied areas if occupancy sensors are installed to automatically switch light fixtures on and off.

For this opportunity, savings estimates have been calculated for installing occupancy sensors to control all of the existing linear fluorescent fixtures in the office, lab, and blower room. Again, an even mix of 40-watt and 34-watt lamps has been assumed. Installing occupancy sensors to control these fixtures would result in annual energy savings of 708 kWh or about $41 per year in energy cost savings if lighting operation was reduced by 50%.

The order-of-magnitude cost estimate to implement this measure is $300 resulting in a 7.3-year simple payback. This estimate is based on an assumption that three occupancy sensors would be required and wall switch sensors would be appropriate in most areas. Savings estimates assume that the existing lighting system is retained. If T8 lamps and electronic ballasts were installed throughout the plant (see Measure 2), savings associated with the occupancy sensor measure would be reduced. These calculations are also shown in the Appendix.

Occupancy Sensors in the Office, Lab, and Blower Room:
Power Savings: 0 kW
Electric Energy Savings: 708 kWh
Annual Cost Savings: $ 41
Estimated Project Cost: $ 300
Simple Payback: 7.3 years

ECO 4 – Install LED Exit Lighting Fixtures

Most of the older, typical exit signs utilize incandescent lamps for lighting. Incandescent lamps are very inefficient, and lend themselves to improvement opportunities with other lighting alternative.

One very strong opportunity is to replace the incandescent lamp exit sign with a new LED exit sign. LED technology is steadily improving, and costs are dropping, to make this highly efficient and effective source of light a real energy conservation tool. During the facility walk through, the exit signs were overlooked. However, from the site photos, it is noted that there are two exterior doors. For this opportunity, we will assume that the facility has two exit signs.

Retrofit of LED Exit Lights:
Power Savings: 0.06 kW
Electric Energy Savings: 491 kWh
Annual Cost Savings: $ 28
Estimated Project Cost: $ 80
Simple Payback: 2.8 years

ECO 5 – Address Building Envelope and Climate Control Issues

During the walk-through, it was noted that the facility has a newer furnace and no air conditioning. Windows are single pane but in good condition. Attic covers were missing in the entryway closet and the blower room.

The cover in the closet should be replaced so as not to allow mixing of air from above the ceiling with the air in the occupied space. We assume the blower room cover was off to allow excess heat from the room to escape. Consideration needs to be given to the indoor environment that may adversely impact any laboratory equipment and invalidate any test results using said equipment.

Consideration should be given to utilizing the heat given off from the aeration blowers for heating of the building if at all possible. There are professional consultants specializing in this aspect to better direct the owner should this be of interest.

Energy efficient windows should be considered as the existing windows require replacement only. It is typical for the cost of replacing existing windows with energy efficient windows to have a very high simple payback. Therefore, the replacement for energy reasons alone is not favorable to the owner.

Energy savings from projects related to updating building envelope components (i.e. – windows, wall or roof insulation) are often cost prohibitive. Thus, simple maintenance of the existing windows, as opposed to complete replacement, is advisable. Similarly, energy savings calculations associated with this type of project are not precise unless detailed data on interior air pressure, infiltration rate, space temperature set points, outdoor air temperatures, etc, are available and/or a comprehensive building energy simulation model is used. Thus, detailed calculations are not provided as the analysis itself is cost prohibitive given the size of the facility and related HVAC systems.

ECO 6 – Address Exterior Lighting Controls

The exterior lighting is on permanently and controlled by photocells or other control device. It was noted during the walkthrough that one of the eight exterior fixtures was on during the daylight hours. This is unnecessary energy use, and the cause needs to be investigated and addressed. It could simply be debris or dirt obstructing the control device, or a faulty control device.

Assuming that a typical existing exterior fixture is high pressure sodium with a nominal 250 watt lamp, the actual watts consumed are 295 watts. If this fixture were allowed to operate continuously for one year it would use:

(295 watts/lamp x 1 lamp/fixture x 1 fixture x 8,760 hr/year) / 1,000 w/kW = 2,584 kWh/year

This amounts to $150 per year. Keep in mind this is for a single fixture 24 hours a day. A photocell only allows the light to work at night, approximately eight hours, saving two-thirds of the energy consumption saving about 1723 kWh or $100.

For a Single Fixture:
Electric Energy Savings: 1,723 kWh
Annual Cost Savings: $ 100
Estimated Project Cost: $ 50
Simple Payback: 0.5 year

ECO 7 – Install Premium-Efficiency Motor (50 Hp Blower Motor)

Replacement of older electric motors with premium efficiency models is often a very cost-effective energy cost reduction measure. Although an efficient motor can cost 15 to 30% more than a standard-efficiency motor, in most cases these additional costs pay back well within the lifetime of the motor. A typical standard motor easily consumes 50 to 60 times its initial purchase price in electricity during a 10-year operating period. Thus improvements of just a few efficiency percentage points in motor efficiency can often pay back within 2 to 3 years.

For all sizes of motors, premium high-efficiency replacement should be considered whenever the motor requires major repair or overhaul. In general, if the cost to repair the motor exceeds 60% of the price of a new efficient motor, replacement is the recommended course.

When a motor is replaced on an “as-failed basis,” the actual cost of the new, high-efficiency motor is the difference between the purchase price of the replacement and the cost to repair the existing motor. Consequently, the preferred time to purchase a premium-efficiency motor is when an existing one fails.

However, in some situations, it may be cost-effective to replace a working motor with a premium high-efficiency motor. Replacing oversized motors, particularly those oversized by 50% or more, with properly sized, premium high-efficiency motors can offer very quick payback because savings are achieved through higher efficiencies over the range of loading conditions. Generally, any motors that are above 5 to 10 hp and that operate at least half the year should be considered for replacement based on energy savings.

