ADVANCED WASTEWATER TREATMENT APPLICATIONS AND BENEFITS

By Ashley Donnelly, Technical Training & Sales Development Manager

Benefits of Decentralized Systems

Decentralized wastewater treatment systems allow for a customized solution based on the specific needs and characteristics of the local area. From reduced infrastructure costs to managed aquifer recharge (MAR), decentralized systems offer a resilient and reliable approach to wastewater treatment, minimizing potential environmental impacts while offering flexibility and scalability. They can be easily upgraded or modified to incorporate new technologies or adapted to evolving regulatory requirements.

This adaptability is particularly beneficial in areas or communities where future wastewater treatment needs may be evolving. Allowing for incremental expansions based on population growth and changing wastewater characteristics, decentralized systems not only offer numerous environmental benefits, but also economic benefits as well offering opportunities for service providers, inspectors, installers, and designers, as noted by the US EPA. These benefits make it an attractive option for addressing wastewater treatment challenges in various contexts.

Decentralized (onsite) systems serve us well, with 25 percent of the population and 30 percent of new construction in the United States utilizing this technology. Decentralized systems do an excellent job of treating effluent onsite, keeping water local to its original source, all while recharging the local water supply. Traditional onsite wastewater systems are tried and true; they are the workhorses that protect public health. In some cases, however, there are sites that require an extra level of treatment due to tight soils, high water tables, or close proximity to water or environmentally sensitive areas. In such cases, strict effluent concentration limits are often required and decentralized wastewater treatment, combined with advanced treatment technologies, offers a viable solution. This article explores the benefits of incorporating advanced treatment technologies in wastewater system design to overcome difficult site conditions, ensuring effective treatment, and meeting regulatory requirements.

Advanced Wastewater Treatment Solves Greater Issues

Advanced treatment technologies for small scale residential and commercial systems are now available that can treat wastewater to levels previously only achievable by large scale wastewater treatment plants. Incorporating advanced treatment technology into a decentralized wastewater treatment system enables the benefits of decentralized systems to be realized where large scale treatment plants would previously have been the design of choice.

Well-known technologies include combined treatment and dispersal, extended aeration, and fixed film systems. These treatment processes utilize naturally occurring microbial communities, which consume the organics and reduce the strength of the waste. Passive advanced treatment technologies, such as combined treatment and dispersal, remove up to 99 percent of wastewater impurities (BOD/TSS) without using any electricity or replacement media. Highly purified wastewater is then released to the soil, recharging the groundwater, preventing soil and groundwater contamination.

Active advanced treatment systems provide high-quality effluent and are effective in reducing BOD, TSS, Nitrogen, and Phosphorus. Depending on the specified technology, the treated water can be captured for reuse for non-potable purposes such as irrigation or industrial processes. This reduces freshwater demand and offers this highly treated wastewater a second use prior to returning it to the ground water. Reuse may require additional levels of treatment such as disinfection.

Passive and active advanced treatment technologies present unique benefits, offering system designers the ability to provide site-specific solutions that tailor the system design to address the specific needs of the area. Passive treatment systems allow a system designer to offer a highly treated effluent solution in remote or off-grid areas where centralized systems may not be available or are too costly for connection.

Tight Soils

Tight soils, such as clay or compacted soils, hinder wastewater infiltration and limit treatment efficiency. Passive treatment technologies provide effective solutions for treating wastewater in these challenging soil conditions. One such technology is the use of alternative media in soil absorption systems. By replacing the native soil or adding a highly permeable media, such as coarse, clean specified sand, the infiltration rate can be significantly improved. The sand media treats the wastewater thereby removing the organics and allowing clean water to infiltrate to the soil below. Tighter soils can more readily accept the treated effluent because there is no organic buildup. Another option is the implementation of active treatment, which provides enhanced treatment to also reduce the organic load to the soil.

High Water Tables

Shallow ground water presents challenges for wastewater treatment systems, as they can interfere with the treatment process and compromise system integrity. In decentralized treatment, technologies such as raised bed systems, mounded systems, and pressure distribution systems provide flexibility. These systems are designed to elevate the wastewater treatment area above the water table, providing proper separation distances that prevent contamination and ensure effective treatment before it reaches the groundwater. Other innovative solutions include constructed wetlands which can be implemented to naturally treat the effluent.

