The full report may be accessed at:
http://trlwq.org/sites/trlwq.org/files/Demo_ProjectCompReport.pdf

Excerpts from the

TABLE ROCK LAKE WATER QUALITY DECENTRALIZED WASTEWATER DEMONSTRATION PROJECT

FINAL TECHNICAL REPORT

By

David Casaletto, Program Coordinator
Gopala Borchelt, Projects Director

Table Rock Lake Water Quality Inc.
P.o. Box 606
Kimberling City, MO 65686
trlwq@lvbw.net
www.trlwq.org

December 31, 2007

U. S. Environmental Protection Agency Cooperative Agreement No. XP8309301

EXECUTIVE SUMMARY

Increasing population and development in the Table Rock Lake watershed threatens water resources by increasing sources of nutrient pollution, not the least of which is failing septic systems. The largely rural population uses onsite wastewater treatment systems (OWTS) to treat wastewater, although these systems are often not suitable to the thin existing soils in the region to treat wastewater. The Table Rock Lake National Demonstration Project tested different types of advanced technology for OWTS. The Demonstration Project also utilized the U. S. Environmental Protection Agency's (EPA) management models for proper maintenance of OWTS. This project planned to find solutions to the many failing and inadequate OWTS in the Table Rock Lake area. Three main goals were:

1. Install and test different types of advanced wastewater treatment technologies to evaluate effectiveness in the unique geological setting around Table Rock Lake.

A number of excellent decentralized treatment technologies including advanced OWTS (or systems with pre-treatment components before dispersal into the soil) had been field-tested elsewhere and were commercially available. The focus of the Demonstration Project was to compare technology and test performance in treating wastewater and phosphorus removal using the BioMicrobics FAST and RetroFAST, Premier Tech Ecoflo and ZABEL SCAT wastewater treatment systems in the Table Rock Lake area and match the treatment units to a lateral dispersal field suitable for the existing soils.

2. Develop a management program following the EPA's recommended management models for OWTS.

With advanced OWTS regular maintenance is needed to ensure proper functioning. Advanced OWTS had received a bad reputation nationwide due to failures from lack of maintenance by system owners. A responsible maintenance entity (RME) was needed to remove maintenance responsibilities from developers or homeowners.

3. Identify legal impediments to widespread adoption of advanced OWTS by changing the regulatory and the wastewater industry's perceptions of these systems and gaining their acceptance in Missouri.

In the past, advanced OWTS technologies have not been widely accepted as feasible or practical and most contractors in the area were unfamiliar with such systems. The few installers that had experience with advanced OWTS, such as drip dispersal, did not generally recommend these systems or install them due to maintenance concerns. With adoption of renewable operating permits requiring maintenance, an answer to this concern would be presented.

Twenty four sites were installed/remediated through this Demonstration Project. Criteria for acceptance into the project included environmental need, installation feasibility, cost share potential and the owner's willingness to cooperate with project goals. Different types of advanced OWTS installed included constructed wetlands, aeration/fixed film, media filters using foam cubes and peat moss and recirculating sand filters. All of these systems highly pre-treat wastewater before dispersal into surface stream or soil.

Monitoring systems were installed on four sites to measure treatment success. Samples were taken from septic tank effluent (raw sewage), treatment effluent (pre-treated, filtered liquids) and sub-surface liquids (after passing by drip irrigation through the soil). Analysis of samples produced evidence of successful treatment with effluent BOD5 (biochemical oxygen demand) and TSS (total suspended solids) values from three of the monitored systems consistently below 20 mg/L. The fourth monitored system was a much higher restaurant-strength waste, which had median treatment BOD5 and TSS of 59 and 32 mg/L respectively. Median sub-surface phosphorus concentrations ranged from 0.5 to 1.2 mg/L demonstrating the soil's capacity for phosphorus removal.

