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TENNESSEE: QUEST FOR ENERGY EFFICIENCY INSPIRES OPERATORS' PURSUIT OF NUTRIENT REMOVAL

Energy Efficiency Measures Provide Opportunities for Nutrient Reduction

At many publicly owned treatment works (POTWs), operators experimenting with cost-saving energy efficiency find their plants also benefit from improved nitrogen removal. These successes provide staff with confidence to implement low-cost modifications and operational changes to further reduce effluent nutrient discharges. EPA's **National Study of Nutrient Removal and Secondary Technologies** investigates optimization efforts across the country, and this fact sheet highlights achievements at the Harriman POTW in Tennessee.

In 2011, the Tennessee Water and Wastewater Energy Efficiency Partnership (TWEEP) was formed between many associations, including EPA and the Tennessee Department of Environment and Conservation (TDEC). The partnership supplied Tennessee wastewater utilities with energy efficiency tools and expertise to support operators in reducing energy costs and pollution. This included providing in-person technical assistance to staffs across Tennessee, including Harriman POTW in 2014.

Harriman POTW

Harriman POTW has a design capacity flow of 1.5 million gallons per day (MGD) and an average daily flow of 0.5 MGD. The plant has two equalization basins, two oxidation ditches, two secondary clarifiers, chlorine disinfection, and two aerobic digesters. Each ditch has two fixed-speed rotors, and no chemicals are added for phosphorus removal.

Prior to the partnership's visit, aeration for Harriman POTW's oxidation ditches and digesters consumed

Harriman Staff: Donnie Fitzhugh and Ray Freeman

43% of the plant's total energy use. The four ditch rotors ran continuously and the digester blowers ran 16 hours each night during the week and continuously on weekends.

Harriman POTW's staff started by following the partnership's suggestion to cycle the four rotors 1 hour on/1 hour off, which decreased aeration energy use by 50%. They noticed a drop in effluent Total Nitrogen (TN), although concentrations were still high, averaging over 20 mg/L. Inspired to realize greater energy savings, staff continued to refine the plant's aeration cycling on their own, resulting in a TN concentration consistently under 10 mg/L beginning in 2017.

In July 2018, Ray Freeman took over as Chief Plant Operator, and, assisted by Operator Donnie Fitzhugh, the two began a quest to drive effluent TN as low as possible. They experimented by ratcheting down rotor

run times in small increments and alternating the rotors' operation. The plant now operates 1 rotor per ditch, cycling 1 hour on/2 hours off in the summer and 1 hour on/3 hours off in the winter.

> "I started by taking baby steps to reduce power consumption. In that process, I could see the reduction in nitrogen. I just kept altering DO levels and equipment run times until I could no longer reduce TN without negatively effecting other parameters, such as BOD." -Ray Freeman

Dissolved oxygen (DO) readings are obtained with a hand-held probe near the influent inlet on the aft side of the first rotor. The DO upper set point averages 1.75 mg/L on the aft side of the rotor, with the lower set point targeted to 0.18 mg/L or less. The plant does have a limited SCADA system that incorporates some timers for the digesters, but the two operators closely monitor and manage all aeration cycling in the ditches by hand. Beginning in 2020, the average effluent TN concentration was an impressive low of 2 mg/L.

Ray also adjusted the digester valves so only one blower is needed to aerate both digesters for six hours each night, further reducing plant energy costs. These aeration strategies save the plant $30,000/year in energy costs, achieving a total reduction in aeration energy use nearing 85%.

Ray and Donnie have now turned their attention to reducing total phosphorus (TP) effluent concentrations and improving the plant's biological phosphorus removal. Over the summer, they began interrupting the 1 hour on/2 hours off schedule twice each day to let the rotors run for 2 hours to drive DO up to 2 mg/L. This was followed by 2 hours off before resuming the 1 hour on/2 hours off schedule. When the plant transitioned to the winter 1 hour on/3 hours off schedule, the 2 hours on/2 hours off cycle was introduced only once per day. Harriman POTW's average effluent TP concentration has already been reduced 25% by these rotor cycling changes over the course of the year.

Harriman Daily Maximum Monitoring Data

	Effluent TN Concentration (mg/L as N)	Effluent TP Concentration (mg/L as P)
Q1 – Q4 2017*	**9.2**	**1.9**
Q1 – Q4 2020	**2.1**	**1.4**
Percent Removal	**77%**	**25%**

**Monitoring data from the first phases of optimization (2014-2016) are not available.*

Optimization Opportunities and Benefits

Optimizing existing treatment systems not only effectively reduces nutrient discharges from POTWs, but it can also result in significant energy and cost savings for utilities. Support from regulatory agencies, onsite consulting, and, most importantly, operator ambition and enthusiasm enabled these Tennessee POTW operators to reach both their nutrient reduction and energy efficiency goals.

Acknowledgements

Nutrient monitoring data were collected from EPA's Integrated Compliance and Information System-National Pollutant Discharge Elimination System (ICIS-NPDES) and internal plant records. Energy savings are also from internal plant records. TDEC and the TWEEP Partnership Team aided POTWs in Tennessee in improving their energy efficiency and, in some cases, nitrogen discharges. Grant Weaver of CleanWaterOps has supported Harriman staff with improving biological phosphorus removal.