Environmentally Sensitive Areas

In areas with strict environmental regulations or sensitive water bodies, advanced wastewater treatment may be necessary to meet the required discharge standards. Installing advanced treatment systems can ensure compliance with applicable regulations. Enhanced nutrient removal is required to achieve these discharge standards to protect water bodies or when a NPDES permit is required. Advanced treatment technologies can remove a high percentage of nutrients including nitrogen and phosphorus from wastewater. Additional treatment options, such as disinfection with UV light or chlorine, can effectively reduce or inactivate bacteria, viruses, and other microorganisms. This reduces the potential for waterborne diseases thereby protecting public health.

It also ensures that the discharged wastewater meets higher water quality standards, minimizing potential harm to aquatic ecosystems and the surrounding environment.

Groundwater Shortages and Managed Aquifer Recharge (MAR)

By recharging treated wastewater directly into the ground, decentralized systems replenish aquifers, helping to restore groundwater levels. This promotes the long-term sustainability of water resources and mitigates the impacts of over-extraction of groundwater resources. It reduces stress on lakes, rivers, and reservoirs, preserving these sources for other essential purposes and environmental habitat. This decentralized approach allows communities to take control and manage their own water resources, reducing reliance on centralized water supply networks.

Long-Term Sustainability and Operations and Maintenance (O&M)

Advanced wastewater treatment systems often incorporate features that provide ease of maintenance. Remote monitoring and sensors have been introduced for effective management. All treatment systems, passive or active, require some level of operations and maintenance. These O&M frameworks are one of the most critical parts of the wastewater management infrastructure, providing reliability and confidence to the public.

Projects in Action
Berkshire East, MA Wastewater Treatment System Provides Highly Treated Effluent and Low Maintenance

The 9,900 GPD Advanced Enviro-Septic (AES) system at Berkshire East, a four-season mountain resort in Charlemont, Massachusetts includes 6,000 linear feet of AES pipe, divided into two-5,000 GPD module beds. The total combined sand bed area for the system is 9,486 sq. ft., with a soil loading rate of 1.2 GPD/sq. ft. The AES system is installed in a stepped configuration to slope the system and reduce the amount of fill required for the project.

The smaller footprint required for the AES system and the ability to install the system with the existing topography made the AES system an attractive option. Reduced fill contributed to an overall reduction in construction costs. Another benefit is the low maintenance of the system and its ability to accommodate the future growth of the resort.

Strict Effluent Requirements Achieved with Extended Aeration Wastewater Treatment System at Lauloa Maalaea Resort in Maui, Hawaii

With stringent effluent quality requirements and limited space on site at the Lauloa Maalaea Resort in Hawaii, the engineer specified an Extended Aeration package wastewater treatment plant. To meet the new regulatory requirements and the design flow of 21,000 GPD the extended aeration process selected for this system utilizes aeration followed by clarification and disinfection.

The flow equalization chamber receives the incoming wastewater, then duplex pumps discharge the wastewater into the aeration chamber. Duplex positive displacement blowers and an air distribution manifold system supply the air needs to the system including air diffusers, airlift pumps, and a scum skimmer. The hopper-style clarifier has baffling to prevent short circuiting and to provide the maximum uniform solids settling area. The settled sludge returns from the clarifier floor sludge well to the aeration chamber by the positive sludge return system. Immediately following the clarifier is a plug flow chlorine contact chamber. The influent characteristics were typical domestic waste loadings, with effluent requirements of less than 20 mg/L BOD/TSS.

Conclusion

In conclusion, decentralized wastewater treatment systems, combined with advanced treatment technologies can provide a practical and efficient solution for overcoming difficult site conditions. By addressing challenges such as high-water tables, tight soils, and strict effluent concentration limits, these systems ensure effective treatment, protect water resources, and meet regulatory requirements. Incorporating advanced treatment technologies offers environmental and economic benefits, making decentralized wastewater treatment an attractive option for areas with challenging site conditions. Moving forward, continued research and innovation in decentralized wastewater treatment technologies will further enhance the efficiency and effectiveness of these systems, ensuring sustainable water management practices for present and future generations as well as the availability of clean water.

ASHLEY DONNELLY, TECHNICAL TRAINING AND SALES DEVELOPMENT MANAGER, has a passion for building relationships within the onsite wastewater treatment industry through training and technical education. Ashley entered the industry over 20 years ago and works to preserve the environment through sound wastewater treatment solutions. In her position at Infiltrator Water Technologies (IWT), she manages the Inside Sales Team and is responsible for maintaining and building customer relationships. This involves assisting engineers, contractors and regulators with technical and design information, training, installation, and operation and maintenance. adonnelly@infiltratorwater.com