Compendium of Decentralized Wastewater Demonstration Grant Projects

U.S. Environmental Protection Agency
Office of Wastewater Management

EPA United States Environmental Protection Agency

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Introduction

The U.S. Environmental Protection Agency (EPA) published a landmark report, "Response to Congress on Use of Decentralized Wastewater Treatment Systems," in the spring of 1997 on the benefits, costs, and applicability of decentralized wastewater treatment technology and management as a means to help address the nation's water quality concerns. According to that report, "adequately managed decentralized wastewater systems are a cost-effective and long-term option for meeting public health and water quality goals, particularly in less densely populated areas," helping to spur a shift in considering decentralized systems as a permanent part of our nation's infrastructure. This report also helped set the stage for a number of federal initiatives to promote the advancement of decentralized wastewater technologies and the best management practices for maintaining these systems, providing critical guidance to state and local officials and wastewater professionals.

In 1999, Congress funded National Community Decentralized Wastewater Demonstration Projects through congressional earmarks at funding levels ranging from $570,000 to $5.5 million. These demonstration projects, selected and overseen by EPA, highlighted improved treatment methods and management approaches. The 18 selected sites covered a diverse range of climates, soils, and ecosystems, each with unique challenges and innovative solutions.

While the results of many of these projects have been featured on presentations, conferences, case studies, and reports, this compendium is the first of its kind to compile an overview of all the demonstration projects funded. The summaries include project objectives, funding, technology, lessons learned, and current statuses of those communities or projects. This compendium will be particularly useful for decentralized system stakeholders, including state and local government leaders, community organizers, non-profits, and homeowners because the demonstration projects ranged in topics from installation of new advanced wastewater treatment systems, community-wide assessments, to green infrastructure and stormwater improvements.

In addition, some of the projects featured laid the groundwork for future decentralized wastewater projects, while others revitalized their communities through the installation and management of new decentralized systems. Many of the projects have continued since their funding ended and are still in operation today.

Image 1: Septic tank riser. (Photo courtesy of EPA)

Summary of Demonstration Projects

The 18 National Community Decentralized Wastewater Demonstration Projects, while differing in type, scale, and approach, offer shared thematic conclusions, which can be particularly valuable for municipalities, organizations, and responsible management entities implementing similar decentralized wastewater projects in their communities. Due to the specificity of each community project, the case studies presented in this compendium help clarify that one size does not fit all in determining solutions for wastewater treatment. However, four common themes were observed from the summary reports. These themes appeared throughout multiple projects summarized in this compendium: Community engagement is critical; localities and states can work together; alternative systems can be successful; and monitoring and data collection is important.

Community engagement is critical. Decentralized wastewater systems, typically serving one household to a small cluster of homes or buildings, rely heavily on personal responsibility to ensure proper maintenance. Therefore, a collective commitment and understanding of these systems is vital to protecting a community's water source, waterbody, or aquifer. Demonstration projects that actively engaged their communities through public meetings, decision-making, and local trainings garnered sustained support through each stage of the project.

Image 2: Septic drainfield. (Photo courtesy of EPA)

Localities and states can work together to advance solutions. Management approaches, including utilization of responsible management entities can significantly vary based on locality and state. Demonstration projects that sought local oversight and management applied some forms of state support or guidance. Collaboration can facilitate technical assistance and knowledge exchange. In addition, funding opportunities can come from a variety of entities (e.g., local or state level).

Alternative systems can be successful in treating nutrients and bacteria loads as compared to conventional systems. To address outdated and failing systems, many demonstration projects piloted different advanced technologies that use additional biological or aerobic treatment in the process. Advanced systems designed to treat nutrients and bacteria can lead to healthier local water bodies. In addition, innovative stormwater technologies, such as green infrastructure, can complement decentralized wastewater systems in treating nutrients and bacteria.

Monitoring and data collection is important. Consistent and ongoing monitoring helps communities measure results over time. These data enable the assessment of technology performance and environmental results. In addition, the information can be useful in assessing investment decisions and priorities.

Note to Reader

This compendium is a technical summary and guide to the accomplishments of the 18 National Community Decentralized Wastewater Demonstration Projects. The compendium provides a summary of each demonstration project, focused on providing a project overview, technology overview, cost analysis, monitoring data, lessons learned, and current status as available.

EPA prepared the individual summaries based on the project grantee's final technical reports as submitted to the Agency. The case studies may also include additional information provided by project engineers, consultants, and project managers involved in the demonstration project. The final reports are cited in the resources section at the end of each summary. The images within each case summary were provided in each project's respective final report, unless otherwise noted. As such, the views expressed in this document are solely those of the demonstration project grantees in their final reports and follow-up discussions and do not necessarily reflect those of the Agency. EPA does not endorse any products or commercial services mentioned in this compendium. We would like to express our sincere appreciation to all the contributors.

Sustainable Communities and Infrastructure Branch
Water Infrastructure Division
Office of Wastewater Management
U.S. EPA

About the Decentralized Wastewater Program

The Decentralized Wastewater Program promotes the proper management of septic systems and other types of decentralized wastewater treatment. The program includes a formal partnership with federal agencies, industry representatives, and non-governmental organizations to work collaboratively at the national level to improve decentralized performance and protect the nation's public health and water resources. More information can be found at epa.gov/septic.

Image 3: Aerial view of rural landscape. (Photo courtesy of EPA)

Decentralized Wastewater Demonstration Project

Grantee Final Report Summary

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A Blueprint for Community-Based Wastewater Management

Grantee: Town of South Kingston

Grant Amount: $3,000,000 ✓ Year Completed: 2007

Grantee Purpose: Demonstrate how small communities with limited budgets and managerial capacities can implement and manage advanced decentralized wastewater treatment systems.

Proposed Project: Replace failing septic systems with advanced decentralized wastewater treatment systems. Develop a comprehensive town-wide low-cost wastewater management program, comprising mandatory ordinances, training for local contractors, and public education awareness.

Project Overview

Located along Rhode Island's southern coastline, the Block Island and Greenhill Pond Watersheds include the communities of South Kingstown, New Shoreham (including Block Island), and Charlestown. Each contain landscapes comprised of wetlands, salt ponds, and estuaries. The grantee reported failing wastewater infrastructure and increased population growth as the primary sources of contamination to the watershed's sensitive ecosystem. The communities developed local onsite wastewater management programs for pollution prevention, enabling them to access a revolving loan program for septic system repairs and training classes for septic system inspectors, as set in Rhode Island's Clean Water Act. In addition to replacing failing septic systems, the communities agreed on the need for local oversight of private systems to promote proper upkeep and operation of existing and future septic systems.

Objectives of this demonstration grant project include:

- Adopt ordinances and enforce local inspection and maintenance;
- Establish treatment standards for sensitive areas and problem sites;
- Provide loans and other financial incentives for system repairs and upgrades;
- Build capacity of and provide trainings for town staff, designers, and service providers;
- Construct 24 demonstration systems and monitor their performance;
- Evaluate wastewater needs and update the management program as needed; and
- Establish an electronic database to track septic system inspections and failing system repairs and replacements, where appropriate.

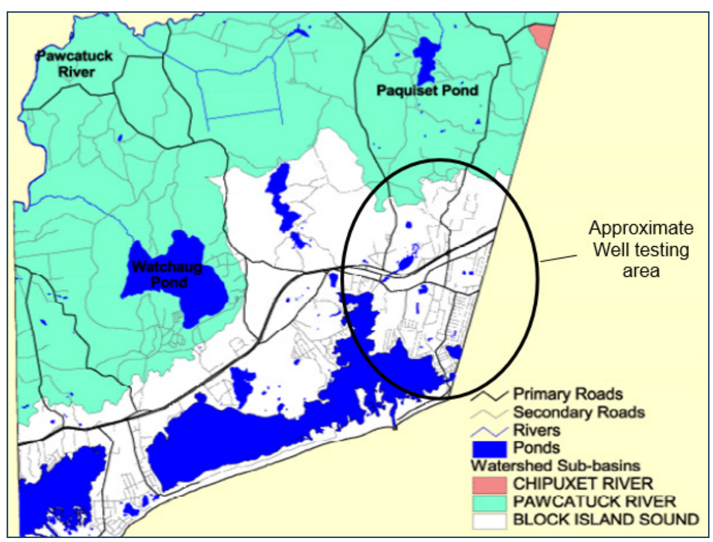

Image 4: Private well testing areas on the Greenhill Watershed. (Photo courtesy of the final grantee report)

Methods

All communities developed independent municipal wastewater management programs to suit their unique needs. They formed a steering committee to guide the technical, monitoring, assessment, and reporting components of the project. The cost of keeping each established program running averaged approximately $50,000 annually. Each management program consisted of the following:

Establishing Ordinances: Each town developed a wastewater management ordinance to improve management of the systems. For example, Charlestown revised its existing ordinance to direct 3 new wastewater districts to conduct inspections of the town's 4,970 systems within 3 years. After the initial inspections, the ordinance was revised again to mandate inspection-based maintenance and cesspool phase out.

Promoting Inspection and Tracking Programs: Each community required trained and approved wastewater management inspectors be used to conduct inspections. Some communities mandated interval inspections that were determined by community districts. Charlestown and South Kingstown communities used private-town licensed inspectors, while New Shoreham employed its own inspector. Use of a town-employed inspector helped keep costs low and ensured reliable, consistent, and impartial inspection results. New Shoreham utilized GIS technology to coordinate and input inspection data into a tracking database for analyzing and displaying results. Charlestown adopted a similar tracking procedure.

Offering Financial Assistance: Each town established low-interest loan programs for septic system repair, upgrades, and replacement through Rhode Island's Community Septic System Loan Program (CSSLP), created to meet the community's financial needs during this project. In addition to the loans, New Shoreham also established a rebate program with support from federal grants; in this case, the funds came from the state nonpoint source program, Clean Water Act Section 319.

Monitoring Water Quality: Each town monitored water quality through volunteer programs. Each community built a working relationship with the University of Rhode Island (URI), community coalitions, and local watch programs to administer the volunteer programs and establish a data sharing initiative. The communities established a baseline of information to understand how factors such as weather and seasonal variations affect water quality.

Technology

The grantee installed 25 decentralized wastewater demonstration systems between 2002-2004. The management plan for the installed systems included:

- Mandatory inspections determined by system type and use, maintenance and repairs as needed, tank pump-outs, and detailed reporting to authorities;
- Immediate replacement of failed systems;
- Complete phase out of cesspools;
- Retrofit of existing tanks with access risers and effluent filters;
- Compliance with inspections ranging from 84-99%;
- Removal of 92% of 129 known cesspools on Block Island; and
- Removal of 154 cesspools in Charlestown and South Kingstown.

The 25 advanced decentralized wastewater treatment systems installed through this grant project consisted of the following technologies:

Secondary Treatment (after septic tank)
Textile Filter
Foam Biofilter
Trickling Filter
Peat Filter
Upflow Filter

Distribution
Bottomless Sand Filter
Tipping D-box and Gravity fed Poly Chambers
Shallow Narrow Drainfield
Bottomless Peat Drainfield

Figure 1: Decentralized wastewater treatment technologies.

Additionally, seven advanced decentralized systems that had previously been installed as part of the separate National Onsite Demonstration Project in 1999 were monitored as part of this demonstration project to help determine long-term treatment performance of advanced systems.

Project Successes

Within the first three years of implementation, all demonstration communities had fully operational wastewater management programs including septic system maintenance, mandatory inspections, and the removal of cesspools and failed systems. All previously unmanaged septic systems are now under some level of town management. The state revolving loan program secured approximately $1.6 million in homeowner loans for septic system repair at the closing of the grant. Each town established an electronic database to track inspection results and organize communication with system owners.

Lessons Learned

Transitioning from an education and voluntary compliance program to an established wastewater management program can be challenging for communities due to community resistance and financial capacities. The Block Island and Green Hill Pond demonstration grant project approached its town-wide management program in phases to help address these challenges.

This phased approach was one of the main driving factors for the success of the program. This began with a focus on critical areas with sensitive water resources, followed by the adoption of ordinances requiring mandatory maintenance, while allowing for a period of voluntary compliance. The project sites then established standards for the use of alternative decentralized systems beginning with wetland buffers. This phased approach also allowed for standards to be established to address the critical areas. Notably, Block Island adopted treatment standards based on soil conditions and homes' proximity to wells and critical water resources.

Lastly, each town initially tracked inspection results, beginning with alternative, large flow, and commercial systems. This allowed for easy and reliable data tracking.

At the close of the project, the grantee concluded that the management principles and technical standards developed for each community can be adopted by those looking to establish a municipal wastewater management program in their own communities.

Present Site Conditions

At the close of the demonstration project, each town successfully transitioned to a municipal funding structure. Each town continued to make program improvements, such as extending inspections to new districts and updating ordinances.

After project completion, a local non-profit organization promoting the protection of Block Island's major salt pond, the Committee for the Great Salt Pond, continued the monitoring on Great Salt Pond. Through 2014, field and laboratory analysis indicated overall good health for the Great Salt Pond; however, the community reports that increases in nutrients and bacteria levels have been detected, especially following storm events, indicating the need for continued vigilance from all pollution sources.

Project Participants and Resources

- University of Rhode Island Cooperative Extension. A Blueprint for Community Wastewater Management: Block Island and Green Hill Watershed, Rhode Island. EPA National Community Decentralized Wastewater Treatment Demonstration Project – Final Summary Report. 2008.
- New England Onsite Wastewater Training Program
- Rhode Island Nonpoint Education for Municipal Officials
- URI Watershed Watch
- College of Environment and Life Sciences Department of Natural Resources Science
- Rhode Island Department of Environmental Management
- Town of South Kingstown
- Town of Shoreham
- Town of Charlestown
- University of Rhode Island Cooperative Extension
- Monitoring Data: http://web.uri.edu/watershedwatch/uri-watershed-watch-monitoring-data/

The Hyatt Wetlands: A Green Infrastructure Demonstration

Grantee: City of Boise

Grant Amount: $975,838

Year Completed: 2015

Grantee Purpose: Add green infrastructure elements to an existing wetland to increase stormwater treatment and reduce pollutants and sediment in runoff.

Proposed Project: Demonstrate innovative green infrastructure stormwater treatment using vegetative sand filters, educate and transfer technical information to smaller communities about water quality and the impacts of land development.

Project Overview

The Hyatt Wetland was originally a 44-acre site with 22 acres of natural wetland serving as a wildlife habitat and a public recreational area. The grantee reported before the project site development, weather events caused stormwater inundation to the tributary surrounding the wetland, which degraded water quality and flooded the lower reaches of the canal system. As part of the site's development master plan, the city (grantee) sought to evaluate the feasibility of accepting stormwater from roadways and roadway tributaries into the wetland. To promote environmental awareness, the city also sought to develop education and interpretation programs that would create a passive recreational opportunity for Boise residents and surrounding communities. The city completed construction in 2013.

The demonstration project's main objectives were to conduct the following actions:

- Demonstrate, evaluate, and document an innovative combination of green infrastructure technologies;
- Treat and re-use transportation right-of-way stormwater generated by the Maple Grove Road extension;
- Provide hands-on educational experience for facility visitors;
- Improve and expand wetland and wildlife habitat;
- Provide an additional clean water source for wildlife habitat; and
- Provide improvements to the water quality of the Thurman Mill Drain.

Image 5: Hyatt Wetland. (Photo courtesy of the City of Boise)

Project Components

The completed grantee project site expanded the original project site to over 50 acres with approximately 30 acres of wetland area. The grantee installed a sediment basin and modified sand filter as part of the stormwater treatment system.

Image 6: Sediment basin dam at stormwater filter. (Photo courtesy of the final grantee report)

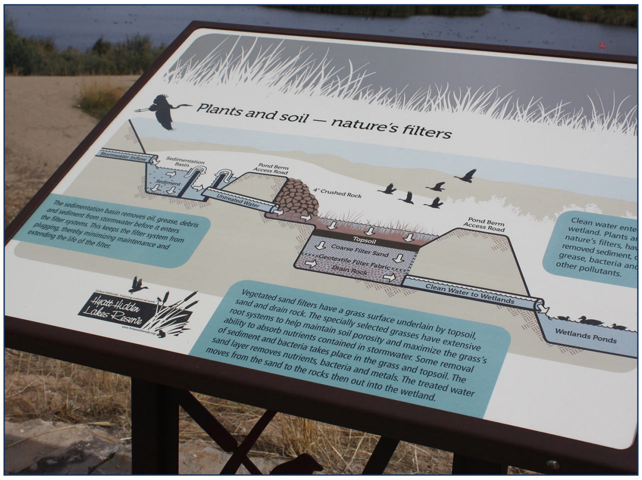

Image 7: Sand filter components. (Photo courtesy of Kris Wagoner)

The grantee constructed the vegetated sand filter with a specifically selected grass surface with 6 inches of topsoil, 18 inches of sand, and 12 inches of 2-inch crushed drain rock placed upon a filter bottom with a 1 percent slope to the wetland perimeter of the filter. As designed, the sand filter treats approximately 80 percent of stormwater runoff within the drainage basin or 50 cubic feet per second of stormwater from 50 acres of the tributary area. The peak stormwater capacity is 13 cubic feet per second. Runoff that exceeds the filter's treatment capacity then discharges into the wetland. The grantee installed a collection system to convey treated stormwater to the wetland. A Supervisory Control and Data Acquisition (SCADA) system automatically controls canal levels by opening control gates directing stormwater into the wetlands during storm events during irrigation season. As a method of treatment and disposal, the grantee installed a permeable interlocking concrete pavement parking lot. The lot has space for 22 automobiles and 2 buses. For education and outreach purposes, the project included the installation of two educational kiosks and a wetland boardwalk. The grantee outfitted them with educational materials and positioned signage along the existing 6,500 feet of pedestrian trails.

Monitoring Results

The grantee reported the Hyatt sand filter and wetland combination treatment, sampled in July 2015, demonstrated the ability to remove pollutants of concern (i.e., *Escherichia coli* (*E. coli*), phosphorus and Total Suspended Solids (TSS)) at notable levels.

- *E. coli* concentrations reduced by 99%
- TSS and turbidity values decreased 86% and 92%, respectively
- Total and dissolved phosphorus reduced by 66% and 91%, respectively
- Dissolved oxygen in the final outfall sample was below the minimum Water Quality Standard of 6.0 mg/L

Table 1: Data from July 2015 water samples taken after passing through the sand filter and wetland components.