The chart presented in the appendix lists savings estimates possible by replacing a standard efficiency motor with a premium efficiency motor for motors that operate continuously, with an energy cost of $0.058/kWh.

Replacing the primary 50 Hp blower motor with a Premium Efficiency Motor would save approximately $929 per year. The cost of the motor would be paid back in about 4.8 years.

For the Primary 50 Hp Motor:
Electric Energy Savings: 16,026 kWh
Annual Cost Savings: $ 929
Estimated Project Cost: $ 4,500
Simple Payback: 4.8 years

ECO 8 – Install Premium-Efficiency Motor (7.5 Hp Raw Sewage Pump)

Please reference the narrative in ECO 7, as it pertains to typical motor characteristics.

Replacing one of the 7.5 Hp raw sewage pumps with a Premium Efficiency Motor would save approximately $53 per year. This equates to about a 34 year payback, so it is not cost effective to just change the motor, but a premium efficiency motor should be purchased for replacements.

For one of the 7.5 Hp Motors:
Electric Energy Savings: 919 kWh
Annual Cost Savings: $ 53
Estimated Project Cost: $ 1,800
Simple Payback: 34 years

ECO 9 – Install VFD’s on all Raw Sewage Pumps

The use of variable frequency drives (VFD) on the raw sewage pumps should be assessed at a level higher than this report in order to identify their ultimate benefit to the energy consumption of the system. If a VFD were installed, it will allow for the pumps to operate at multiple flows and partial loading, thereby optimizing the energy use. Please note that the addition of a VFD may cause harmonics within the system, and the addition of capacitors may be required. Moreover, the installation of VFD's on motors under 30 Hp are typically not cost effective, due to the cost versus the amount of savings. The owner should evaluate this option carefully before proceeding.

For the addition of a VFD in the system, drive efficiency will be neglected. Other assumed values are the same as for Opportunities 7 and 8 above. The baseline energy use for the existing system is as follows:

Shaft hp x 0.746 kW/hp = kW
7.5 hp x 0.746 kW/hp = 5.6 kW
5.6 kW x 6 hr/day x 365 days/year = 12,250 kWh/year baseline energy use

If a VFD was installed to control the pump motor, energy savings would be realized by allowing the system to run at a partial load. A load profile can be estimated using the total annual operation hours and then distributing them across several "flow fractions" that correspond to the Load Factor (sometimes referred to a Part Load Ratio or PLR). Without detailed operating analysis, this method is difficult to be accurate. For the purposes of this report, we will assume that the pump will operate at 100% for 25% of the time, at 80% for 50% of the time, and at 60% for 25% of the time. The facility may break the time down further with more accurate tracking measures if they desire. The reduced energy use related to the addition of a VFD is as follows:

(7.5 hp x 1.0^3 x 0.746 kW/hp x (6hr/day x 365 days/yr x .25 percent of use) = 3,063 kWh/yr
(7.5 hp x 0.8^3 x 0.746 kW/hp x (6hr/day x 365 days/yr x .50 percent of use) = 3,137 kWh/yr
(7.5 hp x 0.6^3 x 0.746 kW/hp x (6hr/day x 365 days/yr x .25 percent of use) = 661 kWh/yr
Total energy use with VFD installed is = **6,861 kWh/yr**

By using the PLR noted above, the proposed VFD system will use approximately 6,861 kWh/year or an annual savings of over 5,390 kWh. This translates to roughly $310 in energy cost savings. It is noteworthy that no peak demand savings are attributed to this modification because a VFD does not prevent a system from reaching 100% load. Thus, the potential peak demands are the same for both the baseline and proposed systems.

Power Savings: 0 kW
Electric Energy Savings: 5,390 kWh
Annual Cost Savings: $ 310
Estimated Project Cost: $ 6,200
Simple Payback: 25 years

ECO 10 – Replace Coarse Bubble with Fine Bubble Aeration

It was identified that the aeration system utilizes coarse bubble diffusion. The aeration process is vital to the overall operation of the facility, in that it not only provides oxygen to the wastewater, but also provides mixing to keep the solids suspended for additional treatment. As noted earlier, the aeration system accounts for 50-60% of the overall energy use at a wastewater treatment facility. This is the process that will manifest the highest overall energy savings opportunity.

The opportunity detailed in ECO 7 addressed changing the 50 Hp motor for the aeration pump to a premium efficiency pump. However, as we know, the facility is operating at 1/3 of its design capacity, and that size is most likely too large for the actual use. With this reduction in flow, it is possible that the pump may be able to be reduced in size, thereby reducing the overall energy use. The rough calculations included in the appendix show that the facility may be able to change to a 20 Hp motor. Please note, the calculations are for estimation purposes only, and the owner should contact a design professional and/or manufacturing representative to analyze this opportunity further.

In addition, the minimum dissolved oxygen requirement for the facility effluent is established in the NPDES permit at 5.0 mg/l. A review of the actual lab test results indicates that the facility is exceeding the minimum requirements, and may be over-aerating. The dissolved oxygen in November was 6.9mg/l and in July was 6.8 mg/l. This is an excessive use of energy, and is also impacting the overall efficiency of the operations of the plant.

To optimize the energy use and operations during this process, the owner should consider replacing the coarse bubble diffusion system with a fine bubble diffusion system. This change to a fine bubble system will improve the oxygen transfer efficiency, and is the best of all scenarios, taking into account the current actual flow rates. Again, please note, the calculations included in the appendix are for estimation purposes only, and the owner should contact a design professional and/or manufacturing representative to analyze this opportunity further.

