Cost-effective alternatives to expanding wastewater treatment plants are emerging.

Do you have something in a smaller size?

By Cindy Wallis-Lage, Terry Johnson and Alan Rimer

More regulations plus more people minus money and land equals a growing trend of local governments using small-footprint wastewater treatment technologies. Using the more efficient or more compact options, owners can upgrade or expand treatment capability on an existing or slightly enlarged footprint. Some processes enhance performance by adding new equipment or chemicals to existing facilities, while others require new structures but less construction or surface area than traditional

Small-footprint technologies are popular in Europe.

alternatives.

Communities are turning to space-efficient and highly efficient treatment technologies for several reasons:

- Insufficient space at existing sites;
- Locating satellite facilities in developed area to facilitate site-specific reuse;
- Development encroaching around existing facilities, reducing the availability of adjacent land for purchase or substantially increasing its price;
- Existing facilities selling adjacent highly valued land to generate funds for new facilities or upgrades;
- The need to lessen the impact of upgraded or expanded facilities on surrounding communities (Compact systems are easier to enclose to control odor and noise, and for aesthetics.); and
- To produce high-quality effluent to meet advanced treatment requirements at a lower cost.

Small-footprint treatment technologies have been popular in Europe and Asia, but only recently have some been adapted for use in American cities and counties. Examples of tight-site technologies include egg-shaped anaerobic digesters; physical-chemical solids separation processes; membrane filtration technologies, including submerged membranes; and compact biological wastewater treatment systems, including an integrated fixed-film activated sludge process, biological aerated filters and membrane bioreactors.

Faster flocculation

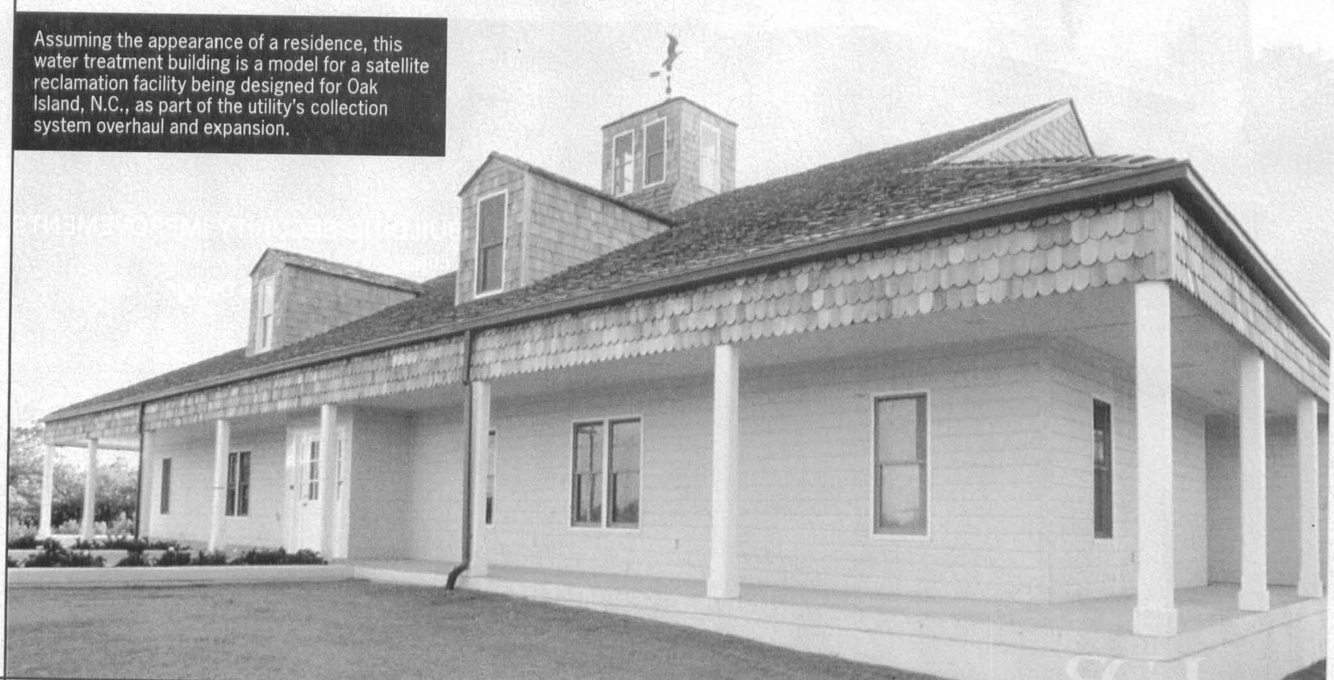
For more than a century, utilities have added chemicals to coagulate and flocculate suspended matter to help remove it. Ballasted flocculation, however, is a relatively new variation in which a ballast, such as microsand, is added to the system to help remove total suspended solids (TSS) and particulate biochemical oxygen demand (BOD) and decrease the size of the clarification area. The high-rate physical-chemical process, initially used in Europe for potable water treatment, has recently been introduced in the United States for treating sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs).