Average septic effluent, treated effluent and subsurface concentrations

Parameter	Septic Tank	Treated	Sub-surface
BOD_5(mg/L)	162	26.8	3
TSS(mg/L)	46	17.7	NA
Ammonia(mg/L)	5.6	4	0.41
Phosphorus(mg/L)	3	2.7	0.93
Fecal Coliform (colonies/100 mls)	271,000	19,488	140

The major results from the Demonstration Project are:

1) **Acceptance by State/County regulatory agencies and installers of advanced OWTS as a solution to failing conventional systems and the use of drip irrigation in imported soil for pre-treated effluent dispersal.**
2) **Remediation of over 25 OWTS near Table Rock Lake and influencing numerous installers and homeowners to seek advanced OWTS options.**
3) **Formation of Ozarks Clean Water Company (OCWC) as a RME to remove maintenance responsibilities (EPA management level 5) from developers and homeowners in cluster systems (subdivisions & apartment complexes that use a decentralized OWTS).**
4) **Changes in the wastewater ordinance by local regulatory agency, the Stone County Health Department, to require renewable operating permits for advanced OWTS (EPA management level 3).**
5) **Demonstration of phosphorus removal achieved through advanced OWTS and drip irrigation in imported soil around Table Rock Lake.**

Data from this project will provide regulatory agencies with scientific evidence necessary to accept advanced OWTS as standard systems removing them from experimental status. Project partners and participants gained applied knowledge of advanced OWTS and alternative treatment technology to help protect water quality resources. Education and outreach through numerous local, statewide and national meetings helped to focus attention on the potential water quality implications of failing wastewater systems and successful remediation systems in the Table Rock Lake watershed. An outstanding benefit of the Demonstration Project includes a change in the way OWTS are installed in southwest Missouri, along with a change in the public's perception of advanced OWTS. Another applied achievement of the project was the formation of OCWC which will continue to grow and provide service to benefit residents of Missouri particularly residents of the Table Rock Lake watershed. This project may serve as a national action model for other lake communities facing similar problems that need effective solutions.

This Project funded through U. S. Environmental Protection Agency by Cooperative Agreement (XP8309301).

Wastewater Treatment Options

BioMicrobics RetroFAST Wastewater Treatment Systems

A RetroFAST treatment system adapts conventional onsite systems by inserting a RetroFAST unit and aeration blower into an existing watertight and properly sized septic tank (Figure 3.4). This not only enhances wastewater treatment performance but may also be used to remediate failed onsite soil absorption fields or lateral fields. Conventional systems utilize a septic tank to hold solids and a lateral field to disperse the wastewater and provide the majority of treatment. Over time, the lateral field can become clogged with microorganisms called biomatt which find this area conducive for growth. This can eventually prevent wastewater from moving away from the system causing overflow, soggy lawns, plumbing system back- ups and surfacing. Replacement of the soil absorption system is a drastic form of repair can be costly as well as cause damaging to the existing property. RetroFAST wastewater treatment units can be adapted and inserted into the existing tank to promote the growth of aerobic bacteria on the fixed film media in the tank. This helps remove more of the pollutants that originally fed the biomatt that formed the clogging layer in the failed lateral field. RetroFAST systems oxygenated effluent also promotes the development of aerobic bacteria in the soil which digests the existing clog and helps to renovate the failed lateral field.

Many conventional systems or failed systems due to clogged lateral fields are good candidates for RetroFAST units. Upgrading an onsite wastewater treatment system with a RetroFAST unit may not only help prevent system failures, but may also greatly increase the treatment value of the system, protect the environment and increase the value of the property.

Figure 3.4: RetroFAST unit installation in an existing septic system

Task 4 - Treatment System Monitoring

Objectives:

The Demonstration Project contracted with Midwest Environmental Consultants, (MEC) to conduct monitoring to evaluate the performance of four onsite systems that were included in the demonstration project. The four systems were selected to demonstrate how advanced treatment technologies popular in other areas of the United States could be installed and operated in challenging site conditions in the Table Rock Lake area. These challenging conditions commonly consist of shallow soils and limited lot sizes.