By changing to a fine bubble aeration system, the facility should be able to reduce the size of the blower motor from 50 Hp to 15 Hp, while realizing an overall reduction in energy use of 228,723 kWh. This will provide a potential savings of $13,265 per year. The calculations included in the appendix and these cost projections are for estimation purposes only, and the owner should contact a design professional and/or manufacturing representative to analyze this opportunity further.

Moreover, the change to a fine bubble aeration system will help in the treatment and reduction of the solids in the system. This should result in a thicker sludge being able to be produced, and less volume to dispose of.

Power Savings: 26.11 kW
Electric Energy Savings: 228,723 kWh
Annual Cost Savings: $ 13,265
Estimated Project Cost: $ 16,000
Simple Payback: 1.2 years

Section 6.0 – Sustainable Energy Opportunities

An evaluation of sustainable design concepts is proposed for the owner to review and evaluate. These include community initiatives, renewable energy alternatives, and Village policies that may be able to improve the facilities environmental impact.

Personnel Behavior Changes: The staff and personnel at the facility will have the most significant impact with respect to energy use. The personnel must be comfortable in the work environment, or any modifications will be deemed unacceptable and will be changed back. This includes quality of light, climate control, noise generation, and the overall 'feel' of the work space. Working with the personnel to take responsibility for the facility, and encouraging positive changes to climate control, use of lighting, and use of electronic equipment will result in increased energy savings at the facility.

Buying 'Green': This means the selection of products and services that minimize environmental impacts. It includes the evaluation of not only the product itself, but also its lifecycle including raw materials, manufacturing processes, transportation of goods, storing, handling, the use of, and the actual disposal of the products. These include not only electronic goods (computers, lab equipment, etc.), but also cleaning products and office supplies.

Facility Vehicle Fuel Options: As new vehicles are purchased for the facility, the Village should consider hybrid or alternative fuel models.

Energy Cogeneration: The site currently produces methane gas naturally from the digestion process. However, due to the facility's small size (less the 1 MGD), the methane generation has a low efficiency and volume, and does not lend itself to a cost effective production opportunity.

Solar Renewable Energy: There is the potential to install solar panels to allow the facility to produce additional energy in an effort to offset the overall energy costs at the facility. If the owner is interested, we recommend contacting a professional designer to assist with this opportunity.

Wind Renewable Energy: There is the potential to install small wind turbines to allow the facility to produce additional energy in an effort to offset the overall energy costs at the facility. The facility is situated in a valley, so the opportunity may or may not be feasible. If the owner is interested, we recommend contacting a professional designer to assist with this opportunity.

Section 7.0 – Additional Energy Conservation Opportunities

The following additional opportunities are herein listed for the owner to review and evaluate. Some of these opportunities will be simplistic in nature, while others will be highly complex and require the assistance of additional design professionals for development, design, and implementation. We hope that this list is thorough, however, it may spark the facility personnel into additional ideas and thought processes to further benefit the facility.

Facility Day-lighting where Appropriate: A good way to reduce the need for interior lighting is to take advantage of the natural lighting through the use of skylights or other measures. This method of lighting can lead to higher interior heat due to radiant and convective processes, which will aid the costs of heating during the winter months, but will be a detriment to cooling in the summer.

Installation of Wind Break/Shade Opportunities: Planting trees adjacent to the facility may provide for benefits at various times of the year. The use of trees near exterior doorways may help to reduce the rush of cold air to the inside, assisting the heating process. In addition, fully developed trees may provide shading in the summer months, reducing the radiant and conductive heating to assist the cooling process. There are potential downfalls to site vegetation, which may include additional maintenance (watering, raking, debris removal), storm damage, visual obstructions, or even the potential for safety concerns.

Periodic Replacement of Air Filters: All heating and cooling systems operate most efficiently when air is allowed to move with as little obstruction as possible. Keeping the filters clean and free of debris will only serve to optimize the system and conserve energy.

Lowering the Temperature of the Hot Water Heater: Hot water heaters have multiple heating settings, and most of them are set too high, which is only wasting energy. A periodic check of the temperature setting can assure that the facility is getting the temperature it needs, without being inefficient.