Lawrence, Kan., used ballasted flocculation when the city had to meet federal and state regulatory requirements for storm-related SSOs on a space-limited site. The city began evaluating various treatment and storage alternatives and comparing life-cycle costs. Because ballasted flocculation treats wastewater at a rate 40 to 60 times higher than conventional clarifier loading without the need for storage, the technology requires only 10 percent of the space required for conventional clarification and 2 percent of the space required by other storage alternatives. The total footprint of the Lawrence system is 3,500 square feet, or less than 100 square feet per million gallons.

The Lawrence ballasted flocculation system, ACTIFLO, manufactured by Cary, N.C.-based Kruger, began operating in August 2003 and was the first SSO application of the technology in the nation. Since its commissioning, the unit has treated up to its 40 million gallons a day (mgd) design capacity and has consistently achieved effluent TSS concentrations less than 30 milligrams per liter (mg/L), and typically less than 20 mg/L despite influent TSS fluctuations.

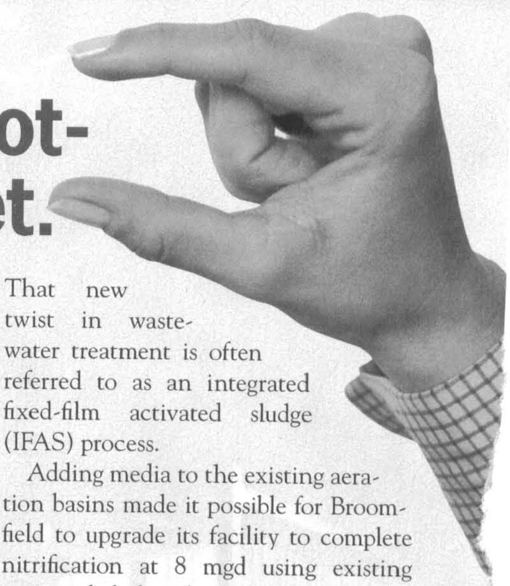
As with every technology, special design operations and maintenance issues must be addressed. The ballasted flocculation design must incorporate adequate screening to protect downstream equipment and integrated system controls to coordinate the excess flow treatment system with the main biological liquid treatment system during wet weather.

Operational problems center on the



Assuming the appearance of a residence, this water treatment building is a model for a satellite reclamation facility being designed for Oak Island, N.C., as part of the utility's collection system overhaul and expansion.

The Lawrence system footprint is 3,500 square feet.



chemical addition system and the potential for effluent foaming. During performance testing of the Lawrence system, foaming was found in the effluent from the basins and was further exacerbated by the cascade outfall to the river. Adding a defoamer to the effluent resolved the problem. Designing a submerged outfall also may prevent foaming, which appears to correlate to removing solids from the raw wastewater. Other issues include off-treatment maintenance, such as tank cleaning, sand storage and equipment maintenance.

MBBR for nutrient control

New nitrogen species and phosphorus regulations are creating headaches for wastewater treatment plant owners and operators. Most conventional treatments for those effluent quality parameters require significantly expanding existing wastewater treatment plants (WWTP), the land for which, in many cases, is limited or even nonexistent. Consequently, many communities must try small-footprint-based treatments.

