

Improved Efficiency at Wastewater Treatment Facilities

Initiative Summary: Improving efficiency at wastewater treatment facilities through outreach programs based on sustainable infrastructure principles.

Goals: Assist 50 percent more treatment plants per year to improve efficiency (a 50 percent improvement over the current 6–8 treatment plants)

Implementation Period: 3–4 additional treatment plants per year from 2013 through 2020

Other Involved Agencies: DEP, Outreach Assistance Provider Program (OAPP), wastewater system owners and operators.

Implementation Steps:

- DEP—Increase personnel assigned to OAPP wastewater treatment plant outreach
- Provide funding for additional training seminars/webinar or other venues (possibly via state energy plan funding)
- Provide grant funding for wastewater plant upgrades.
- Emphasize outreach to larger, > 2 million gallons per day (mgd), operations than those analyzed in this work plan for even more significant benefits
- Encourage entities to utilize EPA's *Energy Management Handbook for Wastewater and Water Utilities* and available baseline assessment software as part of facility outreach program: (http://water.epa.gov/infrastructure/sustain/cut_energy.cfm)
- Provide exemptions from Water Quality Management (Part II) permitting if intent of equipment upgrade is for increasing energy efficiency and does not change the overall functionality of a wastewater treatment operation.
- DEP in collaboration with other professional associations provide accredited energy efficiency training programs to help certified operators meet mandatory continuing education unit requirements and professional development hours.

Data sources/Assumptions/Methods for GHG:

Based on past program performance, treatment facilities visited by this program tend to treat around 1–2 mgd. Calculations on GHG savings are as follows:

- 2,500 Kilowatt-hours (kWh)/mgal treated x 1.5 mgal/day facility = 3,750 kWh/day¹
- 3,750 kWh x 365 days = 1,368,750 kWh/yr

Savings at these facilities is estimated at 10 percent, so:

- 1,368,750 kWh/yr x 0.10 = 136,875 kWh/yr savings per facility

¹ Electricity usage was determined by surveying twelve wastewater treatment plants in Pennsylvania and plotting electricity usage against the size of facility. This information was provided by Jim Elliott, Gannett Fleming, Inc. to Rachel Anderson, CCS via email, June 2009.

Converting to CO₂ emissions:

$$136,875 \text{ kWh/yr} \times 7.18 \times 10^{-4} \text{ tCO}_2/\text{kWh}^2 = 98.3 \text{ tCO}_2/\text{yr per facility}$$

Table 1 summarizes the GHG savings possible from implementing a 50 percent increase in treatment plant upgrades. By upgrading an average of 3–4 additional facilities per year, a total of 0.022 MMtCO₂e can be saved.

Table 1. GHG Savings and Costs of Treatment Plant Upgrades

Year	Average Additional Treatment Plants Improved	Savings per Facility (metric tons CO ₂ e/year)	Total Savings Above BAU (metric tons CO ₂ e/year)	Annualized Capital Costs (\$)	Cost Savings to Plants (\$)	Cost of Additional Personnel	NPV of Net Costs (2007\$)	Cost-Effectiveness (\$/tCO ₂ e)
2013	3.5	98.3	1,376	7,103	(\$415,399)	44,761	(\$236,370)	
2014	3.5	98.3	1,720	8,879	(\$498,479)	44,761	(\$289,345)	
2015	3.5	98.3	2,064	10,654	(\$581,559)	44,761	(\$336,739)	
2016	3.5	98.3	2,408	12,430	(\$664,638)	44,761	(\$378,963)	
2017	3.5	98.3	2,752	14,206	(\$747,718)	44,761	(\$416,403)	
2018	3.5	98.3	3,096	15,981	(\$830,798)	44,761	(\$449,417)	
2019	3.5	98.3	3,441	17,757	(\$913,878)	44,761	(\$478,343)	
2020	3.5	98.3	3,785	19,533	(\$996,958)	44,761	(\$503,495)	
TOTAL			20,642				(\$3,089,075)	(\$149.65)

Data Sources/Assumptions/Methods for Costs:

The cost of implementation of treatment plant upgrades is estimated at \$5,000 per plant, and upgrades result in an average cost savings of \$25,000 per plant per year.³ Upgrades were annualized over 15 years at a 5 percent interest rate. The cost to DEP to hire additional personnel necessary to increase outreach efforts is in a range of between \$35,000–\$50,000. The total cost savings over the policy period is \$3.1 million discounted to 2010 dollars, as summarized above in Table 1.