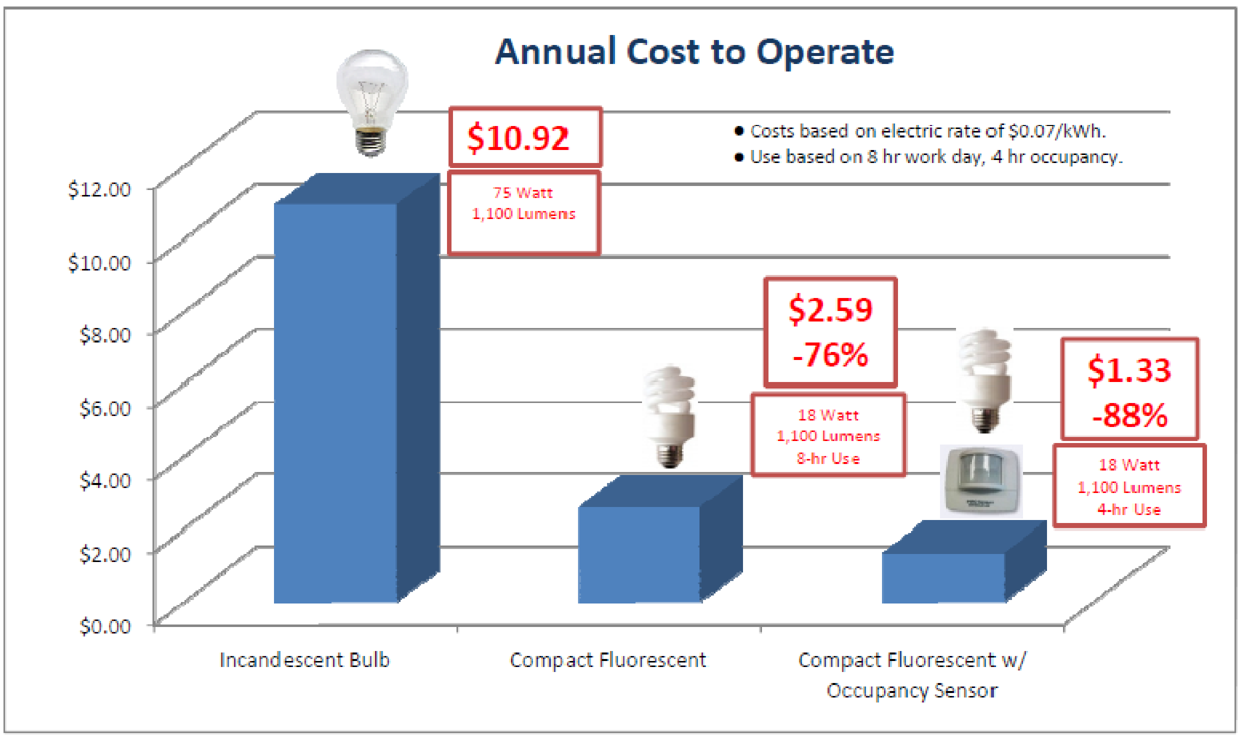
Energy Tracking: Tracking and trending of the facility energy use can lead to energy conservation opportunities. Seasonal fluctuations, as well as changes in loading during the day, may offer the ability to adjust settings and rates. This can be accomplished through manual tracking, the use of spreadsheets, or the implementation of SCADA equipment (Supervisory Control and Data Acquisition).

Equipment Operation and Maintenance: A well serviced, well maintained piece of equipment will always outperform and outlast a neglected one. The facility should have operation and maintenance guidelines, to include inspection, service, maintenance, and even the documentation of this process. The facility staff should already have these measures in place. It is typically only a matter of execution.

Proper Insulation of Walls and Ceilings: As stated in ECO 5, typically the cost of insulating the walls and ceilings of a facility have a very high simple payback, and the results are difficult to estimate. It was noted that the roof has existing rolled insulation installed. However, the facility staff can perform some additional insulating opportunities a portion at a time, and each area or section completed will help the overall energy use at the facility.

Minimize the Effects of Infiltration and Inflow (I&I): No system is leak-proof. It was noted that I&I is present in the system, but is currently not a major issue. All leaks increase in size and volume over time, so this issue will only become greater in the future. In addition, there may be illegal taps, or other sources of water entering the system. Perform a water audit, system inspection, and system analysis to determine where the water in your system is coming from. It is easy to educate the system residents on the effects of a leaky system by placing flyers in their billing invoices, and by providing community meetings periodically.

Replace Incandescent Lamps with Compact Fluorescent Lamps: There were several incandescent lamps identified in the stairway portion of the facility. Incandescent lamps are a very inefficient source of light, with less than 10% of their energy used converted to light. In addition, they have a relatively short life (750 – 3,500 hours) and have a very high heat output. Fluorescent technology provides a much more efficient lamp, with 20% of the energy used converted to light (more than twice as efficient as incandescent). In addition, compared to the incandescent, the life expectancy is between 10-20 times greater, and with the lower heat generation and low cost, this is a strong opportunity. Compact fluorescent technology has come a long way with respect to aesthetics. By paying attention to the rated lumen output, the Color Rendering Index (CRI), and the Correlated Color Temperature (CCT), the end user will often find the change non-intrusive.



In the above graph, the use of fluorescent bulbs can reduce energy costs by 76%, and by coupling that with an occupancy sensor, a total reduction in energy costs of 88% can be expected (based on occupancy use and energy costs).

Section 8.0 – What is the Next Step?

This report outlines multiple opportunities for the Village of Salineville to implement at their Wastewater Treatment Facility. It is imperative that the facility must continue to meet all safety and permit requirements, with no exception. Quality treatment must never be sacrificed. There is no cost saving measure that is worth compromised treatment quality.

The opportunity costs range from zero cost to very significant investments. It is strongly recommended that the Village start with some of the lower cost opportunities, and to continue to track the electric utility bills over time. Once the Village notices some cost savings, other opportunities may become more feasible.

The Village is encouraged to include the community in this process, by updating the customers and raising awareness through various means. It is in the customer's best interest for the utility to decrease its costs, potentially avoiding unnecessary rate increases due to inefficient operations. In the event that some of the larger projects are strongly preferred, the owner is always welcome to contact Ohio RCAP for possible grant, loan, and utility incentive options.

Appendix

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT LIGHTING AND CONTROLS

Most desirable energy efficient measures:

1. Retrofit Fluorescent T-12 with T-8 and Electronic Ballast
2. Replace Incandescent Bulbs with CFL Bulbs
3. Retrofit Incandescent Exit Signs with LED Exit Signs
4. Install Occupancy Sensors or other type of Control
   (Switch Control, Dimmer, Photo-Electric, Time clock, Occupancy Sensor, Daylighting)

Incandescent

Very Inefficient (10%), Short Life (750-3,500 hrs), High Heat
Low Cost, Simple, Instant Start
Replace with Tungsten Halogen or Compact Fluorescent Light (CFL)

Fluorescent

4-Times more Efficient and 10-20 Times Life than Incandescent, Low Cost, Less Heat
Ballasts can Hum and create Harmonic Distortion, Contain Mercury, Hard Cold Start
Replace Standard Ballasts with Electronic ones, Replace T-12 with T-8