The South Adams County Water and Sanitation District (SACWS) in Adams County, Colo., elected to upgrade its trickling filter WWTP with moving-bed bioreactor (MBBR) technology to increase capacity from 4.4 mgd to 7 mgd and meet new limits for ammonia and nitrate nitrogen. The MBBR process incorporates plastic media in the aeration basin. The media supports a submerged attached-growth biological system to remove carbon and control nutrients in lieu of using conventional suspended activated sludge systems. Wall screens located at the downstream end of the basin retain the media but allow the wastewater to pass through to the next treatment step. Adding the MBBR process allowed the county to preserve its simple attached-growth treatment process and avoid more operator-intensive treatment, such as activated sludge.

The new MBBR system replaced an old rotating biological contactor system that operated in parallel with the trickling filter. With the new plant configuration, the primary effluent flow is split between the trickling filter and the MBBR system. The trickling filter effluent rejoins the primary effluent just before the MBBR facilities, where the entire plant flow is treated for ammonia and nitrate reduction to levels that comply with the treatment plant's new discharge requirements.

Broomfield, Colo., also incorporated MBBR technology to enhance the performance of its activated sludge process when it needed to expand its WWTP capacity from 5.4 mgd to 8 mgd and to meet new nutrient requirements. That new twist in wastewater treatment is often referred to as an integrated fixed-film activated sludge (IFAS) process.

Adding media to the existing aeration basins made it possible for Broomfield to upgrade its facility to complete nitrification at 8 mgd using existing activated-sludge basins. Because the added biological growth provided by the media is retained inside the basins, the solids loading rate on the final clarifiers is essentially the same as before the IFAS retrofit.

To complete the biological nutrient removal process, Broomfield demolished an old biotower at the plant to make room upstream of the aeration basins for new anaerobic and anoxic basins. The new basins help remove nitrate and phosphorus, which in turn, helps the WWTP meet its new effluent quality objectives for nutrients.

Membranes go local

Reclaimed water has been used for golf course and landscape irrigation, to supplement recreational lakes, aquifer recharge, industrial uses, and, to a lesser extent, dual-system utility supply. Unfortunately, the space requirements and costs of upgrading existing facilities

With a total footprint of only 3,500 square feet, the ballasted flocculation system constructed in Lawrence, Kan., provides a compact and highly efficient solution for wet-weather-induced sewer overflow problems.

Membrane bioreactors are highly automated.

to produce high-quality effluent by constructing additional storage, pumping and conveyance facilities can be prohibitive. Fortunately, the more affordable satellite water reclamation facilities (SWRFs), can be built on or near existing sewer lines in locations where demand for reclaimed water is high.

Suitable for many applications, membrane bioreactors (MBR) — which integrate submerged membranes with an activated sludge aeration basin — provide an ideal technological foundation for SWRFs. They require only a small footprint to produce effluent suitable for virtually all irrigation and recreational water reuse applications and for reuse by large commercial and industrial facilities.

Membrane bioreactors generally are highly automated, reliable and adaptable to populated areas. They can remove nutrients, including phosphorus and nitrogen, to the highest degree. MBR's key design issues are the initial screening (1- to 2-mm punched screens are required), basin configuration for systems with stringent effluent nutrient limitations, and membrane configuration.

Peoria, Ariz., is designing a 10 mgd/20 mgd peak flow (expandable to 13 mgd/26 mgd) MBR facility that is planned to be online by 2007. Because it will be adjacent to a city park and near residences, the satellite facility is being designed to control odors and noise, as well as to be aesthetically pleasing. The plant will include fine screens, biological nutrient removal, ultraviolet (UV) light disinfection and solids dewatering. The facility for liquid and solids handling will fit on approximately five acres.