	Sedimentation Basin	Sand Filter Discharge	Wetlands Outfall
Aluminum, total (ug/L)	2,530	793	20
Aluminum, dissolved (ug/L)	17	87	<10
Copper, total (ug/L)	10.1	3.3	0.3
Copper, dissolved (ug/L)	3.6	2.8	0.46
Zinc, total (ug/L)	61.4	10.5	4.4
Zinc, dissolved (ug/L)	16.7	9.8	3.2
Ammonia (ug/L)	513	152	28.6
Nitrate plus Nitrite (mg/L)	0.311	1.016	<0.022
Total Kjeldahl Nitrogen (mg/L)	2	1.6	0.8
Phosphorus, total (ug/L)	304	141	103

Table 1: Data from July 2015 water samples taken after passing through the sand filter and wetland components, continued.

	Sedimentation Basin	Sand Filter Discharge	Wetlands Outfall
Phosphorus, dissolved (ug/L)	131	92.3	11.2
Dissolved oxygen (mg/L)	5	7.74	5.92
Specific Conductance (US/cm)	78.4	224	188
pH (SU)	6.5	7.3	7.1
Temperature (degrees C)	20	19.7	23.1
Total suspended solids (mg/L)	77	2.2	5.9
Turbidity (NTU)	22.9	14.1	3.1
E. coli (MPN)	>2,419.6	1,046.2	16.1
Oil and Grease (HEM, mg/L)	<1.2	<1.2	<1.2

Lessons Learned

The grantee observed minor issues affecting the performance of the installed sand filter including concerns with the conveyance system, which directs runoff to the sand filter as originally designed with infiltration galleries beneath the road surface. Those galleries were sealed off after the completion of the project site and thus limited the amount of stormwater flow to the wetland. The grantee also determined the sediment basin in front of the stormwater filter was not sealed during construction, affecting the sand filter. The base material below the sediment basin was highly permeable allowing much of the stormwater discharged into the basin to be infiltrated before it could be conveyed into the filter.

To resolve this issue, the grantee placed a dam at the midpoint of the basin and sealed most of the basin bottom and sides with clayey topsoil. The permeable pavement experienced temporary shallow ponding in a 6-square-foot portion of the lot due to sediment laden water from an upstream tributary discharging into the lot. The grantee corrected this by removing the clogged aggregate and adding new aggregate to the section.

Present Site Conditions

The Hyatt Wetland site continues to be a highly functioning stormwater treatment system. The green infrastructure project has lessened the impacts of water pollution on the groundwater aquifer and surface waters downstream of the Hyatt site, according to the grantee. The project goals of removing phosphorous from stormwater, retaining long-term performance without the need for heavy maintenance, and providing a surface and appearance compatible with park use have been met. The permeable pavement parking lot continues to function as a method of onsite stormwater treatment without additional flooding issues. As a result of this success, the City of Boise proposed and constructed the Hyatt Wetland parking lot to use the same permeable pavement methods. The City of Boise developed an extensive environmental education program for local students using the Hyatt Wetland site as an onsite training tool. The project provides similar local communities to replicate the technology and methods used as a means for stormwater mitigation.

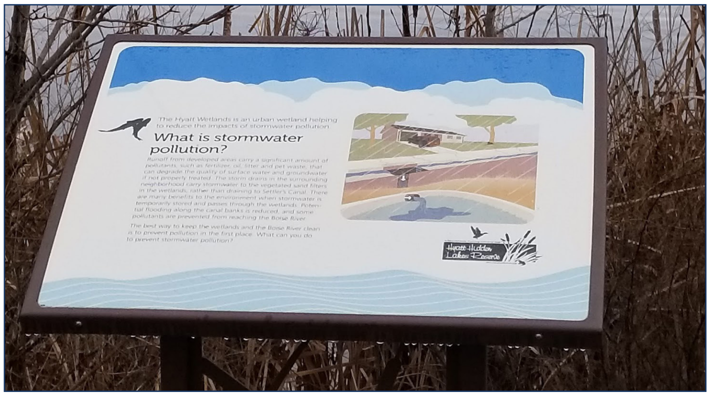

Image 8: Stormwater pollution education sign. (Photo courtesy of the final grantee report)

Project Participants and Resources

- City of Boise. The Hyatt Wetlands: An EPA Decentralized Stormwater Treatment Demonstration Project. Final Report. 2015.
- Ada County Highway District
- Settlers Irrigation District
- City of Boise
- Boise Watershed Environmental Education Center
- Project Website: http://bee.cityofboise.org/watershed/learn/hyatt-hidden-lakes-reserve/stormwater-demonstration-project/

Decentralized Wastewater Demonstration Project
Grantee Final Report Summary

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Demonstration of Innovative Approaches to Decentralized Stormwater Management in Northeast Ohio

Grantee: Chagrin River Watershed Partners, Inc.

Grant Amount: $745,600

Year Completed: 2011

Grantee Purpose: Address challenges to the installation of green infrastructure techniques that utilize infiltration and evapotranspiration methods.

Proposed Project: Evaluate the effectiveness of green infrastructure techniques that will optimally maintain pre-development hydrology patterns of development sites.

Project Overview

The Chagrin River Watershed Partners (CRWP) is a nonprofit organization that helps communities manage erosion and flooding. The grantee reported that Northeast Ohio faced challenges to implementing green infrastructure site design and stormwater management. The challenges identified included a lack of guidance for decentralized stormwater management, minimal flexibility in local codes to allow decentralized stormwater management, and a need for demonstration sites.

To help address these challenges, EPA awarded CRWP a grant in 2004 to install green infrastructure practices at several sites within the watershed. The project, which concluded in 2011, consisted of technical support, education, and funding to the design, construction, and monitoring of four green infrastructure demonstration projects.

The project objectives consisted of implementing green infrastructure, building regional support for decentralized stormwater management, developing technical support and specifications for structural components, and enhancing and revising community codes on decentralized stormwater management. The demonstration projects incorporated a variety of green infrastructure practices such as rain gardens, permeable pavers, vegetated swales, stormwater detention basins, and bioswale retrofits to roadside drainage ditches.

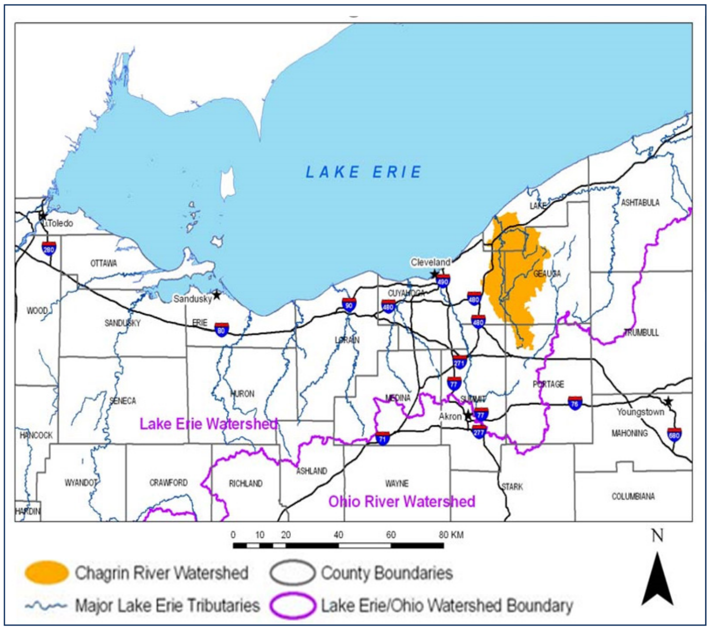

Image 9: Map of Chagrin River watershed in yellow. (Photo courtesy of the final grantee report)

Project Descriptions and Results

Commercial Office Building Stormwater Project (Cawrse & Associates, Town of South Russell): The grantee used several methods to reduce runoff volumes and treat collected runoff generated from impervious surfaces. They installed a 400-square-foot rain garden to treat 3,400-square-foot of commercial building roof runoff. The rain garden filters used an amended soil mix of 70 percent sand and 30 percent leaf compost 2-feet in depth. The project also included installation of a permeable paver parking lot with 4-inch perforated polyvinyl chloride (PVC) subsurface drainage tiles. This parking lot system discharges to a vegetative swale of 25 percent native soils, 75 percent imported sandy loam soils and native perennial herbaceous plants and shrubs. An installed stormwater detention basin with inundated depths of 0.0-0.5 feet detains runoff volumes generated from the site.

Results: The grantee conducted stormwater quantity, sediment load, and nutrient monitoring to evaluate the design and effectiveness of the green infrastructure practices. Cawrse & Associates completed the project in October 2008.
Collected data indicated an approximate 40 percent runoff ratio reduction, meeting runoff volume expectations. Fall and summer total dissolved nitrogen levels were below the threshold of 1.0 mg/L, while winter and spring levels were above the nitrogen threshold. Phosphorous levels remained below the threshold of 0.8 mg/L. Total Suspended Solids (TSS), chlorides, and copper levels all fluctuated seasonally as well, similarly to the total dissolved nitrogen.

Image 10: Permeable paver parking lot at office building. (Photo courtesy of the final grantee report)

Scenic River Rain Garden Project (Munson Township): This project installed three rain gardens to infiltrate and redistribute stormwater from construction sites of two shelter pavilions and a parking lot. The project was designed to detain, infiltrate, and reduce runoff volumes by pooling runoff to a depth of 0.5 feet. The rain gardens also contained a 4-inch perforated PVC underdrain with the excavated trench wrapped in filter fabric and backfilled with washed gravel. Munson Township completed the rain gardens in October 2007.

Results: The grantee used a crest street gauge to record the highest water elevation. Results from the gauge indicated that rain gardens never exceeded their design depth of 6 inches. Plant growth remained healthy in subsequent years. Water quality was not monitored for this project. The grantee did not measure water drawdown times or rainfall amounts, citing budget limitations.

Image 11: Munson Scenic Retreat rain garden. (Photo courtesy of the final grantee report)

Sterncrest Drive Bioswale Project (Orange Village): This project installed bioretention swales (bioswales) along 1,400 linear feet of an existing residential street to distribute, reduce, and treat stormwater runoff. Specifically, 9 95-square-foot rain gardens encircled each of the 9 storm sewer catch basins.

The constructed bioswales consisted of grassed swales and rain gardens at each storm sewer overflow structure. Perforated storm sewer underdrains were connected to a main storm sewer. Catch basins elevated six inches higher than the surrounding rain garden enabled excess overflow from the bioswales to pool within the rain garden prior to discharge through the catch basin. Orange Village completed the project in November 2007.

Results: Orange Village collected surface runoff, soil water (lysimeter), and catch basin samples to analyze nutrient levels. They installed five lysimeters to measure evapotranspiration from plants. Despite numerous rain events from 2008 to 2010 exceeding the 0.75-inch design infiltration criteria of the bioswales, stormwater infiltrated into the bioswale soil completely without overflowing. The grantee reported that this effectively reduced flooding events, which had plagued the area for decades. Dissolved total nitrogen and dissolved inorganic nitrogen (DIN) varied seasonally, with the lowest dissolved nitrogen concentration being near 0 mg/L to the highest being close to 4 mg/L in the catch basin. The bioswales reduced TSS levels and kept dissolved copper below the 10 mg/L threshold. Orange Village did not detect elevated chloride levels from surface water samples; they measured chlorides at or below approximately 400 mg/L throughout the monitoring period.

Fox Hollow Drive and Chagrin Boulevard Bioretention Project (City of Pepper Pike): The City of Pepper Pike installed two roadside bioswales to replace the existing shallow ditches for enhanced stormwater treatment. Each swale included a 2.5-foot soil layer of 70 percent sand and 30 percent peat and leaf compost with perennial herbaceous plants and double-shredded hardwood bark planted and mulched on top. The bioswales contain 6-inch PVC underdrains connected to the subdivision's existing sewer system. The city completed the project at Fox Hollow Drive in June 2008 and at Chagrin Boulevard in July 2008.

Results: The City of Pepper Pike did not install measurement instruments at the Fox Hollow Drive bioswale but did fit three lysimeters at the Chagrin Boulevard bioswale. The Chagrin Boulevard bioswale did not receive surface runoff along the curbed section of the road. They found elevated DIN, phosphorous, and chloride levels within the soil media; however, catch basin sampling results indicate these levels decline prior to discharge into the sewer. The grantee hypothesized that fertilizer was the source of elevated DIN and phosphorous levels, while solid de-icing products, such as road salt, likely contributed to the increased chloride concentrations.

Image 12: Roadside bioswales along Fox Hollow Drive. (Photo courtesy of the final grantee report)

Costs

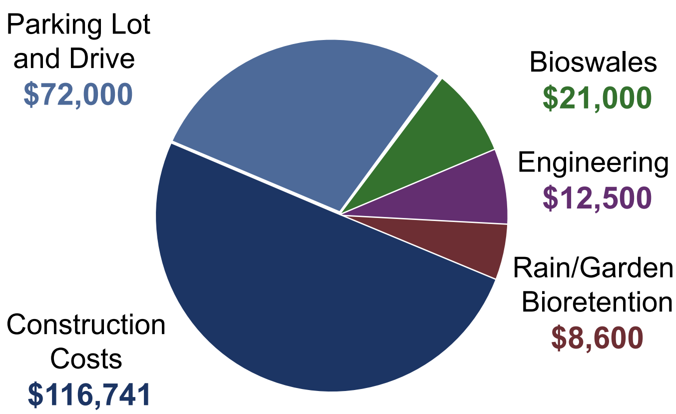

Figure 2: Demonstration project costs.

Lessons Learned

This demonstration project influenced most of the participating communities to adopt and update stormwater, erosion, and sediment control regulation codes. In addition, 45 percent of participating communities adopted riparian setback codes. The project helped develop local best management practices (BMPs) for designing and constructing green infrastructure projects.

These stormwater BMPs can effectively reduce runoff volumes and treat pollutants of concern. Though, the duration and intensity of rain events can influence the efficiency of these stormwater BMPs. These factors should be considered in the design and location of green infrastructure projects.

The diameter of the drainage pipes is important to consider. Smaller drainage pipes can be easily clogged by surface or subsurface sediments, which contributed to a high number of overflows. Community engineers should consider the size of the drainage pipe in the design stage, accounting for the potential heavier than expected rainfall. The sites continue to provide proof-of-concept water quantity reductions; however, further study, development, and implementation of BMP techniques are needed.

Present Site Conditions

All project installations remain in place and functional today. Though, the grantee has conducted minimal data collection and quality assurance checks since 2014. Data from 2011-2013 show that system performance with respect to runoff removal is decreasing. The community hypothesizes that this may be due to the development of preferential flow paths (short circuits) within the system.

Project Participants and Resources

- Chagrin River Watershed Partners, Inc. (CRWP)
- CRWP Member Communities
- City of Pepper Pike, Orange Village, and the Village of South Russell
- U.S. Geological Survey Ohio Water Science Center
- Northeast Ohio Regional Sewer District Water Quality Analysis Laboratory
- U.S. EPA Cleveland Office
- U.S. EPA National Risk Management Research Laboratory Office of Research and Development
- Brennan, Amy and Scharver, Matt. Demonstrating Innovative Approaches to Distributed Storm Water Management in Northwest Ohio, 2004 – 2011. Final Technical Report. 2012.
- Darner, R.A., Shuster, W.D., and Dumouchelle, D.H., 2015, Hydrologic characteristics of low-impact stormwater control measures at two sites in northeastern Ohio, 2008–13: U.S. Geological Survey Scientific Investigations Report 2015–5030: http://pubs.usgs.gov/sir/2015/5030/
- For more information on Green Infrastructure, visit: https://www.epa.gov/green-infrastructure

Decentralized Wastewater Demonstration Project Grantee Final Report Summary

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A Local Approach to Wastewater Regulation and Management

Grantee: Town of Colchester

Grant Amount: $1,530,200 ✓ Year Completed: 2013

Grantee Purpose: Protect public health and the environment through the implementation of a town-wide wastewater management strategy.

Proposed Project: Create a town-wide strategy that educates homeowners, promotes regular system maintenance, and utilizes management practices based on a Responsible Management Entity (RME) for high risk areas.

Project Overview

Colchester has more shoreline along Lake Champlain than any other community in Vermont. It is also the largest Vermont community to rely primarily on decentralized wastewater systems. The town's wastewater officials realized homeowners generally did not properly maintain their septic systems - only seeking help if a problem arose. With this heavy reliance on septic systems, the wastewater officials saw the opportunity for big gains by offering assistance and education on septic maintenance. The goals of this grant project were to create a wastewater management strategy that would support current and future needs, maintain and improve existing infrastructure, advance environmental sustainability, improve public health, preserve and restore stream corridors and the lake shoreline, and maximize the return on every dollar invested.

To accomplish these goals through the grant, the town sought the following:

- Create a management strategy to protect local water resources;
- Identify priority geographic areas to utilize enhanced management;
- Evaluate and adapt different management models and regulatory requirements to minimize impacts of decentralized systems on local water quality; and
- Develop a management program framework and evaluate its implementation costs.

Image 13: Welcome to Colchester sign. (Photo courtesy of the Town of Colchester Government)

Permit Status

The grantee collected septic system permit data prior to this grant. Of the 5,260 systems found, the needs assessment determined the following:

- 1,170 systems (22%) were altered in 2005 or later, requiring either a new permit or permit amendment;
- 2,810 systems (54%) were built between 1967 and 2005; and
- 1,280 systems (24%) had no permit on file, meaning some systems could have been built prior to 1967.

Management Strategies

The grantee performed a wastewater management alternatives analysis to consider different levels of wastewater management. These levels ranged from relatively simple homeowner awareness programs to acquisition of and operation and maintenance of individual wastewater systems by the town. While the town found the first four models from EPA's Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems to be economically feasible, it identified Levels 1 and 3 as the best fit for its needs. These levels were assigned throughout the town based on risk, with risk being determined through the grantee's needs assessment.

Table 2: EPA's Management Models as utilized in Colchester demonstration project.