Notes/Other Considerations:

The DEP Office of Water Management proposes several methods to improve efficiency in order to maintain sustainable infrastructure (SI) within wastewater treatment systems. The efficient use of energy is crucial for sustaining infrastructure and national security. The end of electricity rate caps further exacerbates this issue.

Wastewater treatment plants typically are the largest consumer of electricity on most municipal bills, often consuming more than one-third of the energy consumed for all municipal services. In many instances, opportunities exist to reduce energy consumption at these facilities. To assist treatment plants in improving efficiency, DEP provides outreach to these facilities, teaching

² Kilowatt-hour conversion from <http://www.epa.gov/grnpower/pubs/calcmeth.htm>, accessed May 2009.

³ Thomas Brown, PA DEP; communicated via email to Rachel Anderson, CCS, May 2009.

system operators how to use the system in the most efficient manner for treatment and suggesting ways to reduce the amount of energy required to operate the facility while maintaining compliance with permit limits and conditions.

Three basic types of municipal treatment plants are primarily in use today: activated sludge, fixed film, and lagoon systems. Of the many treatment facilities in Pennsylvania, approximately 70 percent are activated sludge facilities. Activated sludge facilities inject diffused air into an aeration basin to sustain a biological growth in order to treat the wastewater. The aeration basins that these facilities require are the largest consumer of electricity in wastewater treatment systems. Opportunities exist to improve efficiency in many of these facilities throughout the state.

OAPP uses part-time wage payroll instructors who are certified operators or specialists in a given field. These instructors provide on-site technical, managerial, and financial assistance to wastewater system owners and operators. The program responds to system needs identified by DEP regional staff, local government associations, or system personnel. On-site assistance and training are provided through a combination of video, classroom, and Web-based training and one-on-one assistance to address specific system problems. Notwithstanding the uncertainties associated with funding and staffing levels, the OAPP plans to accomplish the following:

- Continue on-site technical assistance for facilities requesting assistance with energy efficiency. The average activated sludge wastewater treatment plant consumes 6,000 kWh/million gallons of wastewater treated. At approximately \$0.08/kWh, the energy consumption is estimated at \$500/million gallons treated. Using energy audits under the auspices of OAPP, DEP proposes to assist approximately 6 wastewater systems in reducing energy consumption per year, with a focus on assisting at least one in each DEP region. On average, these audits will result in an estimated annual energy savings of 10 percent–15 percent in the cost of kWh per treatment plant. It must be kept in mind that due to the relatively low cost of electricity in the past, the preference for wastewater treatment has been aerobic treatment processes. With the expiration of electricity rate caps this may no longer be the most cost-effective solution. Therefore, based on the costs per kWh and available funding, a further focus of this outreach effort will be to encourage and re-educate the owners and operators of wastewater treatment systems on the benefits of more energy-efficient and effective wastewater treatment processes related to anaerobic treatment.
- Continue collaboration with DEP Central and Regional staff in providing training opportunities for operators in conjunction with various associations.
- Integrate the principles of SI in all technical assistance provided by OAPP. This would include providing training with regard to all aspects of SI.
- Distribute the DVD on energy efficiency and other tools for SI.
- In conjunction with the Pennsylvania Water Environment Association, another special Nutrient Reduction Technology conference is scheduled for this fall in the Scranton area on September 10–12, 2009. This year's conference will include energy efficiency, improvements to water quality, and other SI principles.

- Enhance the operator information center web site "Technical Corner" as it relates to SI, energy efficiency, and other operational issues.
- Include SI principals as part of wastewater operator certification program

The DEP Wastewater Outreach Program has provided assistance in energy efficiency since 1993. Unfortunately, in the 1990s energy costs were not high enough to cause a significant amount of interest. While the program had several success stories in the past, many people simply were not tuned into the idea of energy efficiency. In one case, the program saved a municipality over \$100,000 annually (in an approximately 6 mgd system). By today's standards, this type of savings would be greatly magnified. With the expiration of electricity rate caps and the increasing volatility of oil prices, people are now starting to pay attention and ask questions.

