REMEDIATION T

Employees from the Town of Savannah, N.Y., and Knight Treatment Systems (Oswego, N.Y.) test the effectiveness of the district's microbial inoculator–generators.

Continual biological augmentation brings new life to eliminating the need for costly replacement

Douglas J. Nelson and Mark C. Noga

TO THE RESCUE

an old sand filter,

District 1 of Savannah, N.Y., was in trouble. Its cluster system, constructed in the late 1980s, was beginning to show its age. In early 2002, the district came under increased regulatory scrutiny because it was failing to meet its discharge permit limits (see table, p. 38). Operations staff felt the district's violations were directly related to its sand filter, which had a long-standing history of ponding. As a result, the sewer district and its residents had a tough decision: Replace the sand filter at a significant cost to the community or face a consent order. The district decided to pursue an alternate course.

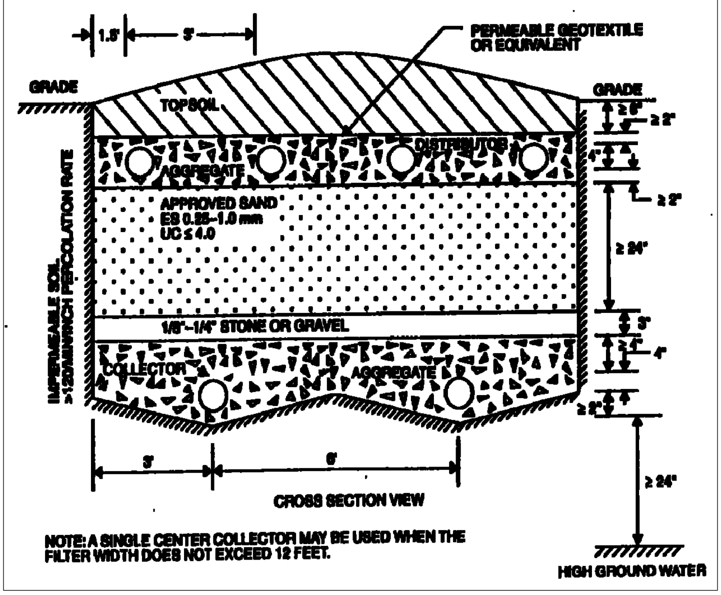
The Investigation

The Town of Savannah's decentralized plan was one of the first of its kind in the nation and was implemented as part of a U.S. Environmental Protection Agency demonstration. The town operates three separate wastewater treatment facilities that treat wastewater from three cluster-system sewer districts. All three districts use septic tanks at each parcel, with gravity effluent sewers and force mains feeding to primary treatment tanks for settling prior to secondary treatment by sand filtration. Sewer district personnel operate and maintain all home septic tanks. The facilities for District 1 use a single-pass, siphon-dosed subsurface sand filter. This system serves 22 homes.

In an effort to identify the root cause of ponding in the sand filter, operations and regulatory personnel met onsite and performed a minor excavation of the sand filter. They made the following observations:

- Water was ponded more than 0.6 m (2 ft) above the distribution piping located at the top of the filter.
- The design of the sand filter did not comply with New York State regulations (see Figure 1, p. 38); rather, the sand filter had been capped with more than 1 m (3 ft) of poor-quality soil to mitigate snowmelt and stormwater infiltration issues.
- There was a well-established, exceptionally heavy biological clogging mat at the upper surface of the sand within the filter.
- The operator was resting half of the filter periodically to promote clog mat dissipation, but the resting time was insufficient to allow acceptable drainage to resume when the filter was put back on-line.
- Sand below the clogging mat was very clean, not saturated, and in very good condition, meeting specification requirements for new sand filters.

Figure 1. Typical Sand Filter Design Under NYS Regulations



Investigators were convinced that the excessive biomat production stemmed from the soil cap, which caused reduced air exchange within the filter. While oxygen concentrations where not measured directly, the fact that a heavy, dark biomat was formed indicated that an oxygen-limiting condition existed at the surface of the sand. This heavy biogrowth, in turn, led to a saturated zone at the filter surface and decreased treatment effectiveness of the filter.

Operations personnel, in conjunction with operations assistance staff from the New York State Department of Environmental Conservation, began searching for operations-oriented solutions to the ponding. After several months of adjusted operation (primarily resting 50% of the filter area), they saw little improvement. It seemed that the filter would need to be rebuilt.