Level 1: Homeowner Awareness	• Applied at the town-wide level • Education for each homeowner on septic system function and maintenance • Periodic maintenance reminders
Level 2: Maintenance Contracts	• Unnecessary as Level 1 reminders were justified to be satisfactory for lower risk areas
Level 3: Operating Permits	• Applied to high and medium risk priority areas • Applied to all advanced systems regardless of risk • Specific to each permitted system
Level 4: RME Operation and Maintenance	• Not justified given level of risk town would assume over Level 3
Level 5: RME Ownership	• Not economically feasible

Plan Implementation

The grantee categorized the plan implantation tasks as:

- Database updates;
- Public outreach and education;
- Program development;
- Ordinance revisions;
- Implementation of town-wide awareness program;
- Implementation of operation and maintenance (O&M) permits; and
- Promotion of good stewardship.

Costs

The final grant report outlines estimated costs for implementation of the recommended plan on a per household basis. The grantee estimated initial startup costs to be $8,000. Annual operating costs are projected to be $28,000. The final report requested that the Town of Colchester Select Board to decide which recommendation to implement and a timeline for implementation.

Results

Based on its assessment, the Town of Colchester chose to pursue operating permits (Level 3 of EPA's Voluntary Guidelines) as their level of decentralized wastewater management.

Present Site Conditions

To enact this level of management, the grantee determined that adoption of the measures could not be enacted without a change to state statute. The current Vermont state statute does not allow a delegated authority to place conditions on wastewater permits that are more stringent than state requirements. To adopt one of these management frameworks, Colchester would need the ability to place more stringent conditions on wastewater permits for systems in more vulnerable areas. There has been ongoing dialogue between the Town of Colchester and the state. Due to the difficulties of this process, the Town is conducting a basic educational outreach program as a lower level means of decentralized system management. As of the date of this report, the grantee is still working with the state to allow the town to implement Level 3 management via operating permits.

The final grant report also noted that some areas of the town were not appropriate for a decentralized approach. Rather, the grantee concluded that the municipal sewer system was the more appropriate means of wastewater treatment for these areas, such as in Malletts Bay, where improvements are currently under development to address bacteria and water quality concerns.

As a result of some of the work done under this grant, the town launched its Clean Water Initiative in 2015, which included a series of plans, regulations, programs, and capital projects that were designed to improve and protect the community's water resources. The town considered stormwater management alternatives as part of this demonstration project, where stormwater runoff was found more likely to contribute a larger portion of water quality impacts. For example, Colchester enacted new zoning regulations along the southern shore of Inner Malletts Bay requiring the management of the first inch of rainfall on a property with a preference for green infrastructure practices.

One of the biggest achievements of the demonstration project was the formation of a stormwater utility for Colchester. The utility began operations in Summer 2017.

Project Participants and Resources

- Town of Colchester, VT. Wastewater Management Feasibility Study: Report on Task 5 of the Integrated Water Resources Management Program. Final Report. 2013.
- Town of Colchester, VT. Needs Assessment for Onsite Wastewater Treatment Systems. 2011.
- EPA's Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems: https://www.epa.gov/sites/default/files/2015-06/documents/septic_guidelines.pdf

An Innovative Approach to Solving Wastewater Problems in Chepachet Village

Grantee: Town of Glocester

Grant Amount: $642,122 Year Completed: 2012

Grantee Purpose: Remediate failing decentralized wastewater infrastructure within a historic and preserved community in order to demonstrate how advanced wastewater treatment systems can provide a solution for areas with challenging topography.

Proposed Project: Replace failing residential septic systems with five advanced wastewater treatment systems and develop a wastewater management program.

Project Overview

Chepachet Village is a historic mill village located in the town of Glocester, Rhode Island. The Village's industrial-era textile mill was strategically built on a tributary of the Blackstone River to harness the river's hydropower energy. Over time, Chepachet Village developed into a densely populated small town due to high seasonal tourism and clustered housing on small lots along the riverbank. Glocester, the grantee, reported untreated sewage had been discharging into the Blackstone River through a number of failed onsite septic systems and a cistern that had been converted from drinking water storage to a cesspool for wastewater.

Chepachet Village sits on the Branch River aquifer, an important aquifer for the area. Through this grant, the town of Glocester sought to create methods for wastewater pollution prevention, procedures to mitigate stormwater impacts, and a new village-wide wastewater management plan. The demonstration project had three main objectives:

- Devise immediate wastewater management solutions using onsite treatment;
- Assess Chepachet's pollution risks from conventional or failing septic systems, and other sources as part of a long-term wastewater management strategy for the Village; and
- Promote improved wastewater management practices through community involvement and educating the Chepachet Village and surrounding lakefront development throughout Glocester.

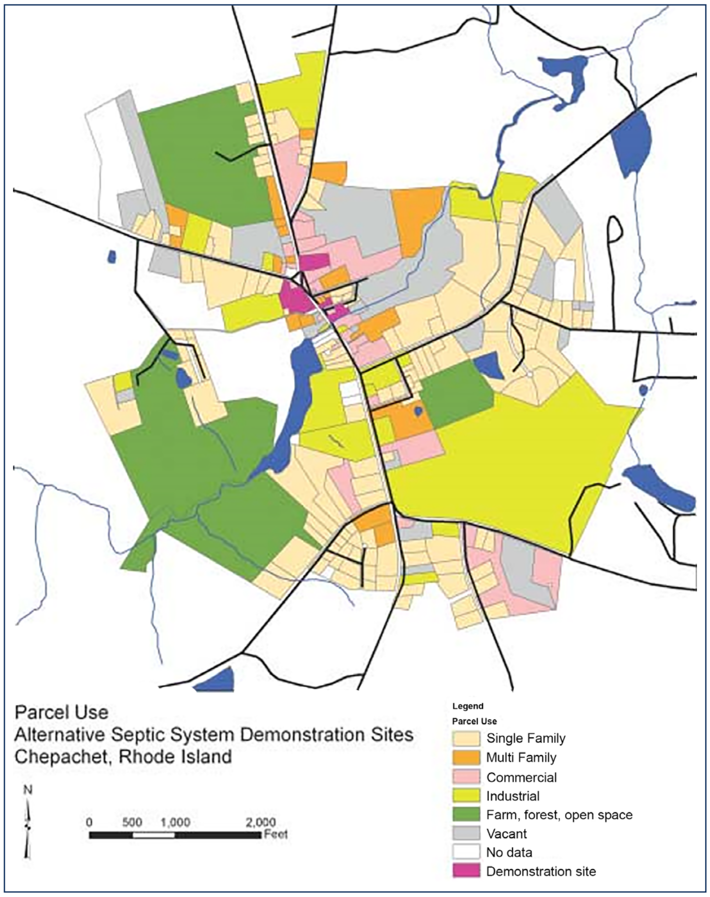


Image 14: Map of Chepachet Village, project site. (Photo courtesy of the final grantee report)

The Village also had the following two water quality improvement goals for the grant project:

- Eliminate untreated discharges of nutrients and pathogens from wastewater into the Chepachet River and the Branch River aquifer; and
- Protect quality of local groundwater to meet current and future drinking water needs.

Technology

The grantee installed five advanced wastewater treatment systems on different properties to demonstrate their applicability for different amounts and types of wastewater outputs. Systems were installed at a restaurant, a large apartment building duplex, a multi-family house and a garden shop, a first-floor retail shop with apartments above, and a first-floor office building with apartments above. The grantee installed the systems in the Village center, which were previously considered infeasible due to the small lot sizes.

The grantee used textile filters as the treatment unit for each site because of their ability to fit into limited spaces, low operational and maintenance costs, and ability to treat wastewater consistently though seasonal variation. Alternative drainfields were also installed at each site, which allowed for greater flexibility given space constraints. This method also preserved their scenic and historical setting, an important factor to the community.

Image 15: Bottomless sand filter fits into a small space at a property on Main Street. (Photo courtesy of the final grantee report)

Installation at neighborhood restaurant and mixed-use retail, office, and residential buildings: For this demonstration site, the grantee reported it considered the restaurant's capacity (100 patrons), lot size (1.6 acres), and its close proximity to a water supply well during the design process. The space for a drainfield installation was very limited, which posed a challenge to this site. The system routes restaurant kitchen wastewater through a three-compartment, 2,000-gallon grease trap and then combines this flow with wastewater from the restaurant bathroom facilities. The combined effluent flows to a 2,500-gallon, two-compartment septic tank, which flows by gravity to a 2,500-gallon recirculation tank. Wastewater then pumps from the recirculation tank to a four-module recirculating media (textile) filter. To save space, these units are located directly above the 2,500-gallon septic tank receiving flow from the restaurant grease trap and above the recirculating tank. Finally, the treated wastewater is pressure-dosed to a shallow, narrow drainfield located in an island within the restaurant parking lot. The drainfield consists of eight 98-foot-long lines fed from the middle and set in 4 zones.

Installation at a large apartment building, duplex apartment, and Glocester Heritage Society: The grantee installed new septic tanks for primary treatment and solids settling for each building at this site. Effluent from each septic tank flows by gravity to a 2,000-gallon recirculating tank and is then time-dosed to two textile filters. After recirculation for improved nitrogen removal, the treated wastewater is pumped to a 7-by-48-foot raised bottomless sand filter. This configuration maximized the available space, keeping the drainfield within a safe setback distance (100 feet) away from existing wells

Installation at a multifamily house and cottage with rustic garden shop on one lot: Prior to installation of the new system, the site contained one septic tank and a failed drainfield for the home and cottage, along with no running water to the barn and garden shop. The advanced septic system installed handles a combined flow of 600 gallons per day of wastewater and time-doses wastewater under pressure to a textile filter. The flow then recirculates back to the septic tank for improved nitrogen removal. After recirculating several times daily, the treated wastewater is pressure dosed to a 7-by-25-foot bottomless sand filter, which serves as a drainfield. The top of this bottomless sand filter is raised above the site existing grade to function in high-water table soils and to provide additional bacterial removal. The bottomless sand filter is a single-pass design where treated effluent is sprayed over the top of the sand filter and undergoes final treatment as it filters through two feet of sand media. It then discharges directly into the ground beneath the filter. By locating the drainfield in a narrow space near the front of the property, a safe setback distance of 100 feet from the well was achieved, without any disturbance to wetland buffers.

Installation at first floor retail shops with apartments above: An advanced wastewater treatment system was installed to replace the old failing system for a building with a combined flow rate of 660 gallons per day. The wastewater from this building flows by gravity to a 1,500-gallon dual compartment septic tank with an effluent filter, and then to a 1,000-gallon recirculating tank. From there, the wastewater is time-dosed to a textile filter designed to accommodate up to 900 gallons per day. The treated wastewater is then pumped to a shallow, narrow, pressurized drainfield.

Installation at first floor vintage office building with apartments above: The grantee installed a 1,500-gallon dual-compartment septic tank and a recirculating textile filter. From the textile filter, the treated effluent is time-dosed to a shallow, narrow, pressurized drainfield. The wastewater from this building flows by gravity to a 1,500-gallon dual compartment septic tank with an effluent filter, and then to a 1,000-gallon recirculating tank. From there, the wastewater is time-dosed to a textile filter designed to accommodate up to 900 gallons per day. The treated wastewater is then pumped to the shallow, narrow, pressurized drainfield. This configuration maximizes separation distance from the drainfield to both the wetland and the well, according to the grantee. Prior to this installation, the wastewater gathered into a cesspool as the primary means of wastewater treatment. The grantee pumped out the wastewater and filled in the cistern before the new system was installed.

Management Options

The next phase of the project was to develop a town-wide long-term wastewater management strategy. The grantee used geospatial mapping to evaluate the sources of pollution to groundwater and estimate suitability of all parcels for onsite wastewater treatment. The grantee performed the assessment using input factors such as parcel size, soils, and proximity to wetlands. They utilized specific risk factors to weigh how prone certain areas were to wastewater pollution. Results showed that 40 percent of lots were either marginally suitable or unsuitable for a conventional system. Requiring use of advanced treatment in high risk areas, with inspection and maintenance of all onsite wastewater treatment systems (OWTS) was recommended. Otherwise, conventional systems would continue to be installed using either mound systems or reduced well setbacks, putting groundwater supplies at risk.

Lessons Learned

The Town of Glocester concluded it should adopt several onsite wastewater management practices and treatment standards for Chepachet Village in the future. This included:

- Ensure basic septic system maintenance
- Phase out cesspools
    - Set a time frame for replacement of all cesspools from first inspection identifying locations of cesspools or requiring cesspool removal within one year of property transfer
- Establish siting standards for new construction
    - Prohibit new system construction or expansion on water table sites less than two feet below ground surface, and within buffers to wells, wetlands, and surface waters
- Establish standards for use of advanced wastewater treatment
- Promote private-well care through testing, workshops, subsidizations of sampling costs, and encouraging upgrades
- Control use of underground storage tanks and hazardous materials
- Manage stormwater to control runoff volume
- Protect and restore wetland buffers
- Expand public education

Present Site Conditions

The demonstration sites are still in use and functioning properly today. The sites are being used as training opportunities for those interested in adopting similar wastewater management methods and as a public outreach tool for community members.

Project Participants and Resources

- Joubert & Loomis. Chepachet Village Decentralized Wastewater Demonstration Project. Final Report. 2005. http://www.glocesterri.org/ChepWastewaterReport.pdf
- Town of Glocester
- University of Rhode Island Cooperative Extension Water Quality Program
- Rhode Island Department of Environmental Management

An Innovative Eco-Machine to Treat Stormwater and River Water on the Blackstone River at Fisherville Mill

Grantee: Town of Grafton

Grant Amount: $671,000 ✓ Year Completed: 2012

Grantee Purpose: Address groundwater and surface water contamination caused by industrial pollution in the Blackstone River at the Fisherville Mill.

Proposed Project: Improve the water quality of the Blackstone River through an innovative water treatment technology, mitigating the concentrations and effects of harmful pollutants.

Project Overview

The Blackstone River flows 46 miles from Worcester, Massachusetts, to Providence, Rhode Island. Prior to this project, on the Massachusetts side, the Blackstone River suffered decades of industrial pollution as well as visible pollution and odors, impacting the livability of the historic riverbank mill villages and the usability of the river for recreational purposes. Due to the severity of the pollution, the river was designated to the state's list of impaired waters.

Fisherville Mill is located on the historic Blackstone Canal Trench that joins with the Blackstone River. This site has been known to house harmful pollutants for years, primarily No. 6 fuel oil (bunker C) and chlorinated solvents. A fire in 1999 destroyed the mill, releasing large amounts of contaminants into the ground and surface water, degrading the canal, and threatening the Town of Grafton's drinking water supply.

This decentralized demonstration project grant authorized the Town of Grafton, the grantee, to install an Eco-Machine, which would pilot and test biological restoration of the canal. The grantee completed the Eco-Machine in May 2012. The Eco-Machine developers proposed their technology could attract diverse organisms to the canal to digest the fuel oils and improve water quality through impaired ecosystem function.

Image 16: Blackstone Canal, Greenhouse, and Canal Restorer with a noticeable oil sheen in June 2012. (Photo courtesy of Project Lead John Todd)

Technologies

The Town of Grafton awarded John Todd Ecological Design $321,000 to design, construct, and operate the Eco-Machine. Other grant funding went to butane injections into the ground at the source of oil contamination. This process dilutes the oil and stimulates growth of oil consuming bacteria that consume it before entering the water. The ecological treatment installation consisted of a variety of interlinking technologies: A solar-powered greenhouse with aquatic tanks and a fungal mycelial loop, a floating plant raft anchored in the canal, and a sediment intake structure. The technologies interact by continuously flowing water from the canal through the greenhouse and back into the canal.

The system designer sought to provide many beneficial organisms to the canal. The Eco-Machine intended to function as an ecological incubator and provide a sufficient diversity of life forms to digest oils and contaminants. This would then transform the canal back into its original healthy state.

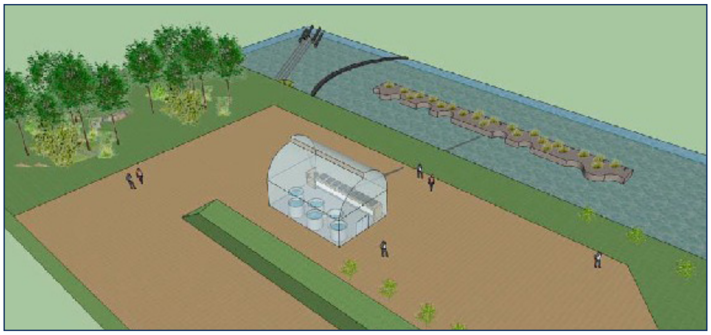


Image 17: The schematic of the facility includes the Eco-Machine, the Restorer in the canal, and the bio-filter. (Photo courtesy of John Todd)

Image 18: Eco-Machine on the Blackstone River at Fisherville Mill. (Photo courtesy of the Blackstone River Valley National Heritage Corridor)

Monitoring Data

Between June and November 2012, the grantee took monthly samples of petroleum contaminated water and sediments within the canal, testing for Total Petroleum Hydrocarbons (TPHs) and Polycyclic Aromatic Hydrocarbons (PAHs). This was conducted at a variety of locations including upstream, downstream, at the bottom filter, under the Restorer in the canal, and in the greenhouse tanks.

The grantee's data show TPHs in water trended downward. TPHs in the sediments increased throughout the summer, with a downward trend from north to south along the canal. The grantee provided Figure 3 (on the right) to document these changes in TPH levels throughout the Grafton system.

PAHs in water exhibited a decrease in levels between the canal and Eco-Machine. Sampling showed an increase in PAHs in the month of September. PAHs in the sediments also increased throughout the summer, similarly to TPHs, with the highest concentrations reported upstream.

Table 3: List of technologies used in this project.

Bottom Filters	• Bottom filters draw 500-1000 gallons of contaminated canal water daily through 4 25-foot microbial bottom filters submersed in the middle of the canal.
Eco-Machine	• The Eco-Machine is in a greenhouse with two sub-components (Myco-Reactor and Aquatic Cells). • The Myco-Reactor breaks down large molecule chains through the use of different species of wood decaying fungi, producing extracellular enzymes. • Water containing the enzymes then moves to the Aquatic Cells, a series of six 700-gallon tanks containing plants, snails, fish, and bacteria, where contaminated water becomes a source of food for the various microorganisms.
Canal Restorer	• A floating raft system with native plant species establishes root systems. • The Restorer receives water flows from the Eco-Machine. • This sustains the ecology seeded into the canal from the Eco-Machine, thereby increasing beneficial organisms and enhancing overall water quality.

