

Alternative Circulation

By **Stephen N. Zeller, Archis Ambulkar**
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In 2008, Brinjac Eng. Inc. assisted Wiconisco Township, Dauphin County, Pa., with obtaining a Growing Greener II Innovative Wastewater Treatment Grant Award for \$84,000 to reduce the township's treatment plant carbon footprint. The other factors considered for treatment plant upgrades included costs associated with 24/7 operations of existing grid-powered aerators, aging and maintenance issues with these aerators, algal control, process improvements and minimizing sludge pumping from lagoons.

Solar circulation system
upgrade generates
operational cost savings

Wiconisco Township owns and operates a 0.125-million-gal-per-day (mgd) secondary treatment plant, permitted under the National Pollutant Discharge Elimination System permit No. PA 0084697, year 2007, and discharges into Bear Creek, a tributary of Wiconisco Creek. The system comprises two lagoons, each divided into two sections with a baffle. The inlet section is completely aerated, and the second section is partially aerated, resulting in facultative conditions.

The existing aeration system at the lagoons consisted of eight grid-powered aerators, with three 5-hp grid-powered aerators installed in the complete mix zones of each lagoon and one 7.5-hp aerator installed in the facultative area of each lagoon. These aerators were required to operate 24/7 due to the complete mix needs and the design of wastewater treatment plant. As a part of process upgrades, the project proposed for installation of one SB10,000 SolarBee unit in lagoon No. 1 and two SB10,000 SolarBee units in lagoon No. 2. Four of the existing aerators were removed from the lagoons, and four aerators were designated as backup (two 5-hp aerators per lagoon: one operating and one standby) to the new solar units.

The solar upflow system involves bringing up water from a desired depth and transporting it horizontally long distances across the water surface. Water brought up to the surface moves radially in all directions away from the SolarBee. With this pattern, the treatment process at Wiconisco changed from aerated lagoons to a system resembling advanced, completely circulated facultative lagoons.

Cost Comparison

Prior to selecting the solar circulation system, cost for replacement of existing mechanical aerators with similar new aerators was obtained. The equipment costs for six 5-hp tornado aerators and two 7.5-hp tornado aerators obtained from Aeromix Systems Inc. was approximately \$64,600, with an estimated total installed cost of \$84,000. The installed cost for three new solar circulation units obtained from SolarBee Inc. was approximately \$140,700.

Considering the Growing Greener II Innovative Wastewater Treatment Grant Award for \$84,000, the actual solar units cost for the township was \$56,700. This effective cost was less than the costs associated with the replacement of existing aeration units,

for which no grant money was available. In addition, the utilization of solar units in combination with some of the existing aerators was expected to reduce operational and maintenance cost. Finally, a 20-year life-cycle cost analysis was performed comparing solar units with replacement of mechanical aeration units assuming no grant.

Although the life-cycle cost analysis goal for solar system option was the replacement of all existing mechanical aerators with newly installed solar units, the actual operational changes were planned in phases. For cost comparison purposes, however, the solar option was considered as a stand-alone option (with no mechanical aerators in operation). Based on the 24/7 operational requirement of existing aerators in the lagoons, total annual electrical costs for these mechanical aerators (existing or new) was estimated around \$16,300 per year. Considering an interest rate of 3%, the total equivalent cost for no improvements was around \$339,207. Cost for installation and operation of new mechanical aerators was estimated around \$403,807, whereas for the solar aeration system (with no mechanical aerators) this cost was estimated to be \$152,602.

Upgrade Analysis

With these considerations, Wiconisco Township installed three SolarBee solar-powered aerators/circulators in March 2009. The treatment plant performance was analyzed prior to and after the aeration system upgrades. The Wasteload Management Chapter 94 Reports as well Discharge Monitoring Reports data indicated that the plant was able to achieve treatment within the prescribed effluent permit limits after the upgrades.

The wastewater treatment plant receives its electrical supply from PPL Electric Co. With the installation of new solar units, the electricity data was monitored from March 2008 to March 2010. The annual average monthly electricity consumption prior to the upgrades (March 2008 to February 2009 period) was around 22,230 kWh per month. With the installation of solar units in March 2009, and considering time required for process stabilization, the average electricity consumption at the plant for the last six months of operations (e.g., October 2009 to March 2010) was considered for comparison purpose.

The average electricity consumption for this six-month period was around 11,830 kWh per month, indicating a reduction in the consumption by about 47% compared to that before upgrades. Correspondingly, the annual average monthly electric bill from the March 2008 to February 2009 time



The township installed three solar-powered units in 2009, reducing electricity consumption.

period (before upgrades) was \$1,600 per month. The average electricity bill for the last six months of operation (October 2009 to March 2010) was \$1,090 per month, indicating a 32% reduction in electrical cost. Some additional cost savings were compensated due to the increase in unit electricity costs from \$0.07 per kWh to \$0.12 per kWh.

It is noted that although the PPL electrical bills correspond to the treatment plant (instead of only aerators), apart from solar system upgrades, the Chapter 94 Reports did not call for any other significant plant modifications during this operational period that would result in significant changes to electricity consumption. Hence, these energy savings were considered to be directly related to the partial replacement of

existing aerators with solar units. With the increase in energy savings, the carbon footprint of the plant based on energy consumption decreased from approximately 9,560 kg carbon dioxide (CO₂) per month (average for March 2008 to February 2009 period before upgrades) to approximately 5,090 kg CO₂ per month (last six-month operation during October 2009 to March 2010 period), indicating about a 47% decrease.

With the current operations, only four of the existing eight aerators (two in each lagoon: one operating and one standby) are retained as backup to the solar units. Further reduction in mechanical aerators will be performed gradually based on the system performance and permit compliance. Overall, the solar units served as an appropriate upgrade alternative

that resulted in energy and cost savings as well as reduction of the treatment plant carbon footprint.

The SolarBee aerators are doing their job as far as saving electricity and also handling algae control without the treatment of biological bugs, according to plant operations staff. **WWD**

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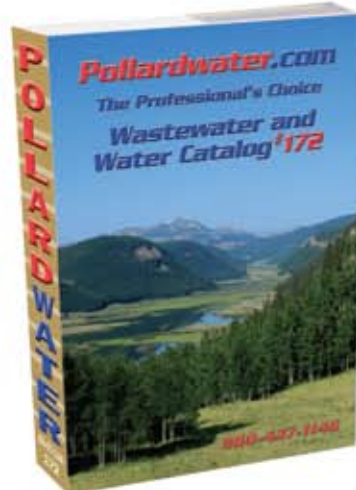
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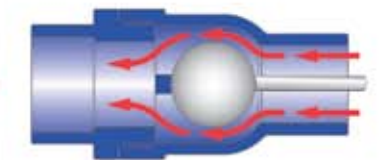
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