The town was in a quandary, as the cost of rebuilding the sand filter was beyond the financial means of the community. Therefore, it needed to find a cost-effective method for remediating the existing sand filter while restoring effluent quality to permit levels.

The Pilot

After gathering input from operations staff, regulatory officials, and vendors, town officials decided to install two microbial inoculator–generators within the existing District 1 primary treatment tank. The installation was a pilot study: The town agreed to pay for services and equipment after the facility had been operating successfully for 3 months.

The microbial inoculator–generator is a tank insert that is designed to grow and inoculate downstream treatment units with specific strains of bacteria. A patented matrix of *pseudomonas* and *bacillus* bacterial strains that are well-proven to reduce biomat growth are inoculated into the treatment unit, where they reproduce for discharge to the downstream device. The treatment device consists of fixed-growth media within a columnar housing. The pilot design featured a suspended growth medium that was retained within the treatment unit by a grating. (The unit is similar in design to larger units used for municipal wastewater treatment, known as the integrated fixed-film activated sludge process. Such systems are not inoculated with specific strains of bacteria as was done in this study.)

Tank contents are circulated over the growth media by airlift action created by a fine bubble

Permit Limits and Actual Performance

Parameter	Units	Influent-Average/max[1]	Permit Limit
Flow	gal/d	2079/2800[2]	3000
pH	Standard Units	7.2/7.5	6.0-9.5
Settleable Solids	mg/L	0.1/0.1	0.1
Dissolved Oxygen	mg/L		3.0
Total Suspended Solids	mg/L	441/1870	10
	#/day	-	0.250
Carbonaceous Biochemical	mg/L	95/154	5.0
Oxygen Demand (6/1-11/30)	#/day	-	0.125
Carbonaceous Biochemical	mg/L	-	15.0
Oxygen Demand (12/1-5/31)	#/day	-	0.375
NH_3 6/1-11/30	mg/L	71/160	2.0
NH_3 12/1-5/31	mg/L	-	10.0

[1] Data supplied from NYSDEC taken from discharge monitoring reports.

[2] Flow is measured at an effluent weir after the sand filter.

diffuser in the base of the unit. Flow through each unit is estimated to be 95 m^3/d (25,000 gal/d), thereby passing the contents of the 19,000-L (5000-gal) tank through each unit more than five times each day. Installation took place in May 2002 without the direct knowledge of the district residents to avoid atypical user patterns, which might skew the results.

For most important parameters, the discharge permit required effluent sampling and testing only on a quarterly basis, so the district developed a more frequent sampling and testing protocol to ensure that the facility was operating within permit limits during the 3-month evaluation. This protocol called for measuring field parameters at the time of installation and twice per week thereafter. Field parameters included the ponding level in the distribution boxes; solids levels in the distribution line turn-ups; and temperature, dissolved oxygen (DO), and pH at all three sampling locations.

The district also performed laboratory analysis for concentrations of carbonaceous biochemical oxygen demand (CBOD), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and nitrate at the time of installation and every 2 weeks thereafter. Grab samples were taken at the primary tank influent, the primary tank effluent at the dosing chamber, and the final effluent prior to the effluent step aerator. In total, the district conducted 25 sample events for field measurement and six sampling events for laboratory analysis.