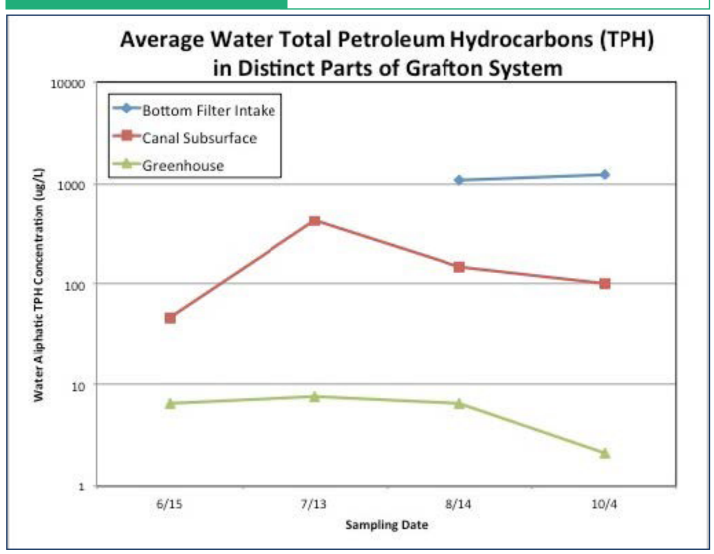


Figure 3: TPH averages (ug/L) of bottom filters, canal subsurface, and Eco-Machine from June to October 2012.

The grantee also sampled for dissolved oxygen, pH, temperature, chemical oxygen demand, phosphorous, ammonia-nitrogen, and nitrate-nitrogen for water chemistry. All sampling results can be found in the Grafton Canal Restorer Eco-Machine: Water Quality and Contaminated Sediment Biological Restoration Systems Final Report as cited under the Project Participants and Resources section.

Lessons Learned

The grantee reported that water quality improved; amphibians, fish, and beavers have returned to the canal; and turtles have been seen sunning themselves along the upstream oil booms. The Eco-Machine treated over 300,000 gallons of petroleum-contaminated waters and sediment as part of this project. Due to the short sampling time period, the grantee reported results are preliminary. More data is necessary to determine total success. A multi-year study of this system would be needed to determine the specific role each system component plays in improving water quality.

The grantee reported it expects that over time the combination of the Eco-Machine and the Restorer will act as ecological incubators and seed the canal with beneficial organisms on a continuous basis. This will strengthen the ability to help manage nutrients and remove hydrocarbons from the water and sediments. The grantee believes if the system establishes itself and performs as designed, then low-impact hydrocarbon remediation will become more widely affordable.

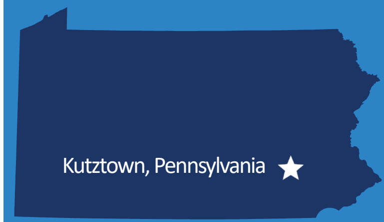
Present Site Condition

The Eco-Machine has continued to operate since its launch in 2012; it is operated on a voluntary basis by the site owner, Fisherville Redevelopment Company, LLC (FRC) with the help from several local universities.

- Water quality has continuously improved since project inception. There appears to be growing complexity and diversity in the flora and fauna of the affected area.
- FRC has hosted more than 100 tours of the facility for technical schools, universities, and graduate and post graduate programs.
- The facility has become a platform for scientific inquiry in the area and delivers complex lessons in system thinking, ecosystem and organismal function to students, professors, and the regulatory community.
- The grantee reports that the study of the system's functions and its potential applications is delivering multiple social goods including remediation, tourist amenity, a living classroom, and a living laboratory.

Project Participants and Resources

- Todd, J., et al. Grafton Canal Restorer Eco-Machine: Water Quality and Contaminated Sediment Biological Restoration Systems Final Report. 2012
- Brown University Superfund Laboratory
- Clark University Hibbett Laboratory
- Worcester Polytechnical Institute
- Tufts Cummings School of Veterinary Medicine
- Tufts School Environmental Engineering and Public Health program
- The Conway School Ecological Design Program
- The National Park Service
- Massachusetts Department of Environmental Protection
- Blackstone Valley Canal Commission



Decentralized Wastewater Treatment System: The Water Purification Eco-Center

Grantee: Rodale Institute

Grant Amount: $695,450

Year Completed: 2013

Grantee Purpose: Develop an onsite wastewater treatment system that incorporates both traditional and alternative wastewater systems to demonstrate new and effective methods for wastewater treatment and reuse.

Proposed Project: Design, construct, and monitor a wetland sewage treatment and drip irrigation system, as well as install rainwater harvesting green infrastructure on the center's roof for water reuse purposes.

Project Overview

The Rodale Institute, the grantee, is a nonprofit organization focused on developing best practices for organic farming through research and outreach. The Institute constructed the Water Purification Eco-Center (WPEC) as a decentralized wastewater treatment and disposal system for public restroom facilities to demonstrate a model of onsite wastewater treatment that combines conventional and alternative wastewater treatment. The system uses harvested rainwater for toilet flushing and filters and treats it several times before dispersing it by drip irrigation into a nearby perennial garden. The demonstration grant project included a multi-step process of wastewater treatment consisting of septic tank and primary treatment, construction of a wetland cell, installation of a recirculating bio-filter, and construction of a subsurface drip irrigation system.

Technology

The treatment system developed by the grantee collects rainwater from the facility's roof and stores it in an underground cistern. The rainwater is used to flush toilets, and then flows into a septic tank for solids separation. From the settling tank, the water is then sent to a constructed wetland for microbial filtering. The water is recirculated between the wetland cell and the equalization tank through a trickling bio-filter. The treated effluent is then sent through a drip irrigation system to a nearby perennial garden.

Rain Collection

The Rodale Institute designed the facility with a roof that collects rainwater that feeds the facility's water supply. Rainwater is brought down to the sub-grade cistern and then pumped to supply the non-potable water for toilets and urinals. Standing seam metal roofing was installed for easy rainwater catchment.

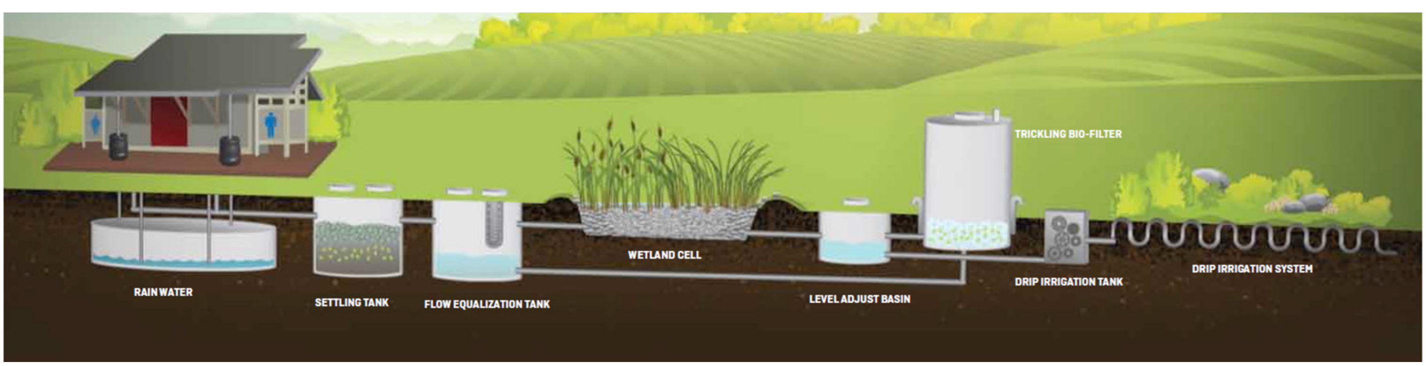


Image 19: Design of the Water Purification Eco-Center. (Photo courtesy of the final grantee report)

Wastewater Collection and Primary Treatment

Wastewater from the facility flows by gravity into an underground septic tank for primary treatment and for solids to settle at the bottom of the tank. Effluent pumps collect the septic tank effluent. The collection system consists of a primary treatment tank, flow equalization tank, in-tank high-head effluent pumps, and small-diameter collection mains.

Constructed Wetland

Water pumps into a subsurface horizontal-flow constructed wetland where lined gravel filters are planted with wetland plant species. As wastewater moves through the wetland, the bacteria attached to the gravel and plant roots breaks down organic waste, suspended solids, and nitrogen. With regular maintenance, such as removing, cleaning, and replacing gravel, along with testing liners for water tightness, the wetland has a conservative estimated service life of 30 – 40 years. Though, higher estimates range up to 100 years. From the wetland cell, the water flows to the level-adjusted basin, which maintains water levels in the wetland cell and provides a staging zone to determine if the water should flow through the tricking filter for recirculation or be processed to the drip irrigation field.

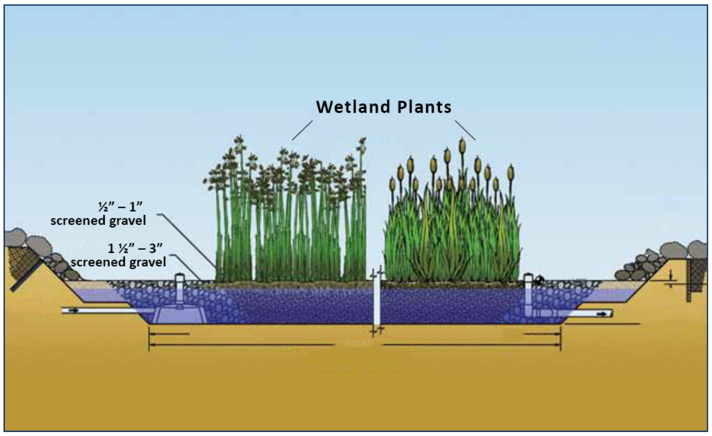


Image 20: Schematic of subsurface constructed wetland. (Photo courtesy of the final grantee report)

Trickling Bio-Filter

After the wetland cell, the water is sent from the level adjust basin to a trickling bio-filter, which consists of loosely packed high-surface area media within an enclosed tower. Made from plastic honeycomb boxes, housing a durable surface for bacterial growth, the media breaks down the organic material and nutrients from the effluent. Wastewater sprays intermittently over the media and trickles to the bottom where it collects and flows by gravity back to the tank. Water then recirculates back to the flow equalization tank and through the wetland.

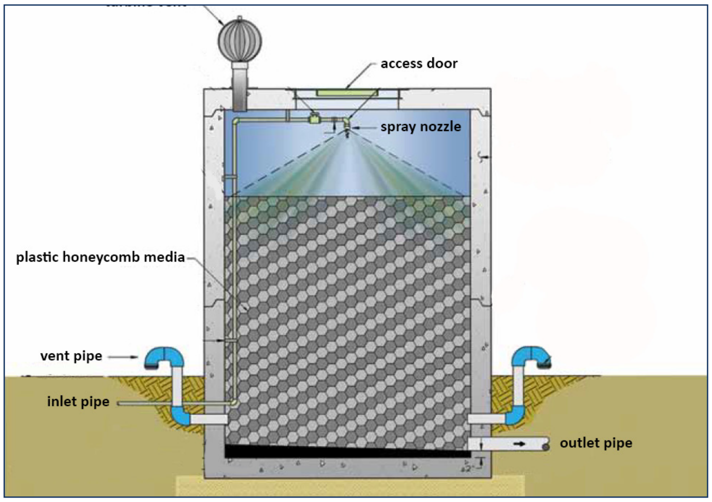


Image 21: Schematic of trickling bio-filter. (Photo courtesy of the final grantee report)

Subsurface Drip Dispersal

The upper layers of native soil contain a complex ecology and are natural systems for the removal, sequestration, and transformation of nutrients found in water bodies. Any contaminants are generally removed within the first two feet of soil. The treated effluent collects in a dosing tank, pumps via drip tubing below the surface, and percolates through the soil matrix. Eventually, the treated effluent is dispersed into the water table.

Image 22: Restroom facility, wetlands, and drip irrigation field. (Photo courtesy of the final grantee report)

Monitoring Data

The grantee conducted seven rounds of water sampling between March and December 2012. During each sampling event, the grantee pulled samples from the septic tank, pre-cell, wetland cell, and irrigation tank. Samples were also collected from two and four feet underneath the effluent-irrigated landscaped areas. Table 4 on the next page summarizes the reduction of each sample parameter as reported by the grantee.

Table 4: Summary of reduction as reported by the grantee.

Phosphorous	• Substantial drop between septic and pre-cell chambers • Final leachate concentrations averaged 0.4 mg/L (septic tank averaged approx. 21 mg/L)
Fecal Coliform (FC)	• Reduction of 99.99% by the time the wastewater made it to the irrigation system • Final leachate concentrations averaged 3.6 FC/mL (septic tank averaged 120,000 FC/mL)
Nitrogen	• Average levels of 8.8 mg/L by the time the wastewater made it to the irrigation tank • Final leachate concentrations averaged 1.3 mg/L (septic tank averaged approx. 75 mg/L)
Total Dissolved Solids	• Concentrations did not significantly reduce • No negative impacts on human health from measured levels
Dissolved Oxygen	• Typical levels in the septic tank averaged <1 mg/L • Average levels rose to at least 5 mg/L, high enough to support aquatic life, after treated wastewater reached wetland

Lessons Learned

The Rodale Institute strived for a solution that could be adoptable and adaptable to other sites with similar needs and challenges. The grantee found the footprint of this system can fit inside a backyard and treats the typical output from a 3-bedroom house, which averages 300-500 gallons per day. The grantee concluded this makes this system replicable and feasible for many homeowners.

Visitor feedback on the constructed wetland was positive. Visitors found the wetland aesthetically pleasing and intelligently designed to fit into the landscape.

The system itself is low maintenance. Aside from routine upkeep on the pumps, there has been little for the grantee to maintain since system installation and startup.

Present Conditions

The grantee reports that the site is fully functional and operating well. The grantee is not currently collecting data on the system due to lack of funding.

Project Participants and Resources

- Rodale Institute. *Water Purification: Innovative On-site Wastewater Treatment.* Final Report. 2013.
- Langan Engineering and Environmental Services
- Natural Systems Incorporated
- Franc Environmental
- Kutztown University
- Maxatawny Township Board of Supervisors
- DelVal Soil and Environmental
- Down to Earth Design
- Water Purification Eco-Center Website: https://rodaleinstitute.org/about/facilities-and-campuses/water-purification-eco-center

Decentralized Wastewater Demonstration Project Grantee Final Report Summary

The views expressed in this document are solely those of each demonstration project grantee in its final report and follow-up discussions and do not necessarily reflect those of the Agency. EPA does not endorse any products or commercial services mentioned in this document.

Protection of Groundwater Resources via Technologies to Reduce Nutrient Contamination in the Upper Deschutes Watershed

Grantee: Deschutes County

Grant Amount: $5,500,000 Year Completed: 2005

Grantee Purpose: **Address nitrate pollution impacting a shallow, unconfined aquifer caused by failing decentralized systems.**

Proposed Project: **Utilize and implement cost-effective denitrifying wastewater treatment technologies to homes on the Upper Deschutes River Basin.**

Project Overview

Deschutes County, Oregon, has experienced rapid development growth in recent decades. The grantee reported that the development of housing subdivisions created difficulties in adequately siting individual wastewater treatment systems and water supply wells. These systems threatened the groundwater quality in the area. The grantee also reported that the county did not have land use planning that were designed to address potential water quality impacts from decentralized systems laws in place at the time of the subdivision's development.

Deschutes County recognized these issues in 1996. Since then, the county completed a study finding a centralized sewer system was infeasible. As a result, the Oregon Department of Environmental Quality (DEQ), in coordination with Deschutes County and the U.S. Geological Survey (USGS), obtained funding to strengthen its existing septic systems.

This project aimed to:

- Field test decentralized wastewater systems with denitrifying technology;
- Develop a decentralized system maintenance structure;
- Perform groundwater investigations and develop a 3D groundwater and nutrient fate and transport model; and
- Establish a loan program to replace or retrofit failing or inappropriately sited decentralized systems.

Image 23: Deschutes River. (Photo courtesy of U.S. Forest Service)

Technology

The county solicited proposals from the national onsite professional community as the initial step for technology selection. This project utilized 13 different advanced wastewater treatment technologies with the primary goal of reducing nitrogen contamination to the groundwater. The grantee assessed each technology for its ability to treat the wastewater. The final report presented the individual system's performance statistics.

Table 5: Demonstration project technologies.

AdvanTex™ AX-20	Uses textile in packed bed filter as replacement for sand or gravel
AdvanTex™ RX-30	Uses textile pieces similar to AdvanTex™ AX-20 but smaller
Amphidrome®	Uses deep sand media contained in vertically oriented tube
Biokreisel	Rotates biological contractor turned by small motor
Dyno2™	Recirculates gravel filter combined with wetland treatment system components
EnviroServer	Provides both fixed film and suspended growth processes with forced aeration
MicroFAST®	Uses both attached and suspended growth processes in a unit that combines the packed bed approach with forced aeration
IDEA BESTEP	Suspends growth activated sludge treatment within a single tank
Amphidrome®	Uses deep sand media contained in vertically oriented tube
Innovative Trench Designs	Attempts to replicate denitrification processes from non-proprietary designs
Nayadic	Designs with nested chambers - an inner reactive vessel and outer clarification chamber
NiteLess	Uses all wastewater treatment processes contained to single tank
NITREX™ filter	Contains a nitrate-reactive media that converts nitrate to nitrogen gas
Puraflo®	Packs bed filter using peat fiber as filter media

Costs

In the La Pine project area, a standard conventional septic system typically costs $3,500 in 2000-2001, the years of the demonstration project wastewater treatment system installations. New nitrogen reducing treatment systems ranged from $8,900 to $19,000 while nitrogen treatment retrofits into existing systems ranged from $3,500 to $18,900. Maintenance costs to homeowners were typically $200-$250 annually. Costs to retrofit systems depended primarily on the condition of the existing system and other structural constraints on the property.