The four sites included the Cape Fair Resort, the Lampe Resort, the Shell Knob Restaurant South (S) and the Kimberling City Residence (Table 4.1). The Cape Fair Resort, Lampe and Shell Knob Restaurant S treatment systems included drip dispersal into imported soil. Imported soil was considered to be a potential means of improving effluent dispersal for sites with shallow, rocky soils. Therefore, it was a priority to include these systems in the monitoring program. The Project Advisory Board (PAB) suggested that subsurface water quality monitoring be included at all four sites. Therefore, the project included innovative subsurface monitoring approaches to collect water quality data below the dispersal fields. These data were not intended to be compared to specific standards, but rather were intended to provide specific water quality information to better understand subsurface dynamics at each site monitored.

Table 4.1 Monitoring Locations, System Characteristics, Monitoring Parameters and Testing Frequency

Owner	Bedrooms/ Flow (gpd)	Type of Treatment System	Type of Subsurface Monitoring System	Samples to Collect	Rainfall	Water Chemistry Analyses	Water Chemistry Sampling Frequency
Cape Fair Resort	16 bedrooms 1,920 gpd	Bio-Microbics FAST® with drip dispersal into imported soil	Plastic sheet and half-pipe lysimeters	Septic tank effluent, FAST effluent, plastic sheet and half-pipe lysimeters	Daily	Total Suspended Solids, Biochemical Oxygen Demand, pH, Total Phosphorus, Fecal Coliform Temperature, Conductivity, Dissolved Oxygen, Ammonia, Nitrite/Nitrate, Total Nitrogen	Monthly (August 2006 through July 2007)
Lampe Resort	1,560 gpd	Zabel SCAT® biofilter with drip dispersal into imported soil	Half-pipe lysimeter	Septic tank effluent, SCAT effluent and half-pipe lysimeters	Daily	Same as above	Monthly (November 2005 through July 2007)
Shell Knob Restaurant South	1,500 gpd	Restaurant wastewater discharging into a Bio-Microbics FAST® unit with drip dispersal into imported soil	Plastic sheet and half-pipe lysimeters	Septic tank effluent, FAST effluent, plastic sheet and half-pipe lysimeters	Daily	Same as above	Monthly (November 2005 through July 2007)
Kimberling City Residence	3 bedrooms 360 gpd	Bio-Microbics RetroFAST® with existing Infiltrator dispersal system	Piezometers	RetroFAST effluent, subsurface piezometers	Daily	Same as above	Monthly (November 2005 through July 2007)

Kimberling City Residence Monitoring Results

1. Operating Conditions and Hydraulic Loading Rates

The Kimberling City Residence RetroFAST system (Figure 5.37) operated dependably through the study with no known blower malfunctions. Hydraulic loading was estimated based on days of occupancy per month for a one bedroom home with the two adult residents.

