Innovation Drives South Granville Water and Sewer Authority

NC WWTP embraces new technology to achieve consistent effluent phosphorus levels

By Will King, P.E. and Jeanna Walls

Located 15 miles outside Durham, North Carolina, the South Granville Water and Sewer Authority (SGWASA) serves the town of Butner, nearby communities Creedmoor and Stem, and the rest of southern Granville County. SGWASA's mission is to provide quality services to customers in an efficient, sustainable, and environmentally conscious manner.

The SGWASA WWTP was upgraded in 2015 to replace infrastructure that had reached the end of its design life and enable the 5.5 million gallons per day (MGD) facility to meet more stringent nitrogen and phosphorus effluent limits. As part of the upgrade, SGWASA replaced the plant's existing jet mixing pumps and headers in the anaerobic and anoxic selectors and converted their oxidation ditch to include post anoxic and reaeration zones as part of a five-stage Bardenpho nutrient removal process. Overall, the facility consists of dual bar screening, extended aeration, biological nutrient removal, clarification, denitrification filtration, chlorination, and dechlorination. The sludge is digested in two stages, dewatered using a screw press, and finally disposed of via land application.

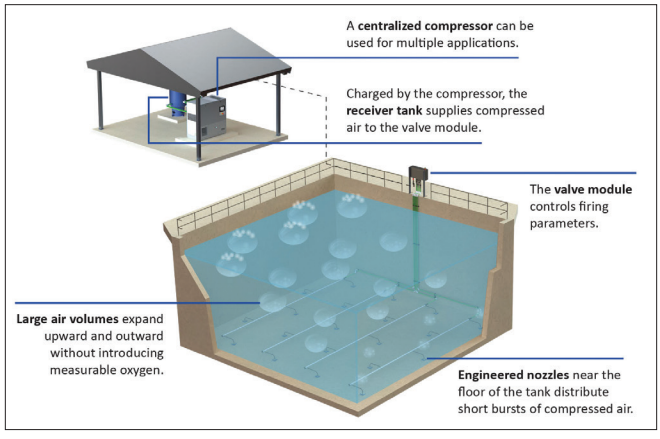
COMPRESSED GAS MIXING

After considering the pros and cons of all available mixing technologies, design engineer CDM Smith selected BioMix™ Compressed Gas Mixing (CGM) to replace the jet mixing system in the anaerobic and anoxic selectors. An EnviroMix technology, BioMix CGM provides uniform mixing of tank contents by firing programmed, short-duration bursts of compressed air through engineered nozzles located near the tank floor.

CGM was the ideal choice for SGWASA's upgrade for the following reasons:

- By utilizing two 50-horsepower compressors as opposed to more than half a dozen motive pumps, the BioMix CGM system delivers an estimated 75% energy cost savings versus the existing jet mixing system.
- In the post anoxic zones, the BioMix nozzles were interlaced with the existing fine bubble aeration system. BioMix CGM easily integrates with aeration equipment and can operate concurrently with or independently from aeration for optimized process conditions.
- BioMix CGM enabled the facility to meet stringent nitrogen and phosphorus effluent limits by providing complete mixing with proven negligible oxygen transfer for optimal anaerobic and anoxic process conditions. Since the 2015 upgrade, the facility has not exceeded any permitted effluent quality limits.

SGWASA Plant Overview



BioMix Compressed Gas Mixing: How It Works

Additionally, all in-tank components of a BioMix CGM system are maintenance free, non-clogging, and self-cleaning. Patented nozzles and headers are compatible with any tank geometry or configuration, conforming to the slope of the tank floor to eliminate "dead spots." BioMix systems can accommodate multiple applications, leveraging a centralized compressor system that minimizes maintenance and maximizes energy efficiency.

Throughout the 2015 upgrade, the staff at SGWASA worked closely with the engineers at EnviroMix to ensure optimal results. "EnviroMix's very good customer service means a lot. We like the whole system, and obviously we've gotten positive results from it," said Cody Norwood, SGWASA plant superintendent.