Monitoring Results

This project selected 49 sites on the Upper Deschutes River Basin to receive denitrifying technologies. The grantee installed groundwater monitoring well networks around each decentralized system to monitor monthly for a year, and then quarterly for another two years. The final report illustrated the challenge the county faced by denitrifying decentralized systems to meet the 10 mg/L performance standard. The system that consistently met the 10 mg/L standard, the NITREX™ filter (see description in Table 5), included a secondary carbon source and anoxic environment to reduce the nitrate to nitrogen gas. Most other systems relied on recirculation to the primary clarifier in order to promote denitrification.

Loan Program

The original proposed plan included more than 200 systems for either retrofit or new installations. However, the State of Oregon had a rule, which was in place in 2005 and has since been repealed, that prevent the installation of treatment systems. Therefore, the remaining grant funds went toward the implementation of a low-interest loan program. In cooperation with DEQ, Deschutes County developed a Request for Proposal (RFP) for an organization or agency to contract with the county to administer the loan. The RFP included concepts like loan repayment at time of sale or other such deferred payment options. Additionally, Deschutes County considered utilizing the Clean Water State Revolving Fund (CWSRF) financing available for decentralized systems at the conclusion of the project.

Recommendations for Management Program

While the grantee determined additional levels of maintenance are required for the advanced treatment technologies installed as part of this demonstration project, it also determined that the thousands of existing systems typically lacked the most basic types of preventative care. To create a decentralized wastewater management program meant to address this issue, the grantee undertook a lengthy citizen input process that established the following recommendations:

- Issue a combined construction and operating permit for all decentralized systems;
- Bring existing systems into the operations and maintenance (O&M) program;
- Develop a computerized system for tracking maintenance activities to be made accessible to the public;
- Mandate a certification program for maintenance providers, installers, and pumpers;
- Encourage the permitting agency to use a variety of methods to ensure compliance;
- Provide continuing education for homeowners through handouts, home show booths, Earth Day fairs, media coverage, and more; and
- Coordinate a phased implementation of the O&M program.

Lessons Learned

As a result of the grant project, the county noted several lessons learned:

- Alternative or innovative wastewater treatment systems can provide comparable or improved performance over conventional systems, particularly where such systems are designed and installed to promote denitrification;
- Maintenance professionals should be developed and promoted, so that individual providers can focus on decentralized system maintenance as a primary business;
- Long-term data on the performance of decentralized systems is necessary. Most studies, including this demonstration, are short lived and do not provide extended examination of systems that are expected to operate for twenty years or more;
- No studies could be referenced with enough evidence to point to decreased pollution for a scientific justification of a maintenance program;
- Inviting the public to join the decision-making process was essential to the integrity of the project;
- Committee members took ownership of the overall recommendation development process and the product due to an extensive fact-finding and educational process, changing the public’s outlook; and
- Predictions of future impacts to the aquifer, as produced by the USGS 3D nutrient fate and transport model, indicate that the quality of the aquifer will continue to decline with increased development that uses conventional decentralized wastewater systems. The model also predicts that the use of innovative treatment technologies will be effective in lowering effluent nitrogen concentrations.

Present Site Conditions

Deschutes County passed an ordinance in 2008 requiring homeowners to upgrade their septic systems. However, voters overturned that ordinance a year later, requesting the DEQ take the lead which they did though the formation of a committee to discuss topics such as geology, soils, hydrogeology, toxicology, and septic system technology. In June 2013, the committee fulfilled its role and provided their recommendations to DEQ.

Advanced wastewater treatment systems are being installed gradually, primarily on new development. Though, there continues to be a large amount of nutrients from existing conventional systems. Deschutes County established a fund with a local community assistance program for a non-conforming loan program. A new Community Development Financial Institution, Craft3, has started offering low interest loans for septic system projects throughout Oregon and Washington State.

Project Participants and Resources

- Rich, Barbara (La Pine Project Coordinator). La Pine National Demonstration Project 1999-2005. Final Report. 2006.
- Deschutes County Community Development Department. Protection of Groundwater Resources in the Upper Deschutes River Basin, Oregon. September 2008. https://www.epa.gov/sites/default/files/2015-06/documents/lapine_report.pdf
- Baggett, Robert & Nigg, Eric. South Deschutes/North Klamath Groundwater Protection: Reports and Recommendations. July 2013. Prepared by Oregon Dept of Environmental Quality.
- Information on Deschutes County loan program: www.neighborimpact.org
- Information on Craft3 loan program: https://www.craft3.org/Borrow/clean-water-loans

Innovative Community-led Approaches to Wastewater Treatment Problems in Low-Income Communities

Grantee: The Rensselaerville Institute

Grant Amount: $867,300 ✓ Year Completed: 2009

Grantee Purpose: Reduce risks to public health due to poorly constructed or non-functioning septic systems in a community with high rates of poverty and population growth.

Proposed Project: Install decentralized or alternative onsite wastewater technologies in communities in need or provide a connection to a centralized sewer as appropriate. Implement a large public education and outreach effort and invigorate towns through use of the Small Towns Environmental Program, a self-help model.

Project Overview

The Lower Rio Grande Valley is home to some of the nation's most economically challenged communities. In addition, the area experienced uncommonly high levels of public health illnesses. The grantee, The Rensselaerville Institute (TRI), determined the illnesses may have been partly caused by improperly functioning wastewater treatment systems or, in some cases, a complete lack of these systems. The grantee proposed to address the lack of proper wastewater treatment in this area.

TRI coordinated outreach, training, permitting, design, and implementation services. The project began in 2004 and continued through the end of 2007. During the demonstration grant period, TRI reported the following accomplishments:

- Serviced 90 homes with failing systems or no system;
- Developed a replicable self-help model to rehabilitate failing septic systems and deliver wastewater services at reduced costs;
- Created capacity and advocacy among key stakeholders, including engineers, permitting authorities, community leaders, etc.; and
- Demonstrated the economic utility of wastewater through significant community improvement.

Image 24: Map of Lower Rio Grande Valley. (Photo courtesy of Texas A&M University)

Seeking more cost-effective alternatives to fully centralized wastewater treatment, the Texas Water Development Board (TWDB) commissioned a feasibility study to consider decentralized wastewater management as an option for 125 Hidalgo County colonias. Colonias are residential subdivisions, usually in unincorporated areas of a county. There are more than 2,000 colonias in the Lower Rio Grande Valley.

Cluster systems with septic tanks for pre-treatment, re-circulating sand filters for advanced treatment, and low-pressure dosing fields for disposal or reuse were the preferred alternatives in the study. TWDB determined cluster systems would be feasible at half of the cost of conventional, centralized sewer systems. However, due to a lack of interest, no colonias applied for funding and, therefore, TWDB eventually de-obligated its funding to support other projects. The grantee determined it needed a more proactive approach. TRI perceived the following four barriers necessary to overcome for colonias to accept this decentralized approach:

1. Lack of mutually acceptable cost comparisons for engineers
2. Unfamiliarity of the link between insufficient wastewater management and illness
3. Absence of visible well-functioning alternative systems
4. Low resident participation in creating solutions

Technology

Although TRI did not utilize a decentralized cluster system for residential communities, it undertook multiple projects within various colonias of the Lower Rio Grande Valley. The grantee's goal was to reduce exposure to untreated wastewater for as many residents as possible, while overcoming the barriers stated above. TRI accomplished this through a combination of single home system installations and connection to a centralized sewer system. The following are two examples of projects that overcame the barriers mentioned above and successfully used a decentralized system approach.

Hidalgo County Head Start: The Hidalgo County Head Start (HCHS) building accommodated 100 employees and produced more than 800 gallons of wastewater per day. This required bi-monthly pumping as its five septic tanks and drainfields were in a state of failure. TRI installed a new system, which included three 1,000-gallon pre-treatment septic tanks and a 750-gallon dosing tank that equally distributed wastewater through an array of small diameter pipes, through the entire length of a trench, and then into the soil. The HCHS building was TRI's largest project.

Big 5 in Edinburg, Texas: The second largest project TRI completed was in colonia Big 5, where 20 residents had failing septic systems replaced with aerobic treatment plants. These failing systems leaked into residents' backyards, forming pools of sewage discharge, and creating hazardous health conditions. After a thorough review, the grantee selected the Clean H2O Machine Model CM500 for the site. The CM500 used an extended aeration process, otherwise known as activated sludge, wherein a small remote air compressor and single tank with two compartments achieve a high degree of treatment. TRI used a low-pressure dosed field design that uniformly distributed treated wastewater into the soil.

TRI reported it was unable to develop a clustered system and did not utilize decentralized wastewater treatment in seven other treatment projects. TRI assisted 73 additional homeowners connect to a traditional centralized sewer system.

Project Costs

TRI received $867,300 in EPA grant funding for execution and implementation of this demonstration project. A financial breakdown of costs is below. TRI also received in-kind contributions amounting to $343,929.

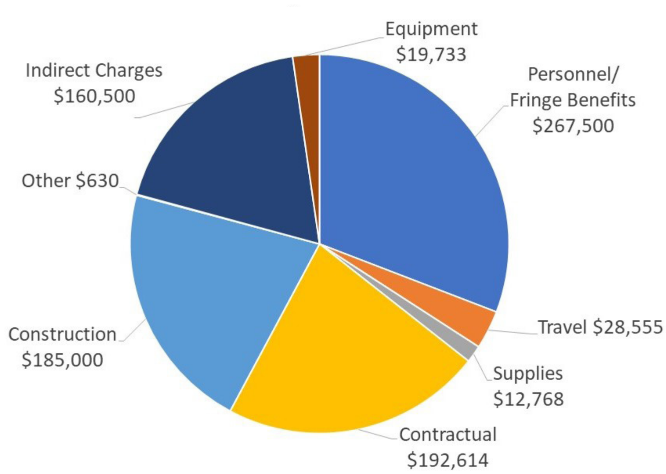


Figure 4: Project costs.

Self-Help Model: Small Towns Environmental Program (STEP)

The grantee designed the program to test the efficiency and cost-effectiveness of its self-help model, the Small Towns Environmental Program (STEP), in developing and constructing alternatives to traditional wastewater treatment and practical benefits of effluent reuse. STEP engages residents directly to solve community environmental problems.

In this grantee-led program, community members contribute time and energy to decrease the costs of a project. Communities can use STEP to capitalize on their own resources (e.g., manual labor or material) and thereby reduce costs. This decreases the cost of labor in many instances and raises funds through events, and secures contributions. While self-help methodologies seek a cost savings of at least 40 percent, the in-kind contributions described above were approximately 40 percent of the total contract costs. This demonstrates project sustainability in continuing to deliver wastewater services at a reduced cost.

Management Models

EPA's "Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems" provided an optimum framework for TRI. For those projects undertaken in colonias where a decentralized system was impossible to install and resulted in connections to a centralized sewer, TRI determined Management Model 1: Homeowner Awareness as the most appropriate fit. For those projects undertaken in colonias where a decentralized wastewater approach was feasible, TRI chose Management Model 2: Maintenance Contracts. TRI identified potential communities to participate in the program, contracted environmental assessments to be conducted for each site, hired licensed professionals, obtained necessary permits, and educated homeowners on the purpose, use, and care of their wastewater treatment system.

Monitoring Data

In September 2009, TRI ordered soil samples at the HCHS building and Big 5 colonia decentralized projects. The results were irregular with many significantly above EPA limits. TRI suggested the higher levels of contaminant concentrations occurred due to conditions that existed prior to the completion of the project. Soil conditions were dry with no odors present, both of which would indicate a higher likelihood of proper system operation.

Table 6: Soil sample concentrations at HCHS Building, September 2009.

Sept. 4, 2009: Hidalgo County Soil Sampling Findings	
Sample Parameter	Result
Total Nitrogen	2,273 mg/Kg
Phosphorous	296.1 mg/Kg
Fecal Coliform	1,800 cfu/g
Potassium	4,476
pH	8.58

Lessons Learned

The grantee reported 90 homes and more than 450 residents of the Lower Rio Grande Valley now live with functional wastewater treatment systems, which they would have otherwise been unable to afford. TRI learned many lessons throughout the course of this project including:

- Support from state and local officials is critical. TRI could not overcome regulatory barriers to make decentralized systems successful. An open dialogue among local and state officials, systems manufacturers, engineers, and federal authorities should have been held prior to identifying participating colonias.
- TRI determined it would have been helpful to identify project partners or additional funding sources to manage some of the barriers. For example, one of the projects was abandoned because it was in a flood zone area, requiring a flood certificate for construction. To obtain that certificate, each home would need to be raised 14 inches from ground level. The current condition of these homes made that option impractical. A housing partnership might have provided the resources to accomplish this effort.
- An ongoing well-funded program should be established to ensure decentralized systems are properly maintained. While this burden is typically on the homeowner, many local residents lack the resources to take care of their systems on their own.

Present Site Conditions

The last colonia self-help project was funded in August 2009. This project extended a sewer line to serve 11 families who had failing septic systems in the City of Pharr.

Project Participants and Resources

- The Rensselaerville Institute, Onsite/Cluster Wastewater System Management Program Final Report. 2009.
- EPA's Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems: https://www.epa.gov/sites/production/files/2015-06/documents/septic_guidelines.pdf
- The Rensselaerville Institute
- The Texas Water Development Board
- Texas Commission on Environmental Quality and Colonias: https://www.tceq.texas.gov/border/colonias.html

A National Framework for Decentralized Wastewater Management in Rural or Underserved Communities

Grantee: Alabama Center for Rural Enterprise

Grant Amount: $571,300 ✓ Year Completed: 2014

Grantee Purpose: Remedy decades of economic, environmental, and public health wastewater management challenges in Lowndes County by correcting the inadequacy of conventional septic systems in treating sewage due to clay soils.

Proposed Project: Create a structure for a wastewater management entity that reduces health risks and potential contamination due to inadequate sanitation services and serves as a model for similar rural communities throughout the U.S.

Project Overview

Lowndes County in Central Alabama is within an area referred to as the Black Belt region. The Black Belt is historically known for its rich topsoil layer. The impermeable clay soils underlying the topsoil make traditional wastewater treatment by conventional septic systems inadequate. Compounding the issue is the region's economic status; the county's population has an overall poverty rate of 27 percent. Due to the heavy clay soils, installation of properly functioning septic systems are largely cost prohibitive, leaving many residents without basic wastewater treatment and exposed to public health threats. Through use of these grant funds, the Alabama Center for Rural Enterprise (ACRE) sought to lay the groundwork for providing sustainable solutions.

Some of the project outcomes included:

- Surveying more than 4,000 families to prompt a geographic framework of wastewater management needs in the county;
- Working with universities on data collection, health concern assessments, and the development of wastewater treatment designs to address local deficiencies;
- Developing an overlay of maps to assess future wastewater needs; and
- Promoting local community involvement through community meetings, town agreements, and educational opportunities.

Image 25: A pool of raw sewage in a Black Belt-area neighborhood. (Photo courtesy of the Alabama Center for Rural Enterprise)

Household Surveys

ACRE surveyed 4,166 homes on residential wastewater management systems. The survey concluded, although a large majority of homes had some type of septic system installed, many were failing. Many residents regularly experienced septic system back-ups in or on their properties, including inside the home such as bathtubs or sinks, or outside, such as sewage pooling on lawns. The grantee's survey provided a baseline screening to determine the scope of the issues facing the community with the goal of finding potential solutions to the problem. Table 7 below illustrates the data collected from this survey.

Table 7: Alabama Center for Rural Enterprise household survey results.

Survey Question	Number of homes in community	Percentage of homes in community
Number of homes with septic system	3,362	81%
Number of homes without septic system	552	13%
Number of homes with raw sewage on property	243	6%
Number of homes with septic systems over 20 years old or failing	1,554	37%
Total number of surveys	4,166	--

Work Plan

The work plan created as part of this project prioritized the following elements:

- Expansion and upgrade of the current wastewater treatment facilities in Hayneville and Fort Deposit to address the needs of residents in unsewered areas;
- A design in Hayneville to prevent the lagoon from overflowing;
- A wastewater treatment plant in White Hall to allow residents to connect to the public sewer;
- A decentralized system in Gordonville to remove raw sewage;
- An approach to remove legislative barriers to expand the operation of the Black Belt Water and Sewer Authority, enabling the management of decentralized systems for those unable to connect to sewer; and
- Continued efforts with the Alabama Department of Public Health to help foster policy development to facilitate the permitting of septic systems, encompassing affordable and sustainable solutions.

Lessons Learned

The data collected from the survey provided insight into current obstacles and potential solutions to deliver effective wastewater management strategies and wastewater sanitation infrastructure in a low-resourced, economically stressed rural setting. The structure for a management entity, the Black Belt Sewer and Water Authority, is in place; however, funding is the primary obstacle to its ability to function. The grantee concluded the only septic systems that are approved by the state do not work in the heavy clay soils of the Black Belt region and are also generally not affordable for residents. Citizens have actively engaged in the state rulemaking process; however, they express frustration at legislative barriers and funding obstacles to adequately address the issue of raw sewage in poor rural communities. The grantee has postulated that while it will take federal, state, and private organizations to fund sustainable wastewater infrastructure solutions, ACRE will continue to work on finding those solutions.

Present Site Conditions

The grantee reports that wastewater treatment issues in Lowndes County are ongoing. While the Towns of Hayneville and Fort Deposit have municipal treatment facilities, functioning septic systems are not in place for many homes. In November 2016, ACRE conducted an "International Decentralized Wastewater Design Challenge" to promote the development of affordable onsite wastewater technology that is sustainable under the challenging geologic and socioeconomic conditions of Lowndes County. The Challenge served as a discussion forum for representatives from government, education, and private sector organizations to contemplate solutions for further analysis and consideration.

Health Concerns

The grantee found the health risks and hazards that Lowndes County residents face because of a lack of access to wastewater infrastructure may be affecting local economic development.

Prior to this grant in 2013, ACRE partnered with the School of Tropical Medicine at Baylor College to explore the correlation between untreated wastewater and tropical disease. Local residents living at sites with raw sewage on their property provided fecal, blood, soil, and groundwater samples. Of the stool samples collected, 35.7 percent tested positive for *Necator americanus*, a major species of hookworm.