Below are examples of DEP's past accomplishments:

- On-site technical assistance to Ridgeway Borough on energy efficiency and process control utilized the process of denitrification to save energy and chemical costs. This process utilizes the nitrate that is produced in the process of nitrification for facultative organism respiration. This results in improved water quality by reducing total nitrogen released to the receiving stream and saves money. With an investment of \$500, Ridgeway was able to document savings of \$31,000 annually in energy and chemical costs, in addition to improving the quality of its effluent.
- On-site energy efficiency technical assistance was provided to the City of Warren. In this system older sparge ring diffusers were used for mixing and aeration. By changing the cycles of mixing and aeration, the system could realize a savings of several thousand dollars per month. This project is still underway.
- DEP Central and Regional office staff collaborated to produce a continuing education training program titled "Flush Away High Energy Costs." In conjunction with PA Rural Water, this training session was piloted in the northwestern region and was well received by operators throughout the region. This session provides operators with the tools they need to reduce energy costs within their systems, while maintaining or improving water quality.
- In 1996, an energy efficiency in wastewater treatment systems video was produced jointly by DEP and the Maryland Center for Environmental Training. In the past year, this video was upgraded and digitized to a DVD format so it can be widely distributed.
- A training session was held in the State College area for DEP Central and Regional Office staff on energy efficiency in water/wastewater systems. This session followed a format similar to the "Flush Away High Energy Costs" operator training session. This session will help regional staff to further spread the word about energy efficiency.
- A special conference on total nutrient reduction was held in the Lancaster area last fall. This sold-out event provided operators and managers with tools needed to improve reduction of nutrients and increase efficiency.
- Assistance was provided to program staff involved in a pilot project with Montgomery County Community College to create a certificate program focusing on water and wastewater treatment. Based on the input provided, the pilot program will be modified to include basics of SI with an emphasis on energy efficiency, as well as effective process control.

- The DEP's Southeast Regional Office held a joint meeting for wastewater treatment plant officials. The meeting was held in conjunction with the U.S. EPA, PECO and the Delaware Valley Regional Planning Commission. Continuing education credits were provided and the program is viewed as a successful model to be replicated.

All treatments plants produce excess solids, often referred to as sludge or biosolids. These excess solids have to be treated before their ultimate disposal. There are two basic types of treatment for these solids: aerobic digestion and anaerobic digestion. Anaerobic treatment tends to be more energy neutral or even produces energy, as the methane produced through this process can be used as a fuel. Unfortunately, this technology is not used in many instances in Pennsylvania, due to past problems with the operation, mostly due to problems in handling the gases produced in the treatment process. Technology in this arena has improved in recent years, making the management of these systems safer and more efficient. PA DEP currently has a pilot project in the works that will use anaerobic treatment and, depending on the outcome of this project, expects that other facilities may consider this option moving forward.

In the past fiscal year, DEP had several projects in this arena. These projects are closely tied into the overall goal of SI. In many cases, treatment systems have operated in a fashion set forth by previous generations, where energy consumption was not a large concern. Taking a moment and asking why we operate in this fashion can lead to significant opportunities for reduced energy costs and improved water quality. By today's standard, any treatment facility that is required to nitrify should also consider denitrification, as it can lead to reduced operating costs, lower sludge production, and improved water quality.

The savings realized by energy-efficient measures could easily be used to fund improved water quality. In fact, in cases where a facility starts using denitrification for the beneficial uptake of nitric acid, there would be a recovery of 60 percent of the cost of nitrification and improved water quality at the same time. Cost savings are certain, and the savings could escalate as energy costs continue to rise.

It is a goal for systems to be self-sustaining in the water/wastewater industry. The single largest cost for a wastewater system is the cost of aeration. Fine bubble aeration could reduce those costs by 50 percent. This money could be incorporated into sustainable infrastructure.

Potential Overlap:

None

Subcommittee Comments

Increasingly more stringent NPDES effluent limits may require more energy intensive treatment (nutrients), additional treatment chemicals using pump delivery systems, electronic monitoring equipment, etc. which is not accounted for in the projected costs/cost savings.