To meet increasing demands, the rapidly growing beach community of Oak Island, N.C., is designing a satellite reclamation facility as part of the utility's collection system overhaul and expansion. To help cover an expected total cost of $2.2 million, the project recently was awarded a Clean Water Management Trust Fund grant for its design and construction. The 400,000-gallon-per-day satellite treatment plant will include a fine screen, an aeration basin with an integrated MBR system, and UV disinfection. The plant will produce pure water that will be used to irrigate town property and a nearby golf course, as well as provide some process water for a nearby industry. The facility will be adjacent to a park and built on less than an acre of land. It will be designed to aesthetically fit in with the adjacent housing.

Today, cities and counties are finding themselves squeezed between having to upgrade and expand their wastewater treatment plants and not having the space to do it. Enhancing treatment capacity or performance with little or no surface-area expansion can be difficult. However, cities and counties can draw on the experiences of European communities that have used new technologies where efficient use of space is a necessity. Ballasted flocculation, MBBR and MBR are some of the especially efficient or compact processes that can help communities balance seemingly conflicting goals and challenging needs.

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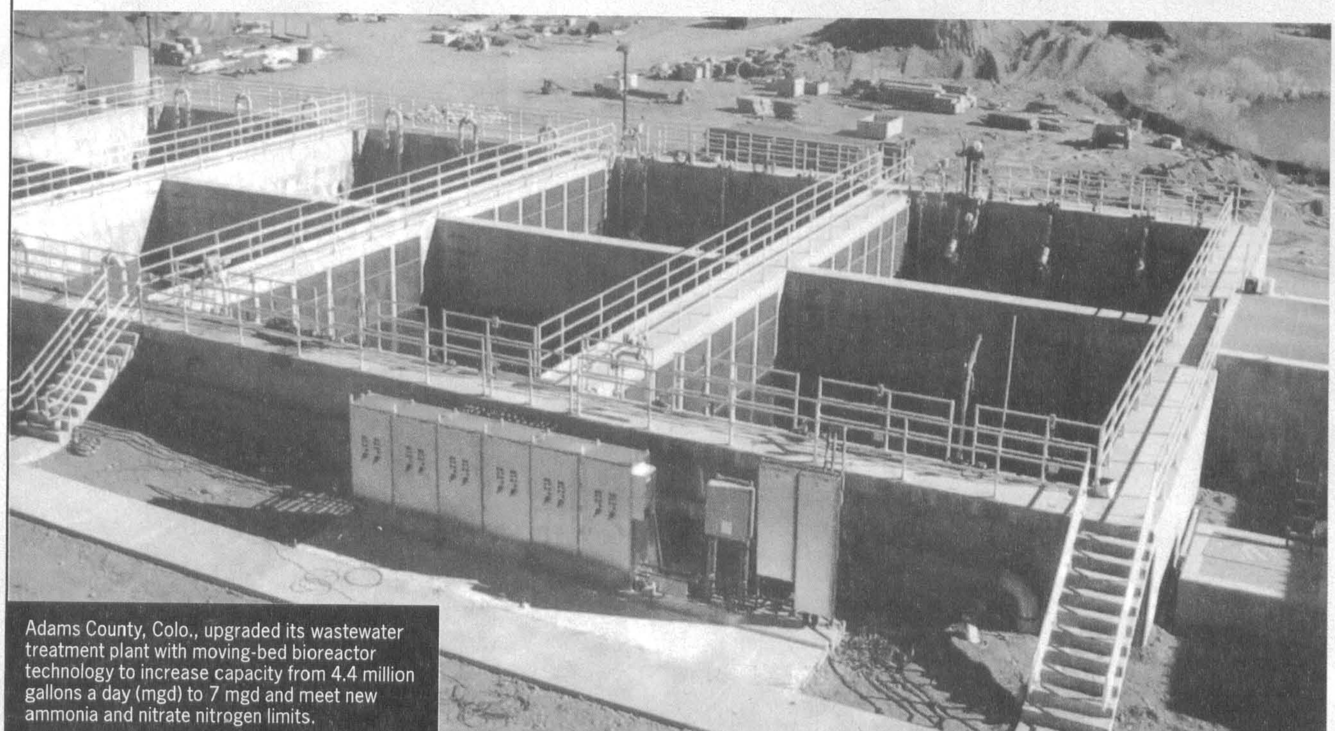

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