In September 2017, the American Journal of Tropical Medicine and Hygiene released a peer-reviewed research paper titled "Human Intestinal Burden and Poor Sanitation in Rural Alabama," highlighting similar findings as the prior study. In this study, stool samples were collected from 55 individuals living in Lowndes County (42.4% of whom reported exposure to raw sewage in their home). Of these samples, 34.5 percent of individuals tested positive for *Necator americanus*, indicating infection is still prevalent within this population

Project Participants and Resources

- Coleman-Flowers, Catherine, The Alabama Center for Rural Enterprise (ACRE). The ACRE Model for Rural Communities Final Report. 2015.
- McKenna, McAtee, et al. Human Intestinal Parasite Burden and Poor Sanitation in Rural Alabama. The American Journal of Tropical Medicine and Hygiene. July 4, 2017.

Decentralized Wastewater Demonstration Project Grantee Final Report Summary

The views expressed in this document are solely those of each demonstration project grantee in its final report and follow-up discussions and do not necessarily reflect those of the Agency. EPA does not endorse any products or commercial services mentioned in this document.

Integration of Decentralized Wastewater Management Concepts into Urban Centralized Infrastructure

Grantee: Mobile Area Water and Sewer System (MAWSS)

Grant Amount: $1,140,305 ✓ Year Completed: 2017

Grantee Purpose: Evaluate the costs, performance criteria, viability, and management of integrating decentralized wastewater infrastructure into existing centralized wastewater infrastructure within an urban area.

Proposed Project: Integrate decentralized wastewater treatment technology into a centralized wastewater system by taking wastewater from an interceptor sewer, treating it with low operations and maintenance (O&M) technologies, and reusing the effluent through drip irrigation near a newly constructed park.

Project Overview

The Mobile Area Water and Sewer System (MAWSS), provides wastewater services to the City of Mobile, Alabama. In 2004, MAWSS lead an effort to integrate several decentralized cluster systems as part of the area's centralized wastewater collection system. Assimilating the two system types became a priority for MAWSS because the region had previously suffered from insufficient wastewater infrastructure capacity and conveyance. The grantee sought ways to minimize wastewater volume, thus increasing collection system and treatment system capacity. Minimizing wastewater volume also minimized the total pollutant load being discharged from privately owned treatment works back to receiving streams. To demonstrate the feasibility of integrating decentralized wastewater treatment into a centralized wastewater system, the grantee diverted 40,000 gallons per day (gpd) of raw sewage from the Three Mile Creek interceptor sewer, treated it with simple O&M technologies (described in Technology section), and reused the treated and disinfected effluent through drip irrigation into a city park.

The demonstration project components consisted of the following:

- Three types of treatment technologies;
- Subsurface drip irrigation technology;
- Water quality monitoring;
- Evaluation of reuse; and
- Conducting public education and outreach.

Image 26: Urban community park in Mobile. (Photo courtesy of City of Mobile Parks and Recreation Department)

Technology

Following pre-treatment, including the use of a rotary mechanical screen to remove solids, oils, and greases, MAWSS treated the wastewater to secondary levels. First, the wastewater was treated through one of three biological treatment technologies, then disinfected using ultraviolet (UV) light, and finally dosed to a subsurface drip irrigation system within an urban community park. The grantee applied the treated effluent to the shallow surface soil via subsurface drip irrigation technology with an effluent loading rate to the soil of 0.3 gpd/ft2. UV disinfection of the effluent was designed into the system to protect public health. The following biological wastewater treatment technologies treated up to 40,000 GPD each, utilizing 3.1 acres of the park for subsurface drip irrigation.

Table 8: Wastewater treatment technologies used in this demonstration project.

BioMicrobics RetroFAST ™	• Treats fine screened effluent • Utilizes multiple treatment units in one tank • Ideally suited for smaller municipalities
Aquapoint BioClere™	• Modified trickling filter over clarifier, a settling tank that continuously removes solids • Natural fixed-film biological treatment • Use ranges from residential to small municipalities
Delta BioPod ™	• Wastewater treated through fixed-film process digesting biodegradable waste • Houses engineered plastic media for biomass growth • Ideal for commercial use

Costs

Installation, including equipment, costs a total of $1,037,000. Power costs were documented and based on design flows. For example, the Delta BioPod systems used about three times the power due to air blowers than the Aquapoint BioClere system. Daily power costs, based on 15,000 GPD, are highlighted below.

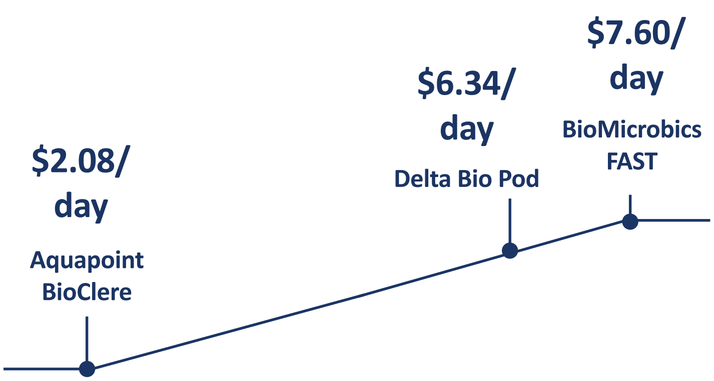


Figure 5: Costs per day of each wastewater treatment technology.

Monitoring Data

To establish a represent baseline, MAWSS began monitoring water quality in the area of the proposed drip irrigation prior to construction in the summer of 2004 through 2007. The grantee installed five monitoring wells. However, due to the final layout of the drip irrigation area, it determined only two wells should be sampled on a long-term basis. The grantee analyzed the water samples for nitrate, phosphorous, and fecal coliform. The grantee concluded the drip irrigation system did not significantly impact groundwater quality.

Influent and effluent samples were collected monthly and analyzed for biochemical oxygen demand, total suspended solids, ammonia, nitrate, phosphorus, pH, detergents, and fecal coliform. Figure 6 illustrates the data collected for effluent phosphorus. Data on all sampling parameters including groundwater quality can be found in the grantee's Final Report. Overall, all sampling parameters tested from the effluent produced results adequate for use in the drip irrigation system.

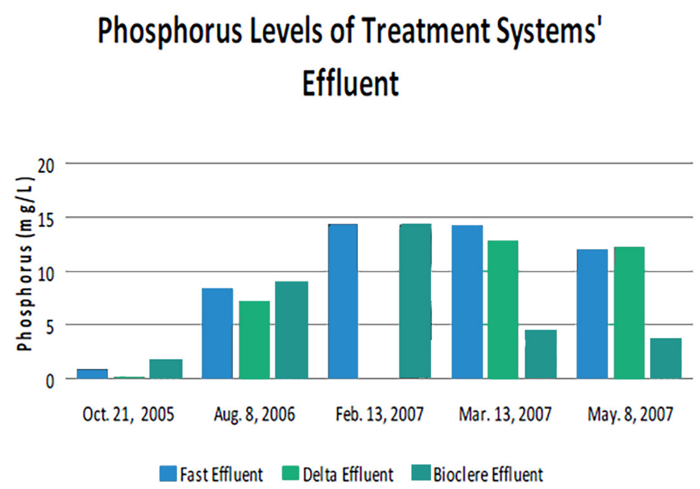


Figure 6: Effluent phosphorus results for all 3 treatment systems, indicating effluent never exceeded 15 mg/L.

Lessons Learned

According to the grantee, the following were lessons learned throughout the course of the project:

- A complete raw wastewater characterization is necessary for properly selecting screening and pumping equipment.
- Proper construction and installation of the subsurface drip irrigation is critical for its performance. Old driveways and underground piping in the area disrupted installation in some areas that may have led to operational problems such as seeps or leaks.
- The drip irrigation loading rates suggested by manufacturer literature appeared to be flexible. Ground saturation during normal operation suggested that a lower, more conservative loading rate should have been used.
- Screen and pump clogging became problematic due to there not being an onsite operator. A more robust selection of equipment was needed.
- The selected treatment technologies were adequate in producing appropriate effluent quality for use in a subsurface drip irrigation system.
- Shallow groundwater quality was not shown to be impacted by the drip irrigation dispersal of secondary effluent on a continuous basis.

Present Site Conditions

The three decentralized wastewater biological treatment units are no longer operational in their original locations. These units were relocated to the outer reaches of the system service area where new sewer and treatment connections were needed. The drip irrigation was also discontinued. The demonstration project was discontinued because:

- Maintenance costs of the treatment units was higher than expected, primarily due to pretreatment issues related to solids in which screens became clogged and pumps were impacted;
- Drip irrigation saturated soil conditions, causing many leaks in the system to be detected; and
- Decentralized treatment units were needed elsewhere in the system.

The park is fully built today. The locality plans to connect the park with a linear greenway approximately 10 miles long consisting of walkways, bikeways, and more.

Project Participants and Resources

- White, Kevin, MAWSS, Volkert & Associates. *Integration of Decentralized Wastewater Management Concepts into an Urban 'Centralized' Infrastructure in Mobile, Alabama*. Final Report. 2012.
- City of Mobile Parks and Recreations Department of Engineering
- Kevin White, PhD., University of South Alabama, Department of Civil Engineering
- Volkert and Associates Inc.
- MAWSS "Our Wastewater System" Webpage: https://www.mawss.com/education-and-outreach/our-wastewater-system

Combating *E. coli* Through Advanced Onsite Wastewater Treatment Systems on the Left Fork Watershed

Grantee: Lincoln County Commission

Grant Amount: $993,486

Year Completed: 2010

Grantee Purpose: Mitigate issues of elevated levels of *Escherichia coli* (*E. coli*) found in local tributaries on the Left Fork Watershed causing public health risks and closures of local swimming areas.

Proposed Project: Demonstrate advanced onsite wastewater treatment system technologies to adequately remove *E. coli* bacteria from the system effluent eliminating surface water impacts.

Project Overview

In the 1980's, Lincoln County, West Virginia, finalized plans to create an artificial lake by making a dam where the Mud and the Left Fork Rivers join. The county set aside a total of 44 acres for development and installed a swimming area and dock in the 1990s. In 1998, the water in the lake had turned red. After water sampling, a definitive cause remained unknown; however, the county previously closed the swimming area on multiple occasions due to elevated levels of *E. coli* present in the nearby tributaries and main fork.

The elevated levels sparked an interest in wastewater treatment throughout the community, prompting the Lincoln County Commission, with help from West Virginia University (WVU) and the WVU Lincoln County Extension Office, to apply for this grant funding. Residents became involved in the process by participating in numerous meetings and engaging with the local university.

This project achieved the following:

- Installed new advanced wastewater treatment systems for 40 homes within the watershed;
- Continually monitored and sampled discharge effluent on specific sites with new wastewater systems and at tributary points;
- Prepared and disseminated reports, and presented at national and state workshops highlighting project activities, findings, lessons learned, and suggestions for improvement; and

Image 27: Peat system installation. (Photo courtesy of Lincoln County Government)

- Prepared and distributed educational flyers to help residents better understand wastewater systems.

Technology

This project featured a variety of different advanced wastewater treatment technologies installed between 2007 and 2010. A majority of sites selected used peat-based technologies. Of the 40 new systems installed, 12 were in-ground systems and 28 were direct discharge with final disinfection via ultraviolet (UV) light prior to final discharge. Most of the systems were direct discharge due to poor soil and lot size limitations. Table 9 outlines the varying types of advanced decentralized technologies used by the grantee.

Table 9: Description of systems used in this demonstration project.

Puraflo Peat System	Bio-filter system treating effluent through peat fiber media rendering effluent suitable for reuse
Premier Tech Ecoflo Peat System	Attached growth pre-treatment system that reduces contaminants and nutrients before discharge into soil
Quanics Synthetic Media System	Bio-filter systems using tank containing media such as foam cubes for treating effluent
Microfast Synthetic Media System	Aerobic, fixed film packed bed reactor with fully submerged media acting as fixed activated sludge treatment
Eljen Geotextile System	System that pretreats effluent with patented two-stage Bio-MatTM process
Sand Filter System	For homes with limited land, a sand filter allowing effluent to drain through a sand bed rather than drainfield

Costs

The grantee's final report outlined the individual costs of the 40 systems installed throughout the course of this grant. Costs for each system ranged from:

Figure 7: List of low-cost to high-cost systems installed.

The total cost for the systems was $439,693.52 with an average cost of slightly under $11,000 per system, as indicated above.

Monitoring Results

The grantee took water samples at 18 different tributary sampling points over nine separate dates in 2005-2006 under a variety of conditions. Of the combined 162 different samples, 64 percent were over the acceptable *E. coli* limit of 200 colonies per 100 milliliters (mL). These results helped the grantee determine which homes within the watershed would receive new advanced wastewater systems.

The grantee later changed the sampling locations to be closer to the actual systems. Between 2008 and 2010, the grantee continuously sampled 11 different sites. One of the sampling points, which included seven adjacent homes with newly installed advanced systems, showed consistently lower levels of *E. coli* than anywhere else in the watershed. This indicated the installation of advanced wastewater systems improved the bacterial health of local tributaries.

The project also provided sampling of the direct discharge effluent from the new wastewater systems. *E. coli* along with biological oxygen demand, total suspended solids, and fecal coliform were monitored at 12 different direct discharge sites. Almost all of the systems sampled had favorable results leading to acceptable *E. coli* levels.

Lessons Learned

The Lincoln County Commission concluded advanced wastewater systems, when installed correctly and in contiguous homes, can decrease bacterial levels in local tributaries. They determined the impact of wastewater projects improves when residents felt as equal decision-making partners in the wastewater projects, and that local communities also gain important leadership and decision-making skills in this process.

The grantee noted trainings and conversations among county sanitarians and local wastewater installers, as well as the involvement of state regulatory agencies helped raise awareness, increased collaboration, and contributed to project success. They also determined when trainings occurred at the community level for sanitarians, installers, and homeowners, problems with wastewater systems decreased and effective maintenance increased. Prior to this demonstration project, West Virginia had no state laws requiring wastewater system installers to receive continuing education in order to keep their licenses. This has since changed.

The grantee surmised systems' high prices and high maintenance requirements proved difficult for rural and low-income communities. It concluded there is a need for more research and development of systems that are more affordable and have less complex technology. Finally, it felt that permitted direct discharge systems needed to have their final effluent monitored to ensure systems properly decrease bacteria concentration.

Project Extension Post-EPA Funding

Although the EPA-funded grant project concluded in 2010, the West Virginia Department of Environmental Protection funded the project to continue through the end of 2015.

- The Lincoln County Commission continued to be the recipient of all funds and managed all projects.
- An additional 77 homes received new advanced wastewater systems bringing the total to 117 homes.
- At the end of the project in 2015, the average cost for each system was $23,445.

Throughout all phases of the project, homeowners did not have to contribute funds. The Lincoln County Commission provided all funding to homeowners through grants.

Present Site Conditions

The grantee completed the project in 2015. Recent updates include:

- Since 2016, West Virginia has required monitoring of direct discharge once every five years for homeowners to keep their NPDES permits.
- A devastating flood occurred in June 2016. Nineteen homes that received new septic systems from this project incurred major system damage. Despite being in the Federal Disaster Declaration Area, project administrators reported funding was not provided to repair or replace these systems. Some of these systems are still in use despite continued impacts from the flood damage.
- In 2017, West Virginia changed its state law to require wastewater system installers to receive continuing education to keep their licenses.
- Public water became available in 2017. Prior to public water, there were many instances of opaque, viscous substances in septic system effluent filters linked to higher than acceptable *E. coli* levels. The grantee noted the houses that converted to public water no longer had issues with system performance and hypothesized mineralization of well water might be to blame.
- Many of the systems with a National Pollutant Discharge Elimination System (NPDES) permit failed to meeting pH level requirements. The grantee found the primary culprit was a certain type of peat filter system that does not meet NSF-40 standards. West Virginia does not approve these particular systems without NSF-40 certification, and it is unknown why they were selected and installed. As of mid-2017, this problem had not been resolved.
- Funding is no longer available to continue the monitoring program. Sampling system effluent was highly beneficial and was the most important driver in the project's initial success.

Project Participants and Resources

- Lincoln County Commission. Alternative Wastewater Demonstration Project: Left Fork Watershed of the Mud River Final Report (Phase 1 – EPA Project). Final Report. December 2004 – February 2010. https://www.epa.gov/sites/default/files/2015-06/documents/mudriverwv_finalreport.pdf
- Phase 2 Report (February 2010 – February 2011)
- Phase 3 Report (April 2011 – May 2012)
- Ric MacDowell, Project Director, WVU Extension: https://www.epa.gov/wv/high-tech-systems-help-low-income-families-deal-sewage-problems

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Restoring Urban Watersheds Using Green Infrastructure Practices

Philadelphia, Pennsylvania

Grantee: Pennsylvania Water Department

Grant Amount: $942,750

Year Completed: 2009

Grantee Purpose: Address the growing challenges of stormwater runoff and water pollution in urban communities, which have been exacerbated by an increasing population and impervious surfaces.

Proposed Project: Demonstrate the effectiveness of green infrastructure pilot projects on the urban watershed and evaluate the projects' stakeholder acceptance and watershed-based life cycle cost analysis.

Project Overview

The Pennsylvania Water Department, the grantee, collaborated with the City of Philadelphia, the Philadelphia Water Department (PWD), and various project participants (see Project Participants and Resources section for full list) on a comprehensive stormwater management plan to utilize green infrastructure methods to retrofit and enhance the city's stormwater system.

Green infrastructure refers to the management of wet weather flows using systems or practices that mimic natural processes that result in the infiltration, evapotranspiration, or use of stormwater to protect water quality and associated aquatic habitat. In the past, stormwater management involved quickly conveying stormwater away from where it landed. Green infrastructure practices, on the other hand, manage stormwater on site by soaking stormwater into the ground surface and slowing the flow.

This demonstration grant project utilized a multi-practice stormwater management approach using green infrastructure practices to reduce water consumption and stormwater runoff. These practices, installed throughout the city, included a detention/infiltration system, green roofs, a roof runoff collection-reuse system, a 50,000-gallon cistern, sidewalks draining to vegetated areas, permeable pavers, grass swales, interior rain gardens, trench drains, and permeable pavement. The results of implementation of these practices reduced water consumption, runoff, and non-point sources. The grantee divided this demonstration project into five individual projects outlined.

Image 28: Example of permeable pavements for increased groundwater recharge rather than surface water runoff in an urbanized area. (Photo courtesy of EPA)

Project 1: Mill Creek Public Housing Redevelopment

The grantee created the city's first-of-its-kind hybridized sewer system at Mill Creek Public Housing Redevelopment. The city constructed this system as part of a 20-acre housing redevelopment project in West Philadelphia. This hybrid of existing combined sewers and separate storm sewers, along with an innovative detention/infiltration system, offered an economical balance between total sewer separation and reuse of the existing infrastructure system. Construction began in mid-2004 and was completed at the end of 2005.