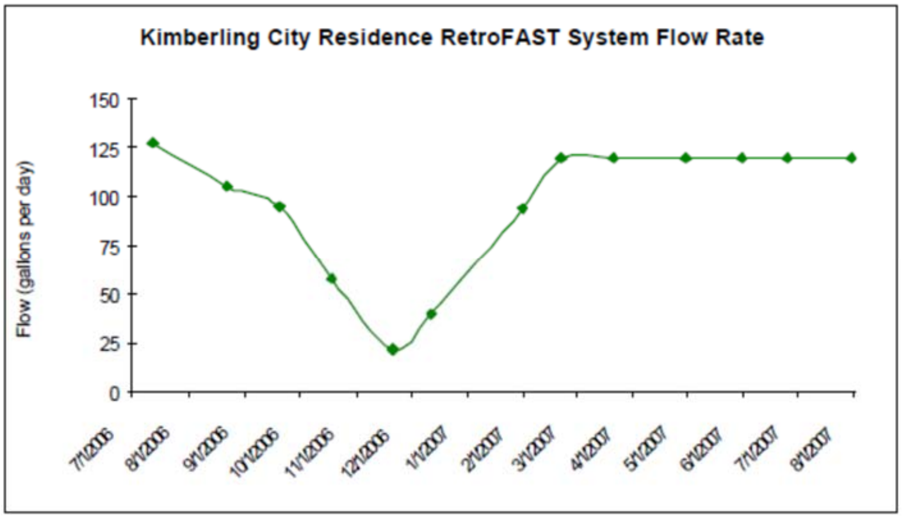


Figure 5.37: Kimberling City Residence- RetroFAST system flow rate

2. **Effluent Quality**

The Kimberling City Residence RetroFAST system modification consisted of inserting tube bundles and aeration diffusers into the outlet cell of the existing septic tank. The septic tank effluent is aerobically treated in contrast to the previous three onsite systems which have separate biological treatment units. Therefore, the Kimberling City Residence site had only one system sampling point, which was the RetroFAST system effluent collected from the septic tank discharge piping.

RetroFAST effluent BOD_5 concentrations ranged between 50 and 225 mg/L during the first half of 2006, but stabilized to concentrations consistently below 30 mg/L for the remainder of the study (Figure 5.38). TSS concentrations also stabilized beginning in mid-2006 and indicated good settling conditions in the RetroFAST settling zone.

Ammonia concentrations were typically less than 1.0 mg/L which demonstrated consistent nitrification (Figure 5.39). Nitrate concentrations, which typically exceeded 10 mg/L, confirmed the high level of nitrification occurring in the system (Figure 5.39). Dissolved oxygen concentrations, generally above 2 mg/L (Figure 5.40), were sufficient to activate nitrifying bacteria.

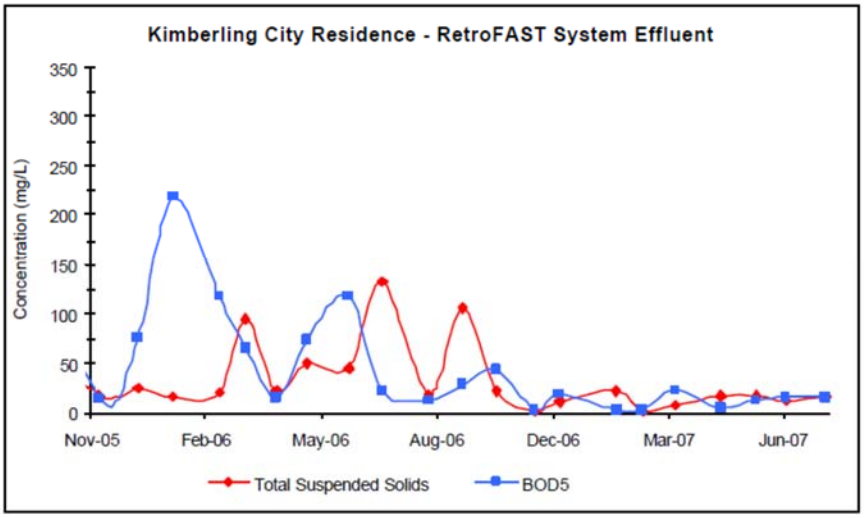


Figure 5.38: Kimberling City Residence - TSS and BOD_5 in RetroFAST system effluent