Mercury Vapor (HID)

6-7% Efficient
Poor LLD, 5-7 min Warmup, Poor CRI (blue cast), 4-5 min cool and restart
Replace with Metal Halide for color issue, with high-pressure sodium otherwise

Metal Halide (HID)

General Lighting, 20,000 Lamp Life, Good Crisp White Light, 12-15% Efficient than I, F, and MV
Shorter HID Life, 2-5 min warmup, 10 min cool down, closed fixture due to breaking
Good color rendition, good for high-ceiling apps

High-Pressure Sodium

30% Efficient with good color rendition, 3-4 min warmup, 24,000 hour life
Golden yellow light, 1 min cool down, lamp cycles on and off at end of life
Yellow light may not be acceptable in all apps

Low-Pressure Sodium

Extremely Poor Color Rendition

LED

50,000 hour life...costs coming down

Lighting Schematic and Terminology

Each light fixture consists of a lamp (or bulb), and perhaps a ballast.

Each lamp converts energy (watts) to light (lumens). **Efficacy** is a ratio of lumens/watt.

A **lumen** is a measurement of the light that a lamp produces.

A **footcandle** is a measurement of the light density striking a surface (1 footcandle = 1 lumen over 1 square foot.

IES Recommended Light Levels

Task Area	Footcandles
General Offices	50-100
Conference Room	20-50
Drafting	100-200
Corridors/Stairs	10-20
Gymnasiums	30-50
Storage Rooms	10-50
Manufacturing	50-500

The primary rating system for the 'color' of light is the Color Rendering Index (**CRI**). It is a rating system from 0-100, and describes how well a light source brings out the true color of an object. A typical incandescent lamp has a CRI of 99, whereas a warm white fluorescent has a CRI of 52. Determine the appropriate CRI level for your work first!

Another parameter is the **CCT**, or Correlated Color Temperature, measured in °K. CCT is a measure of the color appearance to describe the apparent 'warmth' (reddish) or 'coolness' (bluish) of the lamp. <u>2700°K</u> is considered friendly, personal, and intimate; and is appropriate for homes, libraries, restaurants. <u>3500°K</u> is considered friendly, inviting, non-threatening; and is appropriate for new offices and public reception areas. <u>4100°K</u> is considered neat, clean, and efficient; and is appropriate for older offices, classrooms, and merchandisers. <u>5000°K</u> is considered bright, alert, exacting coloration; and is appropriate

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT FLUORESCENT LIGHTING AND OCCUPANCY SENSORS

Salineville, Ohio WWTF Calculations
Date: November 18, 2009

Legend: Input — Input data in the yellow cells
Totals — Calculated data cells for comparison and payback

$ 0.058 — $/kWh, Average Cost of Electricity
250 — Number of Operating Days per Year

3 — Number of Rooms for Occupancy Sensor

Energy Assessment for Existing Interior Fluorescent T-12 Fixtures w/ Standard Ballasts

Existing Facility	Fixture Quantity	Bulbs/ Fixture	Total Bulbs	Total Ballasts	Fixture Watts[1]	Total Watts	Op Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
Office	4	2	8	4	88.5	354	4	1.416	354	$ 0.08	$ 20.53
Lab	6	2	12	6	88.5	531	4	2.124	531	$ 0.12	$ 30.80
Blower	6	2	12	6	88.5	531	4	2.124	531	$ 0.12	$ 30.80
Entrance	2	2	4	2	88.5	177	4	0.708	177	$ 0.04	$ 10.27
Pump	4	2	8	4	88.5	354	4	1.416	354	$ 0.08	$ 20.53
Storage	3	2	6	3	88.5	266	1	0.2655	66	$ 0.02	$ 3.85
Bath	1	2	2	1	88.5	89	1	0.0885	22	$ 0.01	$ 1.28
Totals	26		52	26		2301		8.142	2036	$ 0.47	$ 118.06

Proposed Occupancy Sensor Installation[2]

Total Watts	Operating Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
354	2	0.708	177	$ 0.04	$ 10.27
531	2	1.062	266	$ 0.06	$ 15.40
531	2	1.062	266	$ 0.06	$ 15.40
177	4	0.708	177	$ 0.04	$ 10.27
354	4	1.416	354	$ 0.08	$ 20.53
265.5	1	0.266	66	$ 0.02	$ 3.85
88.5	1	0.089	22	$ 0.01	$ 1.28
2301		5.31	1328	$ 0.31	$ 77.00

Yearly Cost Saving = $ 41.06

[1] *Assume 1/2 fixtures @ 95 watts, 1/2 fixtures @ 82 watts (use 88.5 for average)*
[2] *Occupancy Sensors only placed in the Office, Lab, and Blower, Assume 50% reduction in lighting requirement, 3 rooms total*

3 — Number of Rooms for Occupancy Sensor

Energy Assessment for Proposed Retrofit of Interior Fixtures with T-8 Fluorescent Bulbs and Electronic Ballasts

Existing Facility	Fixture Quantity	Bulbs/ Fixture	Total Bulbs	Total Ballasts	Fixture Watts[3]	Total Watts	Op Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
Office	4	2	8	4	63	252	4	1.008	252	$ 0.06	$ 14.62
Lab	6	2	12	6	63	378	4	1.512	378	$ 0.09	$ 21.92
Blower	6	2	12	6	63	378	4	1.512	378	$ 0.09	$ 21.92
Entrance	2	2	4	2	63	126	4	0.504	126	$ 0.03	$ 7.31
Pump	4	2	8	4	63	252	4	1.008	252	$ 0.06	$ 14.62
Storage	3	2	6	3	63	189	1	0.189	47	$ 0.01	$ 2.74
Bath	1	2	2	1	63	63	1	0.063	16	$ 0.00	$ 0.91
						1638		5.796	1449	$ 0.34	$ 84.04