GOING A STEP FURTHER

In 2021, EnviroMix released BioMix-DC Enhanced Anaerobic Mixing, a technology that enables plants to maximize enhanced biological phosphorus removal (EBPR) by transforming a traditional anaerobic selector into an intensified fermentation tank. Winner of the 2022 WEF Innovative Technology Award, BioMix-DC optimizes EBPR by alternating a short mixing cycle with a long deep cycle. The deep cycle increases anaerobic solids retention time (SRT) while creating a fermentation blanket to generate volatile fatty acids (VFA). The presence of additional VFA leads to the proliferation of phosphorus accumulating organisms (PAOs), the microorganisms responsible for EBPR.

During the long deep cycle, mixing is suspended for prolonged periods of time allowing for solids to accumulate, enhancing fermentation and VFA production. During the short mixing cycle, which utilizes BioMix CGM, intermittent mixing of tank contents is provided by bursts of compressed air. The operating regime of BioMix-DC is site dependent since each EBPR process operates differently based on influent characteristics and facility design.

Upon hearing of the early success of BioMix-DC, SGWASA was eager to upgrade their anaerobic selectors in hopes of achieving more stable EBPR. Since BioMix-DC is compatible with BioMix CGM, no equipment in the tank needed to be altered – the plant only needed a customized controls upgrade with BioMix-DC functionality.

Norwood stated, "We have phosphorus and nitrogen regulations that we need to abide by. So, when this new product was pitched to us, about extra phosphorus removal, obviously we wanted to try it. And then EnviroMix showed the initiative... they didn't just come set it up and walk away. They helped us figure it out; they came and did testing; they basically made us feel comfortable with it."

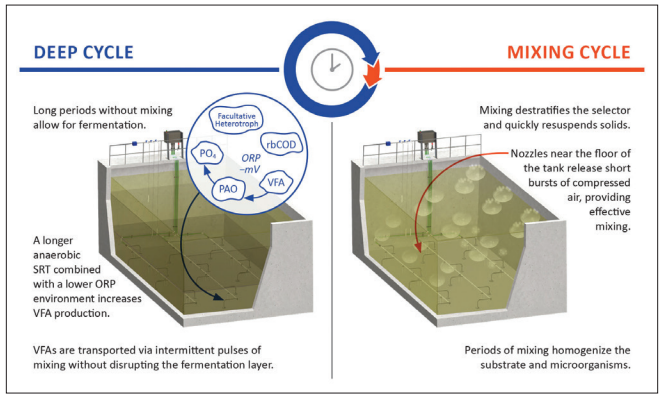
EBPR: MEASURABLE RESULTS

EBPR is the biological uptake of phosphorus by PAOs. While the actual uptake of phosphorus occurs in an aerobic environment, PAOs must first be conditioned by exposure to VFA in an anaerobic environment. PAOs store food under anaerobic conditions and then process the stored food once under aerobic conditions.

Since SGWASA was an early adopter of BioMix-DC, EnviroMix performed extensive testing at the WWTP to ensure desired results. Concentrating on the most critical factors for strengthening EBPR, the following measurements were taken:

- Oxidation reduction potential (ORP): EBPR requires a truly anaerobic environment with an ORP that is consistently below -200 mV. SGWASA's average ORP during the testing period was -423 mV.
- Total suspended solids (TSS): Fermentation is a common way to boost VFA formation. TSS measurements confirm the presence of a fermentation layer. SGWASA's levels in the fermentation layer exceeded the upper range of the handheld TSS meter.

SGWASA's Anaerobic Selector



BioMix-DC Enhanced Anaerobic Mixing: How It Works

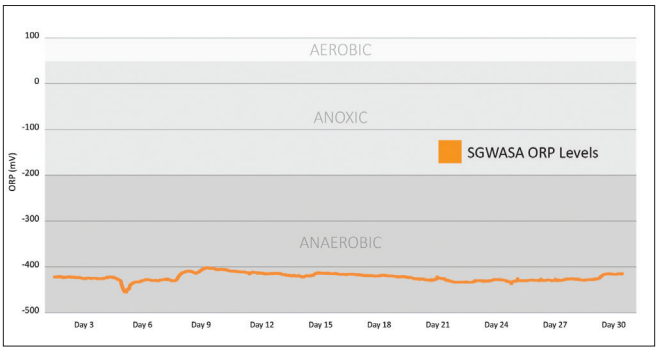
Surface Layer	Bulk Liquid	Fermentation Layer
1,000-3,000 mg/L	3,000-5,000 mg/L	>10,000 mg/L

- Orthophosphate (PO4) release: When PAOs consume VFA, they release phosphorus. When comparing influent phosphorus concentrations to those found in the fermentation layer, SGWASA's levels were more than 600% higher in the fermentation layer.