Monitoring: PWD established a monitoring program in 2008. The grantee concluded the project was functioning as intended to attenuate wet weather peaks; however, in doing so, the pipe was found to hold and slow draining stormwater after storm events.

Costs: Nearly half of the EPA grant funds ($500,000) were used for this portion of the project. The grantee and its partners matched the funds with an additional $982,676.

Lessons Learned: The grantee originally conceived and designed the project to allow infiltration of stormwater. Because the facility was located partially within the groundwater during certain times of the year, this project functions mainly as a detention or slow-release system. Monitoring indicates the pipe is most likely collecting and slowly conveying groundwater into the combined sewer system at times when the groundwater table is particularly high.

At the close of this project, PWD was working on a plan for additional stormwater management with a concept to utilize surface conveyance and treatment via vegetated swales and rain gardens integrated into a new park design.

Project 2: School of the Future Green Roof and Stormwater Flush Toilet

This project highlighted sustainable stormwater management technologies that can be economically incorporated into the design of institutional buildings. A new high school located in West Philadelphia was completed in 2006 and received a Leadership in Energy and Environmental Design (LEED) Gold rating. Approximately 10 percent of the school's roof is covered in vegetation and the grantee installed a roof runoff collection/reuse system. The roof runoff collects rainwater in a 50,000-gallon cistern to be used for toilet flushing. Other features include sidewalks that drain to vegetated areas, permeable pavers, and vegetated swales in parking lots.

Costs: $165,000 of the EPA grant funds were used for this portion of the project. The grantee and its partners matched the funds with an additional $219,250.

Lessons Learned: The grantee found weed growth, which inhibits the desired vegetation. After green roof plant material filled in, the incidence of weeds subsided; however, the school district monitors for weed growth regularly.

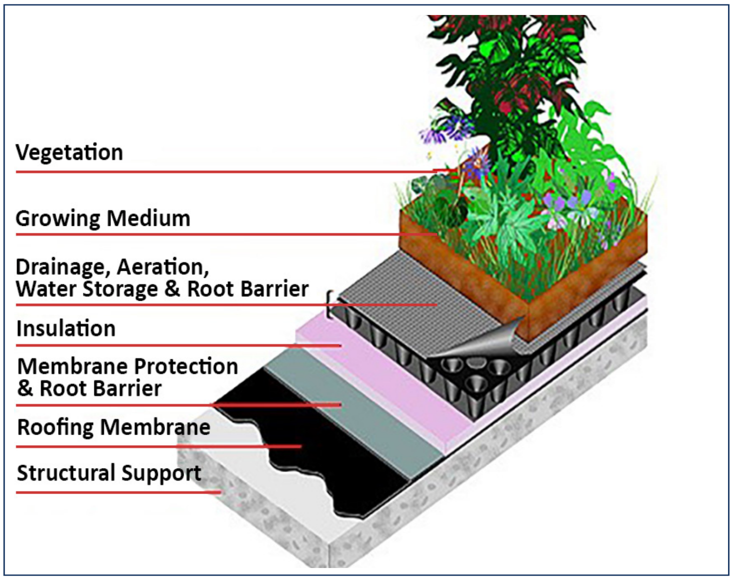

Image 29: Diagram of a green roof.

The potable reuse cistern was successful, though the initial design utilized ozone disinfection, which proved difficult to maintain. The school district switched to a simpler chlorine disinfection method. Since the project was implemented, 11 additional district schools were renovated using similar sustainable methods.

Project 3: Traffic Triangle Stormwater Demonstration

This project redesigned a traffic triangle in West Philadelphia to direct roadway stormwater into green infrastructure practices. The project could serve as an example for the city when streets are built or reconstructed.

Construction began in October 2006 and completed just two months later. The city installed three trench drains to divert road runoff into two interconnected rain gardens. A rise was installed in the bottom garden to ensure that water pools to a minimum of six inches before it is conveyed into the combined sewer system. This system was sized to provide management of the first 1.5 inches of rain.

Costs: The grantee used $52,750 of the EPA grant funds for this project. The grantee and its partners matched the funds with an additional $23,122.

Lessons Learned: The grantee found the location of the rain garden to be problematic. Shortly after project completion, the rain garden was damaged due to a car accident. This happened two additional times. The city installed reflectors and painted the curb with highly visible paint to better alert drivers of the changes, which alleviated the problem. The site also collected litter, requiring frequent maintenance and clean-up. The site functions well with the stormwater management features with no loss of infiltration capacity after over three years of operation.

Project 4: Herron Playground Stormwater Demonstration

This project utilized green infrastructure practices in Herron Playground, located in a neighborhood with a combined sewer system. The grantee constructed an infiltration system as part of an overall reconstruction of the playground to manage both onsite and offsite runoff from adjacent streets. The basketball court was resurfaced with porous asphalt and the stone storage bed beneath the court was expanded to provide additional storage for runoff via a new stormwater catch basin. Construction began in June 2008 and completed in May 2009.

Costs: $175,000 of the EPA grant funds were used for this project. The grantee and its partners matched the funds with an additional $1,358,962.

Lessons Learned: While the overall project included some specific stormwater management considerations to meet regulatory requirements, the city recognized additional opportunities to add green infrastructure while reconstructing the basketball court and managing offsite runoff. This was an opportunity for the Philadelphia Department of Recreation to partner with PWD, which spurred the creation of PWD's Green Open Space program (now called Green Parks program) in which PWD examined parks and recreation sites as potential stormwater management zones. Since project completion, Herron Playground has been a featured site in several green infrastructure management tours and was featured in a local educational video.

Project 5: Edens Lost and Found Public Television Special

Edens Lost and Found is a multi-part PBS series highlighting practical solutions to improve environmental conditions and quality of life in cities. The documentary focused on four cities, including Philadelphia, which highlighted the West Philadelphia community's green infrastructure practices as a means for stormwater management within the community.

This project included a companion book, regional action guides, and a website to encourage collaboration in finding a solution in their own communities. The Philadelphia film was broadcast on PBS beginning on May 2005 and released for purchase on DVD in 2006.

Costs: $50,000 of the EPA grant funds were used for this project. There was no local match.

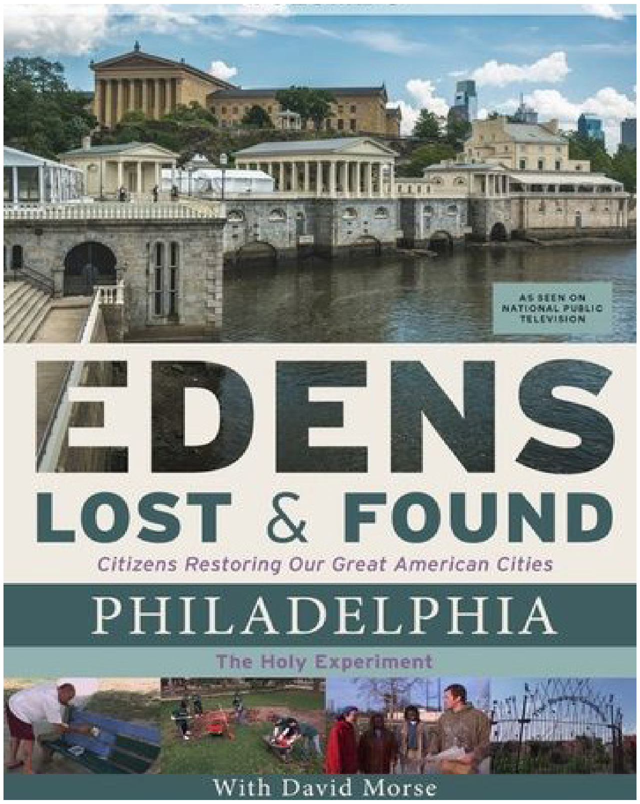

Image 30: DVD cover of PBS' Edens Lost and Found Philadelphia Special. (Photo courtesy of PBS)

Present Status

In 2011, PWD adopted the Green City, Clean Waters program, Philadelphia's plan to reduce stormwater pollution entering its combined sewer system through the use of green infrastructure. EPA and the City of Philadelphia joined in a partnership in 2012 to advance green infrastructure for urban wet weather pollution control, a partnership still in place today. The Green City, Clean Waters program continues to thrive and serves as a leading national example of how green infrastructure practices can transform the living landscape of an urbanized area.

Project Participants and Resources

- U.S. EPA Green Infrastructure Program: https://www.epa.gov/green-infrastructure
- *Restoring Urban Watersheds in Philadelphia using Decentralized Water Resources Management Final Technical Report*
- Philadelphia Water Department: https://water.phila.gov/
- Mill Creek Public Housing Redevelopment Authority
- Philadelphia School District
- Pennsylvania Horticultural Society and University Green Center
- Philadelphia Department of Recreation

Decentralized Wastewater Demonstration Project Grantee Final Report Summary

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Improved Stormwater Runoff Pollution through Green Infrastructure and Decentralized Wastewater Technologies

Grantee: Prince George's County Government

Grant Amount: $993,500 ✓ Year Completed: 2016

Grantee Purpose: Create a cost-effective and sustainable stormwater management plan in Prince George's County to ensure a reduction in nonpoint source pollution from site runoff.

Proposed Project: Utilize green infrastructure technologies and a denitrifying decentralized wastewater treatment system in environmentally sensitive areas, highlighting cost effective measures to retrofit existing infrastructure to improve stormwater management and wastewater treatment.

Project Overview

The stormwater management program in Prince George's County, Maryland, protects and enhances the county's natural and built environments to improve the quality of life for its residents. To protect public health and the environment, the Prince George's County Government received a grant, which provided funding for six green infrastructure projects. The grantee designated the implementation of each project to the public and private sectors to use green infrastructure practices or innovative decentralized wastewater treatment. Stakeholder involvement from the start bolstered community support and helped prevent "not in my backyard" reactions which are common to these types of projects.

The grantee's project objectives were to:

- Provide a cost-effective, innovative approach to urban stormwater management retrofit and redevelopment;
- Develop a multifunctional, dual wastewater and stormwater management pilot scheme;
- Institute a public outreach and education program for local officials, water sector professionals, and the general public on wastewater and stormwater issues; and
- Demonstrate measurable success of the project components.

This grant project summary focuses on one of the six projects funded from the grant. The Brown Station Road project implemented a decentralized wastewater treatment system and green infrastructure practices. The Brown Station Road site is located at the County's Department of Corrections Community Service Facility in Upper Marlboro. The final report provides more information on the other five projects: Granville Gude Park, Montpelier Mansion, Laurel High School, Laurel Volunteer Fire Station #10, and Patuxent River 4-H Center.

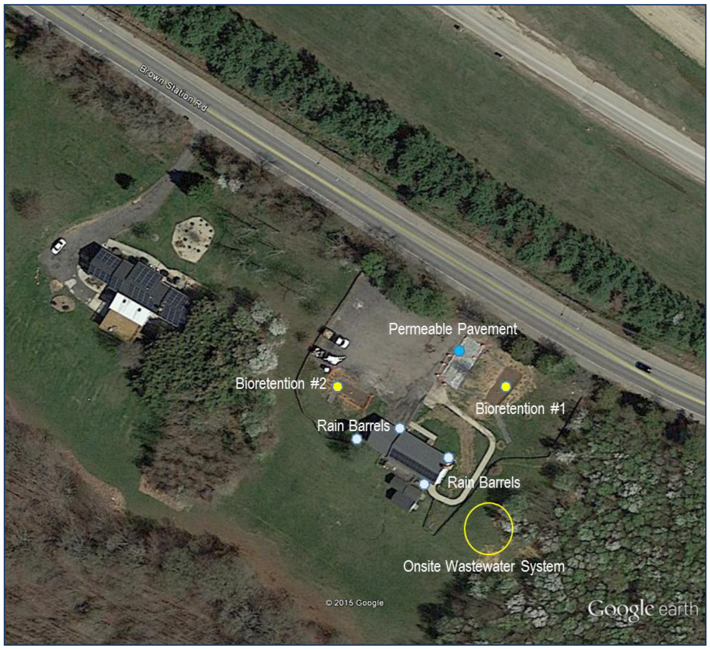

Image 31: Aerial map of Brown Station Road site. (Photo courtesy of the final grantee report)

Technology

This project featured various green infrastructure technologies, such as rainwater harvesting systems, permeable pavement, and bioretention facilities and a new high-efficiency nutrient removal decentralized wastewater treatment system. In addition, the grantee utilized solar panels to power the decentralized system. The new decentralized system included the following major components:

- M550D SeptiTech unit, an advanced decentralized treatment system with an upgraded dosing panel,
- 1,500-gallon septic tank,
- Duplex discharge system, and
- Annual inspection and reporting program.

The county considered other decentralized wastewater systems, but selected the M550D SeptiTech system based on technical and performance factors including onsite conditions. Maryland Department of the Environment (MDE) approved this system as a high-efficiency septic system with added denitrification and a reported average total nitrogen removal capability of 67 percent. In addition, this system handles a wide range of wastewater flows without reducing the overall system efficiency.

The wastewater from the facility is discharged to a primary holding tank before flowing to the SeptiTech treatment tank where the nitrogen, phosphorus, biological oxygen demand (BOD), and total suspended solids (TSS) are reduced. The treated effluent is then discharged into a 130-foot-long by 4-foot-deep drainfield, where it seeps into the soil for further treatment. The system contains a programmable logic controller that can automatically adjust to periods of intermittent use. This feature includes a minimal power setting to keep biological culture alive and a hibernation mode after long periods of no flow.

Costs

The design, planning, and construction cost a total of $305,410: $89,736 for the wastewater system and $215,674 for the stormwater best management practices (BMPs), which included the rain barrels, permeable pavement, and bioretention facilities. Estimated total operations and maintenance (O&M) costs are $2,800 annually: $600 per BMP for the stormwater system, not including the rain barrels, plus an additional $1,000 for the wastewater system.

Monitoring Data

The grantee conducted water quality monitoring at the Brown Station Road project to better understand the efficacy of the wastewater treatment system with respect to nutrient reduction. The grantee monitored two monthly sample collections at the treatment tank effluent and the dosing tank effluent and discharge points. Monitoring occurred in June, July, and November of 2015. The first sampling event delivered the highest rate of nitrogen removal of 44 percent; however, this was lower than expected based on the average system performance of 67 percent of total nitrogen removal. The results of the second and third sampling events found 21 percent and 13 percent of total nitrogen removal, respectively, and were considered unacceptable (*See 2015 Memorandum*). The county requested guidance from SeptiTech on ensuring the system operates within specifications. A septic system contractor conducted a site investigation and determined a faulty pump relay was to blame. This pump relay was replaced. A final monitoring report from April 2016 indicated total nitrogen removal of 85.7 percent, exceeding the average nitrogen removal from that particular system (*See 2016 Memorandum*).

Table 10: Results from the first monitoring event, June 25, 2015, after system installation.

Parameter	Inflow (mg/L)	Outflow (mg/L)	% Reduction
BOD_5 (mg/L)	76	7.2	90.5%
TSS (mg/L)	160	85	46.9%
Nitrogen (mg/L)	64	36	43.8%
Phosphorus (mg/L)	4.8	2.5	47.9%

Present Site Conditions

This project is still in operation today. EPA conducted a field trip as part of SepticSmart Week 2016 to tour the site.

Image 32: Former Deputy Assistant Administrator for EPA's Office of Water, Mike Shapiro (left) and Office Director for EPA's Office of Wastewater Management, Andrew Sawyers (right) on the site tour. (Photo courtesy of EPA)

Lessons Learned

The county used a new and innovative high-flow media mix for the bioretention facilities at this site. Initially, the grantee experienced difficulty locating a vendor to supply the high-flow media, but eventually identified three sources. Due to the limited number of vendors and the specialty nature of the mix, the mix costs approximately five times the typical bioretention soil mix. This unforeseen problem increased costs to the project as a whole, which should be considered in future projects using the new high-flow media mix.

Project Participants and Resources

- Prince George's County Department of the Environment. *National Community Demonstration Project for LID and Septic Systems in Upper Patuxent River Watershed Final Technical Report*. Final Report. March 2016.
- Tetra Tech. *2015 Memorandum: Brown Station Road LID and Decentralized Wastewater Treatment Project.* 2015. Prepared for Prince George's County. Fairfax, VA.
- Tetra Tech. *2016 Memorandum: Brown Station Road LID and Decentralized Wastewater Treatment Project*. 2016. Prepared for Prince George's County. Fairfax, VA.
- Anne Arundel County. Upper Patuxent River Watershed Restoration Action Strategy for Anne Arundel and Prince George's Counties, Maryland. 2004. Anne Arundel County, Office of Environmental & Cultural Resources. Annapolis, MD.
- Maryland Department of the Environment. Maryland Stormwater Design Manual, Volumes I and II. 2009. Baltimore, MD. https://mde.maryland.gov/programs/water/stormwatermanagementprogram/pages/stormwater_design.aspx

Advanced Decentralized Wastewater Treatment Technologies at the Skaneateles Lake Watershed

Grantee: City of Syracuse

Grant Amount: $665,095

✓ Year Completed: 2009

Grantee Purpose: Demonstrate the use of commercially available advanced decentralized wastewater treatment systems at lakefront properties to replace conventional septic systems, which do not meet regulatory drinking water standards due to challenging topography and soil conditions.

Proposed Project: Replace failing conventional septic systems with cost efficient pre-engineered enhanced treatment units (ETUs) and create an oversight management plan, supported by regulatory enforcement, to ensure the long-term success of advanced septic systems.

Project Overview

Skaneateles Lake is a critical drinking water source for the City of Syracuse (grantee) in New York. The lake provides an unfiltered water supply for over 250,000 residents. The grantee reported that many lakefront properties' septic systems in the watershed were failing and polluting the lake due to improper installation, age, and/ or lack of maintenance. Installing conventional septic systems that function properly has been challenging for properties in the watershed. Much of the lake's shoreline is steeply sloped with poorly draining soils and slow permeability. To remedy these concerns, the grantee constructed efficient and cost-effective advanced decentralized wastewater treatment systems on selected properties with challenging site conditions.