Proposed Occupancy Sensor Installation[2]

Total Watts	Operating Hrs/Day	Total kWh/day	Total kWh/yr	Dollars per Day	Dollars per Year
252	2	0.504	126	$ 0.03	$ 7.31
378	2	0.756	189	$ 0.04	$ 10.96
378	2	0.756	189	$ 0.04	$ 10.96
126	4	0.504	126	$ 0.03	$ 7.31
252	4	1.008	252	$ 0.06	$ 14.62
189	1	0.189	47	$ 0.01	$ 2.74
63	1	0.063	16	$ 0.00	$ 0.91
1638			945	$ 0.22	$ 54.81

[2] *Occupancy Sensors only placed in the Office, Lab, and Blower, Assume 50% reduction in lighting requirement, 3 rooms total*
[3] *T-8 Bulb fixtures estimated to be 63 watts per fixture*

Yearly Cost Saving = $ 34.02

Yearly Cost Saving = $ 29.23

587	Total kWh/year saved with Fixture Retrofit
708	Total kWh/year saved with Occupancy Sensor (no Retrofit)
$ 41.06	Total Saved per Year with Occupancy Sensor Installation
$ 34.02	Total Saved per Year with Fixture Retrofit
$ 63.25	Total Saved per Year with Fixture Retrofit and Sensor Installation

$ 100.00 — The est. cost to purchase and install and occupancy sensor, per room
$ 40.00 — The est. cost to purchase and replace the lights and ballast, per fixture

Simple Payback Calculations:

$ 300	Cost of Measure	7.31	years for Simple Payback
$ 1,040	Cost of Measure	30.57	years for Simple Payback
$ 1,340	Cost of Measure	21.19	years for Simple Payback

Note: All calculations are based on assumptions and standard values. Actual figures will be based on manufacturer, installation, and actual use.

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT LED LIGHTED EXIT SIGNS

Salineville, Ohio WWTF Calculations
Date: November 18, 2009

Legend:

Input	Input data in the yellow cells
Totals	Calculated data cells for comparison and payback

$ 0.058	$/kWh, Average Cost of Electricity
365	Number of Operating Days per Year

Energy Assessment for Existing Interior Incandescent Exit Signs

Existing Facility	Fixture Quantity	Bulbs per Fixture	Total Bulbs	Fixture Watts[1]	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Total kWh/yr	Dollars per Year
Office	2	2	4	30	60	24	1.44	$ 0.08	526	$ 30.48
Totals	2		4		60		1.44	$ 0.08	526	$ 30.48

[1] *Assume fixtures with 2 bulbs @ 15 watts each*

Energy Assessment for Proposed Retrofit of Interior Fixtures with T-8 Fluorescent Bulbs and Electronic Ballasts

Existing Facility	Fixture Quantity	Bulbs per Fixture	Total Bulbs	Fixture Watts[2]	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Total kWh/yr	Dollars per Year
Office	2	n/a	n/a	2	4	24	0.096	$ 0.01	35	$ 2.03
					4		0.096	$ 0.01	35	$ 2.03

[2] *LED Bulb fixtures estimated to be 2 watts per fixture*

491	Total kWh/year saved with Fixture Retrofit
$ 0.08	Total Saved per Day with Fixture Retrofit
$ 28.45	Total Saved per Year with Fixture Retrofit

$ 40.00	The est. cost to purchase and replace the exit signs, per fixture

Simple Payback Calculations:

$ 80	Cost of Measure	2.81	years for Simple Payback

Note: All calculations are based on assumptions and standard values. Actual figures will be based on manufacturer, installation, and actual use.

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT EXTERIOR LIGHTING AND CONTROLS

Salineville, Ohio WWTF Calculations
Date: November 18, 2009

Legend:

Input	Input data in the yellow cells
Totals	Calculated data cells for comparison and payback

$ 0.058	$/kWh, Average Cost of Electricity
365	Number of Operating Days per Year

Note: One exterior light was not controlled properly, and was on during daylight hours. Proper control will reduce use 2/3.

Energy Assessment for Existing Exterior Fixtures By Location and Type										Proposed Occupancy Sensor Installation[2]				
Existing Area	Fixture Type	Fixture Quantity	Bulbs per Fixture	Fixture Watts[1]	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Dollars per Year	Total Watts	Operating Hrs/Day	Total kWh/day	Dollars per Day	Dollars per Year
Office	HP Sod.	1	1	295	295	24	7.08	$ 0.41	$ 149.88	295	8	2.36	$ 0.14	$ 49.96
Parking	HP Sod.	2	1	295	590	8	4.72	$ 0.27	$ 99.92	590	8	4.72	$ 0.27	$ 99.92
Facility	HP Sod.	5	1	295	1475	8	11.8	$ 0.68	$ 249.81	1475	8	11.8	$ 0.68	$ 249.81
							23.6	$ 1.37	$ 499.61			18.88	$ 1.10	$ 399.69
													Yearly Cost Savings =	$ 99.92

[1] Assumed that the exterior light is high-pressure sodium with a nominal 250 watt lamp, actual watts are 295.

[2] Control Measures may need serviced, cleaned, cleared, or maintained to assure proper performance.