The Results

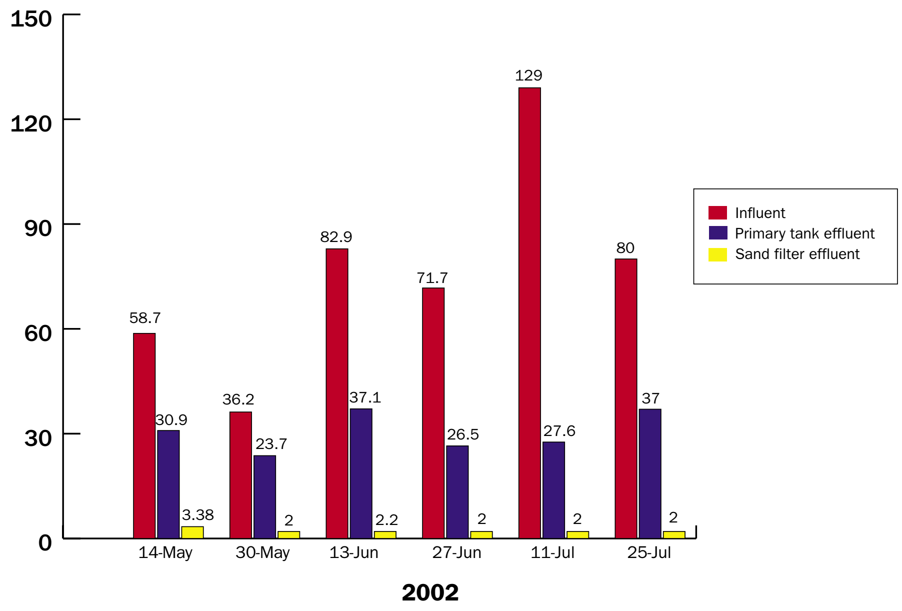
The town would consider the pilot successful if it reduced ponding within the sand filter. During his 17-year tenure at the facility, the operator had never seen the bottom of the sand filter distribution boxes during an inspection. But approximately 6 weeks after installation of the microbial inoculator–generators, the level of ponding had subsided enough to allow him to do just that.

Test data were similarly encouraging. During the testing period, CBOD and TSS values for the effluent showed little change from preinstallation testing (see Figure 2, below, and Figure 3, p. 40). The level of treatment was not compromised by the reduction of the clogging mat originally found at the top of the sand in the filter. Physical observations of the filter surface indicated a significant biological growth that did not limit flow.

DO levels varied greatly, but these fluctuations

Before installation of the microbial inoculator–generators, water was ponded more than 76 cm (30 in.) above the filter sand.

Figure 2. CBOD Reductions



KNIGHT TREATMENT SYSTEMS/TOWN OF SAVANNAH, N.Y.

A microbial inoculator-generator is lowered into the treatment tank.

could be attributed to rain events and potential DO meter problems. It is important to note that the DO sampling point was at the beginning of the effluent aeration ladder. Effluent DO levels reportable to regulators were, in all likelihood, higher than those recorded at this sampling point.

The most notable outcome of the pilot study was the apparent effect on the nitrogen cycle. Laboratory results indicated some nitrification about 4 weeks into the study and greater nitrification as the study progressed. The onset of nitrification was caused by a combination of several factors, including rising influent temperature, decreasing CBOD within the system, and increased oxygen concentration. Nitrification has maintained the effluent TKN below 20 mg/L — more than a 60% reduction — consistently (see Figure 4, p. 41). It is assumed that nitrification was initiated by eliminating the ponding on the filter, thus lowering CBOD and increasing oxygen levels. Lack of alkalinity has not been eliminated as a limiting factor for further nitrification. Denitrification is probably taking place to a small degree, but with the low levels of CBOD within the sand filter, there is not enough carbon to support denitrification. Adding a carbon source could solve this problem.

Test results for nitrates indicate two probable theories (see Figure 5, p. 41). Either denitrification was a significant factor during the July 11 sampling event or two sample containers, or their results, were inadvertently interchanged for that date. Unfortunately, there is no way to determine which of the two scenarios is correct. If the samples or their results were not switched during sampling, testing, or reporting, then the results indicate there was nearly complete nitrification within the treatment tank and equally effective denitrification within the sand filter on that date. This seems rather unlikely, and TKN