Influent PO_4	Fermentation Layer PO_4
1-3 mg/L	18-110 mg/L

- Effluent P: Comparing influent total phosphorus with effluent orthophosphorus demonstrates removal efficiency and consistency. After the BioMix-DC implementation, SGWASA's performance stabilized, resulting in consistent effluent quality.

With the BioMix CGM system in the anoxic selectors and the BioMix-DC system in the anaerobic selectors, the SGWASA WWTP is set up for long-term success, able to meet current and future nitrogen and phosphorus effluent limits. Norwood stated, "We've



BioMix delivers a low ORP environment.

been able to cut energy costs with BioMix-DC. And obviously, we've had positive results with phosphorus removal."

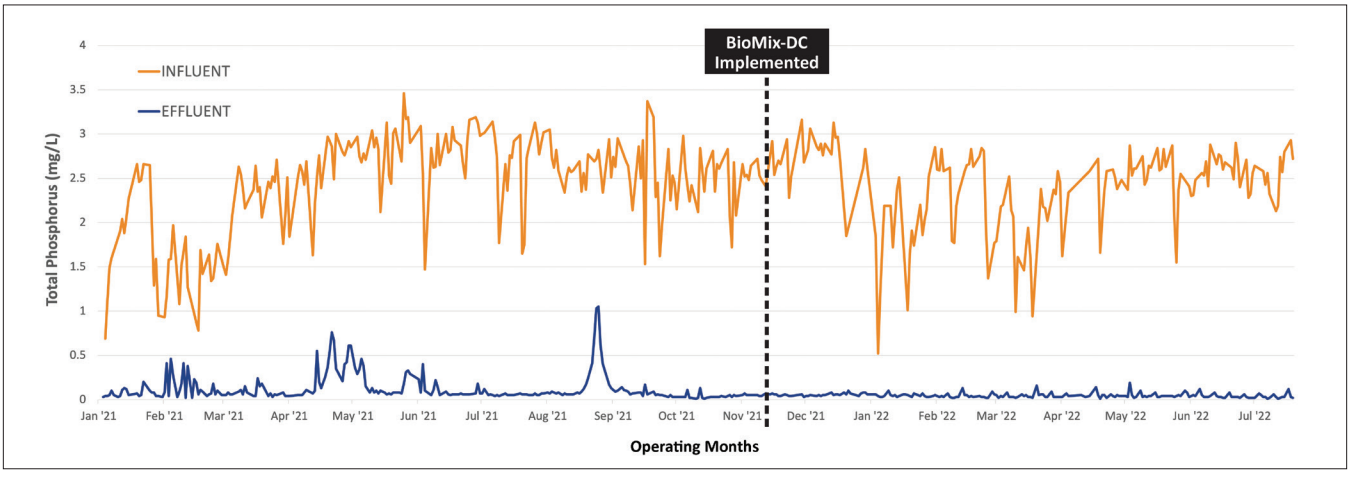
ABOUT ENVIROMIX

Headquartered in Charleston, South Carolina, EnviroMix designs and manufactures treatment systems for municipalities and industrial facilities to dramatically reduce energy costs and help meet nutrient removal limits. Utilizing patented and proprietary technology, EnviroMix provides complete mixing systems, process controls, and energy management solutions to enhance plant performance in the water and wastewater markets. Visit *www.enviro-mix.com* for additional information.

ABOUT THE AUTHORS

Will King, P.E., is the vice president of engineering for EnviroMix. Will has 20 years of experience in management, design, and construction on a wide variety of engineering projects. His experience with wastewater treatment plants includes all components of primary and secondary treatment, solids storage, and dewatering. Will received his civil engineering bachelor's degree and environmental engineering master's degree from Clemson University and is a professional engineer in the state of South Carolina.

Jeanna Walls is the marketing communications manager for EnviroMix. With a background in graphic design and writing, she has spent her career working for a variety of organizations including nonprofits, large corporations, and advertising agencies. Jeanna received her B.A. from the University of South Carolina in Columbia, SC, and her M.B.A. from the University of South Florida in Sarasota, FL.



BioMix-DC enables consistently low effluent P.