1723	kWh, Electric Energy Savings per Year
$ 100	Annual Cost Savings
$ 50	Estimated Project Cost for New Sensor (verify cleaning and maintenance first)
0.50	years, Simple Payback

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT MOTORS; 50 Hp MOTOR

Salineville, Ohio WWTF Calculations **Legend:** Input — Input data in the yellow cells

Date: November 18, 2009

Annual Savings Based On:

$ 0.058	$/kWh, Average Cost of Electricity
24	Number of Operating Hours per Day
365	Number of Operating Days per Year
75%	Estimated Loading Factor

Potential Savings for Premium Efficiency Motors

			Pre - Retrofit			Post - Retrofit							
Motor hp	Est. Annual Hours	Est. Loading Factor	Est. [1] Efficiency	Full-Load Input(kW)	Est. Input(kW)	NEMA Rated [2] Efficiency	Rated Full-Load Input(kW)	Est. Input(kW)	Power Savings (kW)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	Est. Motor Cost $	Simple Payback years
1.0	8760	75%	75%	0.99	0.75	85.5%	0.87	0.65	0.09	803	$ 46.55		
1.5	8760	75%	77%	1.45	1.09	86.5%	1.29	0.97	0.12	1,049	$ 60.82		
2.0	8760	75%	79%	1.89	1.42	86.5%	1.72	1.29	0.12	1,076	$ 62.40		
3.0	8760	75%	81%	2.76	2.07	89.5%	2.50	1.88	0.20	1,724	$ 99.99		
5.0	8760	75%	82%	4.55	3.41	89.5%	4.17	3.13	0.29	2,504	$ 145.25		
7.5	8760	75%	84%	6.66	5.00	91.7%	6.10	4.58	0.42	3,675	$ 213.13		
10.0	8760	75%	85%	8.78	6.58	91.7%	8.14	6.10	0.48	4,213	$ 244.35		
15.0	8760	75%	86%	13.01	9.76	92.4%	12.11	9.08	0.68	5,921	$ 343.43		
20.0	8760	75%	87%	17.15	12.86	93.0%	16.04	12.03	0.83	7,269	$ 421.61		
25.0	8760	75%	88%	21.19	15.89	93.6%	19.93	14.94	0.95	8,331	$ 483.17		
30.0	8760	75%	89%	25.15	18.86	93.6%	23.91	17.93	0.93	8,119	$ 470.92		
40.0	8760	75%	89%	33.53	25.15	94.1%	31.71	23.78	1.36	11,939	$ 692.44		
50.0	8760	75%	89%	41.91	31.43	94.5%	39.47	29.60	1.83	16,026	$ 929.49	$ 4,500	4.84
60.0	8760	75%	89%	50.29	37.72	95.0%	47.12	35.34	2.38	20,869	$ 1,210.38		
75.0	8760	75%	90%	62.17	46.63	95.4%	58.65	43.99	2.64	23,119	$ 1,340.90		
100.0	8760	75%	90%	82.89	62.17	95.4%	78.20	58.65	3.52	30,825	$ 1,787.87		
125.0	8760	75%	90%	103.61	77.71	95.4%	97.75	73.31	4.40	38,532	$ 2,234.83		
150.0	8760	75%	91%	122.97	92.23	95.8%	116.81	87.60	4.62	40,479	$ 2,347.78		
200.0	8760	75%	91%	163.96	122.97	95.8%	155.74	116.81	6.16	53,972	$ 3,130.38		

Notes: [1] Existing efficiency based on ASHRAE Fundamentals

[2] Proposed efficiency based on NEMA nominal efficiencies for premium efficiency motors

ENERGY EFFICIENCY MEASURES - INSTALLING ENERGY-EFFICIENT MOTORS; 7.5 Hp MOTOR

Salineville, Ohio WWTF Calculations

Date: November 18, 2009

Legend: Input — Input data in the yellow cells

Annual Savings Based On:

$ 0.058	$/kWh, Average Cost of Electricity
6	Number of Operating Hours per Day
365	Number of Operating Days per Year
75%	Estimated Loading Factor

Potential Savings for Premium Efficiency Motors

Motor hp	Est. Annual Hours	Est. Loading Factor	Pre - Retrofit: Est. [1] Efficiency	Pre - Retrofit: Full-Load Input(kW)	Pre - Retrofit: Est. Input(kW)	Post - Retrofit: NEMA Rated [2] Efficiency	Post - Retrofit: Rated Full-Load Input(kW)	Post - Retrofit: Est. Input(kW)	Power Savings (kW)	Annual Energy Savings (kWh)	Annual Cost Savings ($)	Est. Motor Cost $	Simple Payback years
1.0	2190	75%	75%	0.99	0.75	85.5%	0.87	0.65	0.09	201	$ 11.64		
1.5	2190	75%	77%	1.45	1.09	86.5%	1.29	0.97	0.12	262	$ 15.20		
2.0	2190	75%	79%	1.89	1.42	86.5%	1.72	1.29	0.12	269	$ 15.60		
3.0	2190	75%	81%	2.76	2.07	89.5%	2.50	1.88	0.20	431	$ 25.00		
5.0	2190	75%	82%	4.55	3.41	89.5%	4.17	3.13	0.29	626	$ 36.31		
7.5	2190	75%	84%	6.66	5.00	91.7%	6.10	4.58	0.42	919	$ 53.28	$ 1,800	33.78
10.0	2190	75%	85%	8.78	6.58	91.7%	8.14	6.10	0.48	1,053	$ 61.09		
15.0	2190	75%	86%	13.01	9.76	92.4%	12.11	9.08	0.68	1,480	$ 85.86		
20.0	2190	75%	87%	17.15	12.86	93.0%	16.04	12.03	0.83	1,817	$ 105.40		
25.0	2190	75%	88%	21.19	15.89	93.6%	19.93	14.94	0.95	2,083	$ 120.79		
30.0	2190	75%	89%	25.15	18.86	93.6%	23.91	17.93	0.93	2,030	$ 117.73		
40.0	2190	75%	89%	33.53	25.15	94.1%	31.71	23.78	1.36	2,985	$ 173.11		
50.0	2190	75%	89%	41.91	31.43	94.5%	39.47	29.60	1.83	4,006	$ 232.37		
60.0	2190	75%	89%	50.29	37.72	95.0%	47.12	35.34	2.38	5,217	$ 302.59		
75.0	2190	75%	90%	62.17	46.63	95.4%	58.65	43.99	2.64	5,780	$ 335.22		
100.0	2190	75%	90%	82.89	62.17	95.4%	78.20	58.65	3.52	7,706	$ 446.97		
125.0	2190	75%	90%	103.61	77.71	95.4%	97.75	73.31	4.40	9,633	$ 558.71		
150.0	2190	75%	91%	122.97	92.23	95.8%	116.81	87.60	4.62	10,120	$ 586.95		
200.0	2190	75%	91%	163.96	122.97	95.8%	155.74	116.81	6.16	13,493	$ 782.59		