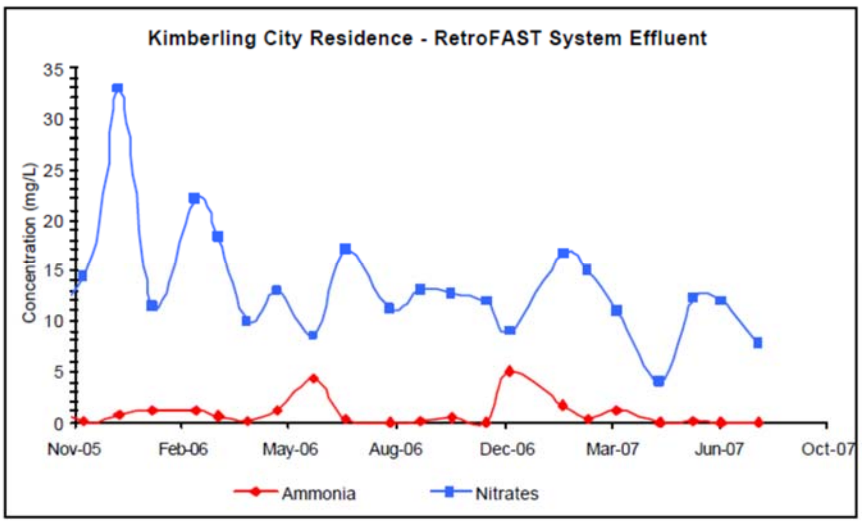


Figure 5.39: Kimberling City Residence - ammonia and nitrates in RetroFAST system effluent

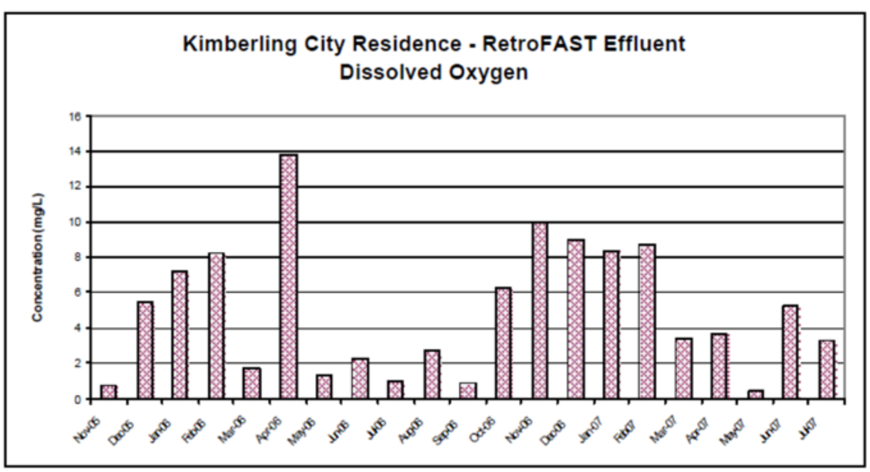


Figure 5.40: Kimberling City Residence - dissolved oxygen in RetroFAST system effluent

3. Drain field Rehabilitation Measurements

The Kimberling City Residence onsite treatment system was an existing system originally installed when the home was built. The system consisted of a septic tank followed by Infiltrator® chamber gravity subsurface dispersal laterals. TRLWQ staff conducted an initial assessment of the system and observed 8 inches of standing water in the drainfield. The standing water indicated a flow restriction potentially due to biomass buildup in the drainfield. The system was selected to demonstrate if the suspected biomass restriction could be reduced with the addition of an aerobic process to treat septic tank effluent before being discharged to the gravity dispersal field. This approach has been identified as a potential method to rehabilitate drainfields.[3]

The Bio-Microbics RetroFAST unit was installed in the existing concrete watertight septic tank. Beginning in November 2005, monitoring staff measured water levels in a vertical PVC pipe inserted through the soil into a dispersal pipe chamber. Standing water depths of up to 0.9 inches were measured in the spring of 2006 during a period of heavy rainfall (Figure 5.41). No standing water was detected in subsequent measurements which included periods of comparable rainfall. These data indicated favorable flow distribution in the lateral field compared to initial conditions. The improvement may have been attributed to reduced biomass buildup in the drainfield following the RetroFAST unit installation. The RetroFAST unit's high-quality, aerobic effluent was favorable for minimal biomass production in the drainfield.