Figure 3. Total Suspended Solids Reduction

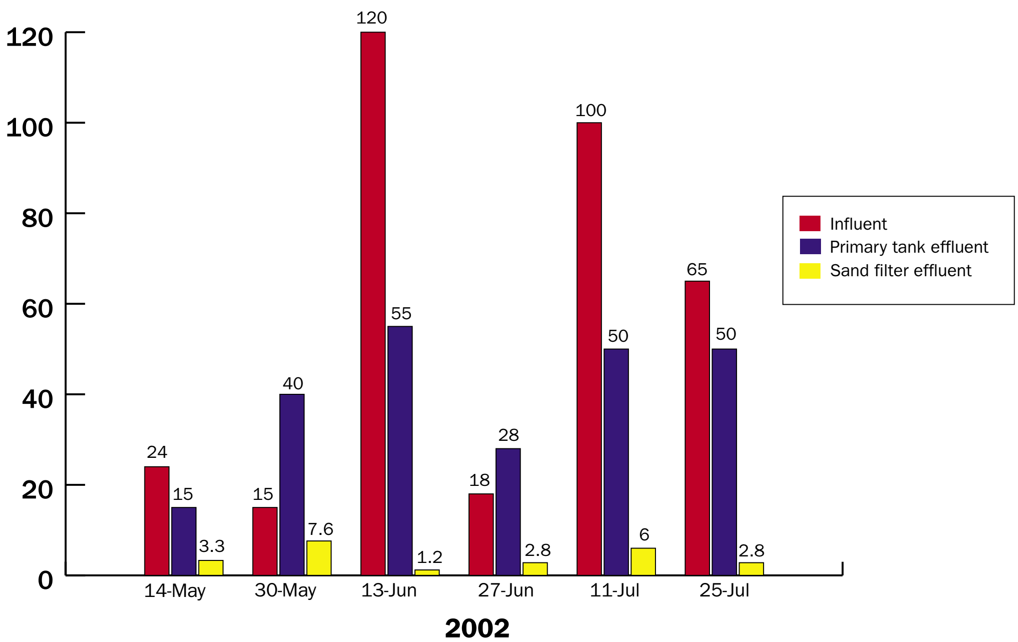


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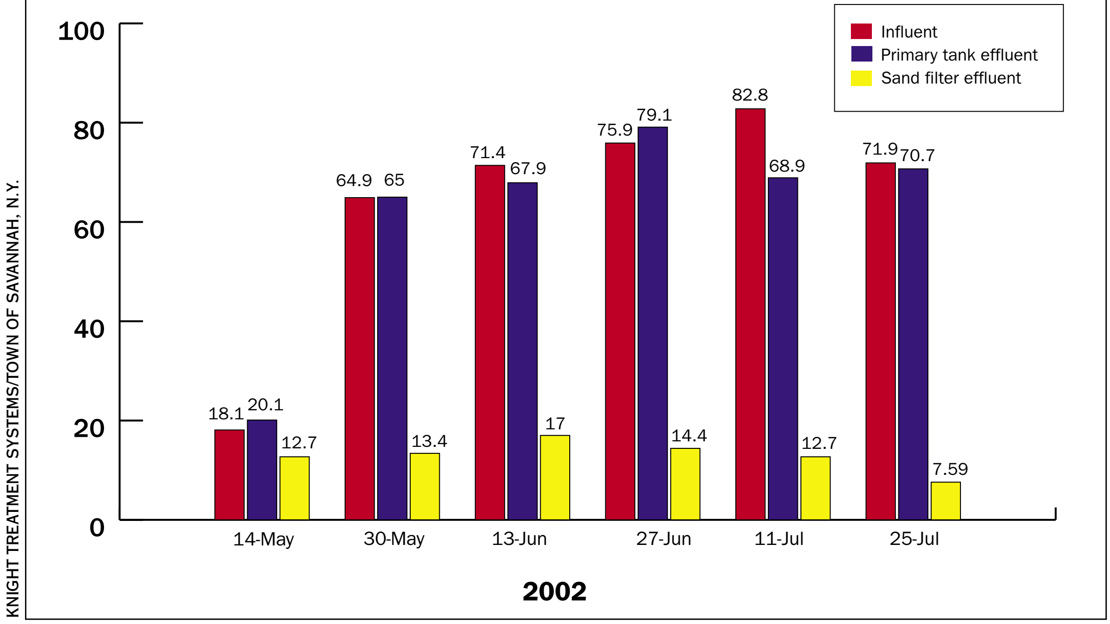
Figure 4. TKN Concentraion



test results do not support this scenario. It is most likely that the samples were inadvertently placed into the incorrect bottles, but there is no direct evidence to support this theory.

Overall, the pilot was a success. The Town of Savannah conserved significant capital costs by choosing to bioremediate its existing sand filter. Effluent parameters of CBOD, TSS, TKN, and nitrates, as well as operational parameters of ponding level, pH, and DO, were maintained or improved as a result of the change of technology. The facility was able to maintain effluent quality as required under the State Pollutant Discharge Elimination System requirements at a very reasonable cost.

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Figure 5. Nitrates