Notes:
[1] Existing efficiency based on ASHRAE Fundamentals
[2] Proposed efficiency based on NEMA nominal efficiencies for premium efficiency motors

Diffused Aeration Design Spreadsheet

250,000	Design Flow, gpd	1.00	Con: Lbs oxygen req'd per lb of BOD removed (typ. 1.0)
81,000	Actual Flow, gpd	4.57	ConN: Lbs oxygen req'd per lb of TKN oxidized to nitrate (typ. 4.57)
220	BOD(in), mg/l	8.34	1 gallon = 8.34 lbs
5	BOD(ef), mg/l	0.50	Coarse Bubble Aeration System typical AOR/SOR Ratio
40	TKN(in), mg/l	0.33	Fine Bubble Aeration System typical AOR/SOR Ratio
5	TKN(ef), mg/l	0.75%	Coarse Bubble typical Oxygen Transfer Efficiency
11	Diffuser Depth (ft)	2%	Fine Bubble typical Oxygen Transfer Efficiency
		0.0173	1 SCFM of air contains 0.0173 pounds of oxygen

Calculating Actual Oxygen Requirements:

Calculate the amount of Oxygen required for BOD oxidation from influent loading in aeration basins (lb/d)

AOR bod = (BODin) x (8.34) x (Con) x (Q_{MGD})

Design	458.70	lb/d	Actual	148.62	lb/d

Calculate the amount of Oxygen required for BOD oxidation from side loading in aeration basins (lb/d)

AOR bod = (BODsl) x (8.34) x (Con) x (Q_{MGD})

Design	114.68	lb/d	Actual	37.15	lb/d
Design	573.38	lb/d	Actual	185.77	lb/d

Calculate the amount of oxygen required for 50% nitrification in the summer (lb/d)

AOR - Oreq(lb/d)tkn = (TKNin - TKNef) x (8.34) x (Con N) x (Q_{MGD})

Design	381.14	lb/d	Actual	123.49	lb/d
Total Design	954.51	lb/d	Total Actual	309.26	lb/d

Determining Air Requirements:

	Design			Actual	

Calculate the Standard Oxygen Requirement:

SOR = AOR / Ratio Factor (Coarse Bubble Ratio = 0.50, Fine Bubble Ratio = 0.33)

Coarse Bubble	1909.03	lbs/day O2	Coarse Bubble	618.52	lbs/day O2
Fine Bubble	2892.46	lbs/day O2	Fine Bubble	937.16	lbs/day O2

Demand O2(lbs/min) = SOR / 1440

Coarse Bubble	1.33	lbs/min	Coarse Bubble	0.43	lbs/min
Fine Bubble	2.01	lbs/min	Fine Bubble	0.65	lbs/min

Quantify the submergence Oxygen Transfer Efficiency (0.75% Coarse, 2% Fine, at diffuser depth

Coarse Bubble	8.25%	OTE	Fine Bubble	22.0%	OTE

Calculate O2 Transfer per minute = 0.0173 * OTE (1 SCFM contains 0.0173 pounds of oxygen)

1 SCFM will transfer oxygen at:

Coarse Bubble	0.0014	lbs/min	Fine Bubble	0.0038	lbs/min

SCFM Req'd = Demand O2 / Transfer O2

Coarse Bubble	929	SCFM	Coarse Bubble	301	SCFM
Fine Bubble	528	SCFM	Fine Bubble	171	SCFM

Estimate Blower Horsepower Required and Annual Energy Costs

$ 0.058	Energy Cost, $/KWh	2.31	1 psi = 2.31 feet of water
24	Hrs/day of operation	70%	Mechanical Efficiency
365	days/year of operation	2	Dynamic Pressure, head loss assoc w/ piping and diffuser(a function of the type of piping, length, diameter, and tortuosity (bend, elbows, etc) and diffuser
		dep/2.31	P = Blower discharge pressure in PSIG (depth pressure + dynamic pressure)
		746	1 Hp = 746 watts

0.23 lbs of oxygen per pound of air

Calculate the Brake horsepower of Blower (BHP)

BHP = SCFM * 0.23 [((14.7 + P) / 14.7) ^ 0.283 - 1] / Mech. Efficiency

			Peak Hp	Selected Hp	Cost/day	Cost/year	
Design Coarse Bubble	34	Hp	43	50	$ 52	$ 18,951	
Design Fine Bubble	20	Hp	25	30	$ 31	$ 11,371	Potential Savings
Actual Coarse Bubble	11	Hp	14	20	$ 21	$ 7,872	per year
Actual Fine Bubble	6	Hp	8	15	$ 16	$ 5,904	$ 13,047

Costs are calculated by multiplying the: (Hp * 0.746 kw/Hp * hours of operation * Energy Cost