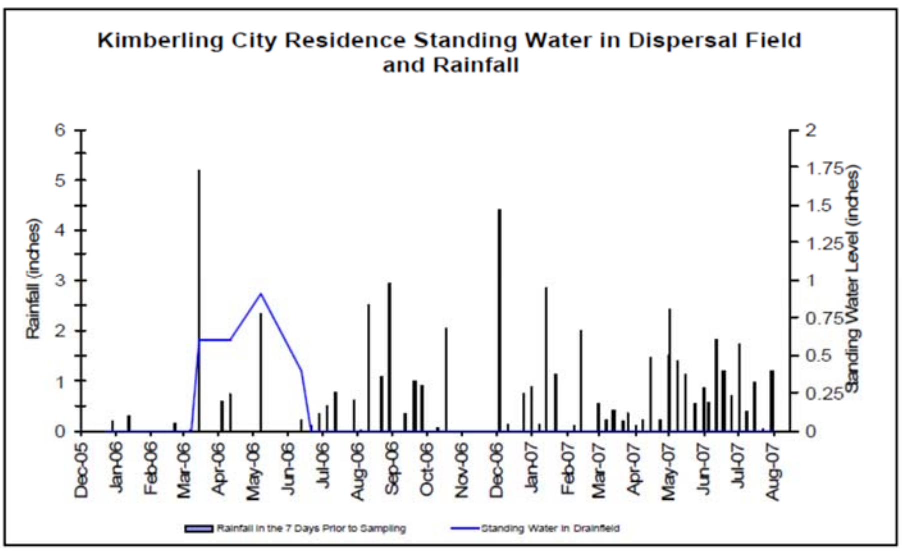


Figure 5.41: Kimberling City Residence - rainfall and standing water in dispersal field

[3] Noah, M., "Investigating Drainfield Rehabilitation", *Water* & *Wastes Digest* April 2006 Volume: 46 Number: 4.

APPENDIX-I

INDIVIDUAL SITE INSTALLATIONS

Kimberling City Residence

The Kimberling City Residence location is a single family residence is located near Kimberling City, Missouri. The home is 3 bedrooms with an average flow of 360 gallons per day.

Reason Chosen: The chamber lateral field had standing and pooling effluent due to biomat build up.

Current System Condition: Conventional 1000 gal. septic tank with gravity flow to chamber leach bed.

Technology: A Bio-Microbics RetroFAST 0.375 unit installed in the property owners existing 1,000 gallon concrete septic tank. The treated effluent will be dispersed by gravity using the existing chamber lateral field. Storm water (gutters) will be diverted from lateral field area.

Size (GPD): 360

Management: This site was constructed on EPA Level 5 under which the Licensee pays a monthly fee to RME, which owns and operates the system.

Lessons Learned: This site demonstrated the successful remediation of a failing lateral field. The aerobic highly treated effluent allowed the bacteria to remove the biomat and the effluent was able to again disperse into the soil. Inspection of the chambers showed no standing or pooling effluent present after only a few months of operation. This property owner also was very excited to be a part of the EPA Level 5 management. He was elected to the Board of Directors of the RME by the other property owners at the first annual member meeting.

Septic tank and chamber lateral field

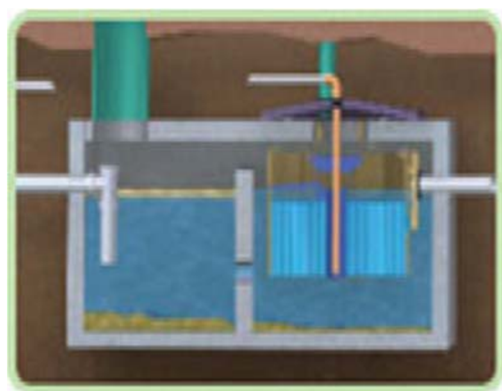
Chamber system full with septic effluent

Existing tank uncovered

Square access hole cut in tank lid

RetroFAST is easy to ship to site

RetroFAST lowered in the tank.



Plastic wings hold system in place.

Diagram of system installed in tank.