The four main objectives of the demonstration grant project were to:

- Identify and replace failing and inadequate septic systems along the lakefront with a variety of alternative treatment systems, and then evaluate their performance;
- Develop a uniform regulatory framework for all jurisdictions within the watershed;
- Promote awareness, education, and training for wastewater professionals, as well as homeowners and the community; and
- Meet effluent concentration standards for biological oxygen demand (BOD) and total suspended solids of 10 mg/L and significantly reduce total and fecal coliform at the down gradient hydraulic boundary of each property.

Image 33: Home on Skaneateles Lake. (Photo courtesy of the final grantee report)

Technology

The grantee selected 19 sites with varied topography, usages, soil characteristics, and challenges to technology. They installed a variety of commercially available decentralized systems throughout the sites. They determined the most-effective system type based on the criteria above, while also factoring in each system's cost efficiency, ability to treat effluent in-tank, proven record of performance, and ease of maintenance. See Table 12 for the types of advanced onsite wastewater treatment systems used.

Table 11: Commercially available decentralized wastewater treatment technologies used for the individual grantee projects.

Premier Tech Env. Ecopure/Peat Filter and Drip Dispersal	Uses fungi and peat moss to time-dose effluent into a mound
Premier Tech Env. Ecoflo/Peat Filter and Drip Dispersal	36-48 hour residence time on the peat for effluent then disperses into a 15' x 20' sand pad
White Knight Treatment System	Microbial inoculator generator oxygenates tank and breeds microorganisms resulting in complete consumption of organic materials
NORWECO-ATU Unit and Drip Dispersal	Contains a clarification chamber where wastewater gets chlorinated and dechlorinated and discharged into a 500-gallon pump tank to a dispersal field
Orenco Systems Inc./ Advantex with Bottomless Sand Filter and Drip Dispersal	Septage is recirculated 5 times and remaining effluent is pumped to dispersal fields
Eljen Trench	Uses in-drains, creating vertical infiltration surfaces which reduce land requirements by 50%
Premier Tech Textile/ Peat Filter and Conventional Trench	Uses an aerobic treatment process where effluent flows to a peat filter and discharges to a 500-gallon concrete dry well
Quanics/Aero Cell Trickling Filter	Fixed-film media installed on top of the OWTS that pretreats before effluent discharges into subsurface trenches
Effluent Dispersal Systems	Drip lines made of polyethylene tubing coated in antibacterial lining installed 6 to 10 inches below the surface

Monitoring Data

Performance evaluations were based on sampling and analysis for BOD, fecal coliform, total nitrogen, and phosphorus. The grantee collected effluent samples from the systems before and after each unit process on a monthly basis for at least one year using sampling wells, lysimeter, or other sampling mechanisms.

Table 12: Average percent reduction of sample parameters.

Advanced Treatment Technology	Percent (%) Reduction				Costs
	BOD	Fecal Coliform	Total Nitrogen	Phosphorus	
Premier Tech Env-Peat Filter	90	86	0	<10	$18,546
Premier Tech Env. Ecopure - Peat Filter and Drip dispersal	74	88	37	<10	$30,000
Premier Tech Env. - Ecopure Peat Filter and Conventional Trench	96	99	67	<10	$28,029
Premier Tech Env. Ecopure - Peat Filter and Drip dispersal	85	47	34	<10	$30,000
Bord na Mona-Bottom Draining Peat Filter	97	100	66	<10	$28,028
Bord na Mona-Bottom Draining Peat Filter	97	95	38	<10	$25,546
White Knight Treatment System	81	98	29	<10	N/A
NORWECO-ATU Unit and Drip Irrigation	-	-	-	-	$8,000
Orenco Systems Inc. - Advantex with Bottomless Sand Filter	91	99	84	<10	$32,842
Orenco Systems Inc. - Advantex with Bottomless Sand Filter	92	99	52	<10	$32,842
Eljen Trench	97	100	83	<10	$24,553
Premier Tech Textile/ Peat Filter and Conventional trench	77	98	62	<10	$36,724

Table 12: Average percent reduction of sample parameters, continued.

Advanced Treatment Technology	Percent (%) Reduction				Costs
	BOD	Fecal Coliform	Total Nitrogen	Phos-phorus	
Orenco Textile Filter and Bottomless Sand Filter	70	94	10	<10	$14,844
Quanics - Aero cell Trickling Filter	47	90	53.1	<10	$20,902

The performance of these nineteen systems led the grantee to conclude advanced wastewater treatment technologies with final dispersal systems can effectively remove BOD, total and fecal coliform, total nitrogen, and phosphorus.

Lessons Learned

The grantee completed the demonstration grant project without any major delays. Updated regulations on treatment systems helped expedite the transition from conventional to advanced decentralized wastewater treatment systems. The grant project established a monitoring program for one year after the installation of the advanced treatment units, which allowed for the systems to be assessed for seasonal changes. The city developed a long-term system operation and maintenance program with homeowners who participated in the demonstration grant project. The management program requires tracking of system performance to promote better system performance, environmental protection, and an extended system life. The grantee also found having well established onsite wastewater treatment equipment manufacturers participate in the project improved documentation.

Present Conditions

The grantee reports that there have been no major failures at any sites where the new advanced decentralized systems were installed to date. The demonstration site continues to be used to inform updated policies and regulations among local jurisdictions. The Skaneateles Lake watershed regulatory authorities now require replacement systems that cannot meet new construction standards have an advanced treatment component. The Syracuse Department of Water continues to track the maintenance records for each of the demonstration sites, which continue to meet performance standards.

Since installation of these systems and the end of project funding in 2006, the New York Onsite Wastewater Treatment Training

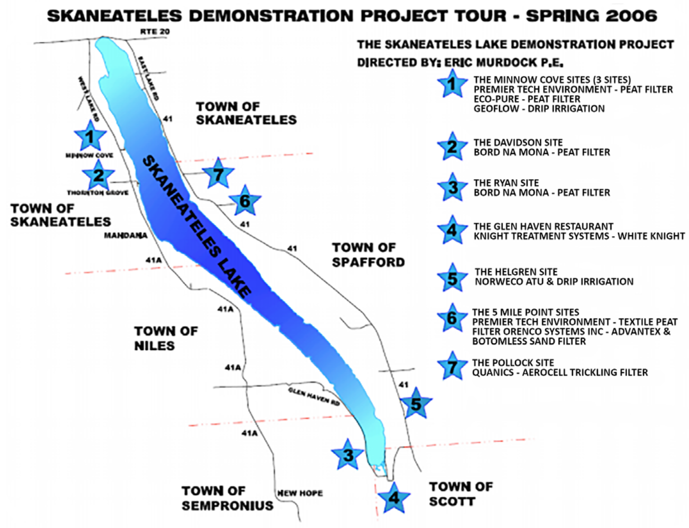

Image 34: Map of Skaneateles Lake Grant Project Tours. (Photo courtesy of the final grantee report)

Network has held an annual two-day workshop serving as an outreach and training tool through field tours and an onsite training event. The onsite event highlights the challenging waterfront sites in the Skaneateles Lake Watershed and the ETUs installed at each site. The grantee indicated one of the greatest benefits of this program is demonstrating the numerous treatment options to local design professionals who are routinely contacted by homeowners to provide system replacement plans. Both wastewater treatment professionals and homeowners mutually benefit from this mutual information sharing. Image 34 illustrates a map with some of the demonstration grant project sites.

Project Participants and Resources

- Murdock, E. E. Skaneateles Lake Demonstration Project Case Study Report. Final Report. 2010. https://www.epa.gov/sites/default/files/2015-06/documents/skaneatelesny_final-report.pdf
- New York Onsite Wastewater Treatment Training Network Annual Two-Day workshop: https://otnny.org/training-descriptions
- Cayuga County
- Cortland County
- Onondaga County
- City of Syracuse

Decentralized Wastewater Demonstration Project Grantee Final Report Summary

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Use of Stormwater Management Techniques in a Residential Suburb

Grantee: City of South Burlington

Grant Amount: $1,500,000 ✓ Year Completed: 2014

Grantee Purpose: Improve the water quality of the impaired Potash Brook Watershed due to poor city stormwater management causing harmful algae blooms from excessive phosphorus loading to nearby Lake Champlain.

Proposed Project: Institute stormwater management techniques specific to suburban settings to mitigate untreated stormwater runoff.

Project Overview

The City of South Burlington is located in northwestern Vermont on the eastern shores of Lake Champlain in Chittenden County. The City of South Burlington, the grantee, identified stormwater impaired streams within the city's boundaries that were causing water quality issues such as algal blooms in Lake Champlain. The city received this grant in 2003 to demonstrate stormwater management techniques in a typical suburban setting. Vermont's first stormwater utility in 2005 grew from the South Burlington community's collective commitment to addressing these problems. This grant project complements the decentralized wastewater demonstration grant project in the neighboring Town of Colchester, Vermont.

Rapid growth and housing and commercial development in Chittenden County overwhelmed wastewater treatment systems, which led to impacts to local streams and Lake Champlain. To preserve and improve the water quality, the city implemented a multifaceted strategy including:

- Increased public education;
- Improved land development regulation;
- Increased water quality monitoring; and
- Stormwater management demonstration projects.

Image 35: Treated stormwater discharging from a retrofit detention pond. (Photo courtesy of the final grantee report)

Stormwater Technologies

The city completed construction of a large-scale stormwater demonstration project in the neighborhood of Butler Farms. This residential subdivision was chosen because the property line between houses runs along a highly channelized tributary stream that flows to Lake Champlain. The following technologies were implemented to improve water quality and to address localized flooding.

Table 13: Stormwater management technologies used in this demonstration project.

Rain Garden	• Two rain gardens installed • Grant funds used to pay for design
Buffer Planting	• Stream buffer plantings installed on the tributary • Reduced erosion, filters runoff, reduces stream temperatures, and provides stream protection
Stormwater Detention Pond Retrofit	• Existing ponds expanded to accommodate more water • Pond outlet structures modified to provide different discharge rates for different storm events
Elimination of Streambank Erosion	• Regraded streambank, vegetative planting, and stone reinforcement to stabilize streambank
Creation of Floodplain	• Large unused lot converted to floodplain • Stream improved so as water rose it could access the floodplain

Grant Project Accomplishments

The city reported implementation of the first known use of multi-spectral imagery as the basis for determining impervious surface and associated stormwater utility fees.

The grantee also developed watershed models for multiple watersheds. These models predict the impact of management activities in the watershed. The city used this information to update its Land Development Regulations (LDRs). In cases of over half an acre of impervious area, the first 0.9 inches of rain are required to be infiltrated or detained. The LDRs also included flow rate requirements during the 1 year, 24-hour storm, which amounts to 2.1 inches.

The city improved residents' understanding of stormwater impacts through public meetings throughout the process. The grantee also improved access to educational and regulatory information online.

Image 36: Floodplain area directly after construction and planting of native tree and shrub species. (Photo courtesy of the final grantee report)

Monitoring Data

The scope of work for this grant project included water quality monitoring initiatives designed to measure the success of the installed stormwater technologies. The grantee established 12 sampling stations to record water quality parameters over the course of the project. The city also conducted flow monitoring within the local watershed and the Butler Farms neighborhood for stream flow and identified progress toward flow reduction during and after rain events.

Project data in 2011 showed steady improvement in stream water quality in Potash Brook since the beginning of the grant project; however, despite these improvements, the chemical, physical, and biological criteria of the Vermont Water Quality Standards were not met. The information provided as part of this monitoring program assisted in characterizing the condition of the watershed as the city moved forward with additional stormwater management activities.

Lessons Learned

This grant project successfully reduced streambank erosion and provided improved stormwater treatment and flood control measures. While these measures provided water quality improvements and flood protection for downstream areas, they did not provide adequate flood protection within the residential neighborhood during large storm events.

The city considered various additional projects, such as replacing culverts and addressing water flowing into the neighborhood from offsite. Those projects did not move forward due to costs, access to land, and limited time. In Spring 2013, multiple heavy rain events caused significant flooding in the neighborhood due to the existing culverts. Soils were so saturated at the time that all rainfall became runoff. Water flowing in from offsite compounded the problem. The city was aware of these issues but unable to address them.

Legal challenges associated with stormwater impaired watersheds delayed full scale implementation of the stormwater treatment technologies. Legal challenges should be addressed as early on in the process as possible in order to avoid potential barriers to project success.

Present Site Conditions

The South Burlington Stormwater Utility continues to keep the city's stormwater drainage and treatment systems working properly through constant evaluation, maintenance, and utilization of new projects. Some of the new projects as of 2017 included:

- Replacement of culverts to provide sufficient capacity, allowing the stream to pass under the road to decrease risks of flooding and increase stream health;
- Creation of a stormwater gravel area to provide flow reduction to a local brook as well as reduce phosphorus loading to Lake Champlain; and
- The Village at Dorset Park plans to upgrade the existing stormwater detention ponds to reduce sediment and nutrients flowing to Potash Brook, which will help prevent erosion of streambanks and reduce the risk of downstream flooding.

Project Participants and Resources

- City of South Burlington
- University of Vermont, Redesigning the American Neighborhood Project
- South Burlington Stormwater Utility. *South Burlington Stormwater Demonstration Project*. Final Report. 2014.
- South Burlington Stormwater Utility Website: www.sburlstormwater.com
- Regional Stormwater Education Program Website: http://sburlstormwater.com/public-outreach/regional-stormwater-education-program/

The views expressed in this document are solely those of each demonstration project grantee in its final report and follow-up discussions and do not necessarily reflect those of the Agency. EPA does not endorse any products or commercial services mentioned in this document.

Importance of a Responsible Management Entity (RME) and Various Advanced Treatment Technologies in Areas of Poor Soil

Grantee: Table Rock Lake Water Quality, Inc.

Grant Amount: $1,940,000 ✓ Year Completed: 2007

Grantee Purpose: Due to steep slopes, fractured limestone, and the thin soils of the Ozarks, septic tank effluent receives little, if any, treatment from the natural environment. Septic system failure plagued the area by diminishing water quality in Table Rock Lake, adversely affecting tourism, and also putting drinking water at risk. This grant sought to improve these conditions.

Proposed Project: Demonstrate advanced onsite wastewater treatment technologies and management through field testing of systems and implementation of a Responsible Management Entity (RME). Identify legal impediments to the acceptance of advanced treatment systems and implement a large public education and outreach effort.

Project Overview

Table Rock Lake is a scenic and popular summer vacation destination in the Ozark Mountains of southwestern Missouri. Increasing populations in the 1990s led to more septic systems in Table Rock Lake communities. Soils around the lake were inadequate for effective wastewater treatment with conventional onsite systems (septic systems). The grantee reported that this led to high failure rates: 75-90 percent of systems over 5 years old in 2001 were not adequately treating wastewater. Untreated wastewater would flow to the lake through the fractured limestone. Recognizing the impact poor water quality could have on the local tourism industry, the community formed Table Rock Lake Water Quality, Inc. (TRLWQ).

TRLWQ initially carried out a septic study that found failing septic systems contributed a significant amount of nutrients to the lake. The study concluded that septic systems were the predominant source of nutrients causing algae to develop in coves. TRLWQ called for more effective upgrades and long-term management of septic systems.

The grantee's objectives were to:

- Demonstrate multiple advanced onsite wastewater treatment technologies;
- Demonstrate long-term management solutions through the creation of an RME;
- Identify legal impediments to widespread implementation of advanced treatment systems;
- Evaluate the feasibility of water reuse; and
- Conduct public education and outreach.

Image 37: Installation of an advanced treatment system. (Photo courtesy of Stone County Health Department)

Technology

This grant project featured the following six different advanced onsite wastewater treatment technologies. TRLWQ selected 24 sites for demonstration (6 cluster systems that served multiple homes, 6 resorts, 9 single family homes, 2 restaurants, and 1 community shower house).

Table 14: Decentralized wastewater treatment technologies used in this demonstration project.

Constructed Wetlands	Simulates natural wastewater treatment
BioMicrobics Fixed Activated Sludge Treatment (FAST)	Fixed-film media, aerated system utilizing bacteria growth
BioMicrobics RetroFAST	Adapts conventional systems by inserting a RetroFAST unit and an aeration blower into the existing septic tank
ZABEL or Quanics SCAT treatment	Bio-filter system using a tank containing media such as foam cubes for effluent treatment
Ecoflo Peat-moss Filter treatment	Attached growth pre-treatment system that reduces contaminants/ nutrients before discharge into soil
Recirculating Sand Filter treatment	Aerobic, fixed-film bio-filter that removes suspended solids from wastewater

Costs

TRLWQ estimated that the average cost in 2001 for an advanced system with drip dispersal in imported soil on a residential site was $20,000 - $25,000. The grantee estimated $45,000 in 2001 for an aeration/fixed-film media system for a small resort and $48,000 in 2001 for a foam cube media filter system at a small resort. The grantee reports decreased cost of installation with greater familiarity with these systems over time. In the case of aeration systems, another factor in the reduced costs may be due to the volume of units sold.

TRLWQ estimated that operation and maintenance fees would remain the same as in 2001 at approximately $20-30 per month.

Monitoring Data and Results

The grantee determined drip irrigation was the best choice for effluent dispersal because the design disperses the liquid effluent over a wide area, allowing for maximum absorption by the soils. Native soils were generally not adequate to provide this treatment, so soil was imported to many of the sites to make drip irrigation effective.

The grantee installed monitoring systems at four sites with varying wastewater treatment technologies to measure treatment success. Samples were taken of septic tank effluent, treatment effluent, and subsurface liquids. Table 15 displays average concentrations among the four sites throughout the monitoring period of 2005 – 2007. The monitoring data indicate a high rate of success.

Table 15: Average septic effluent, treated effluent, and subsurface liquid concentrations at four monitoring sites.

Parameter	Septic Tank	Treated	Sub- Surface
Biological Oxygen Demand (BOD_5) (mg/L)	162	26.8	3
TSS (mg/L)	46	17.7	N/A
Ammonia (mg/L)	5.6	4	0.41
Phosphorus (mg/L)	3	2.7	0.93
Fecal Coliform (colonies/100 mL)	271,000	19,488	140

Lessons Learned and Project Outcomes

A major outcome of this grant project was an acceptance of the use of advanced decentralized wastewater treatment for the Table Rock Lake area. In the past, local stakeholders did not widely accept these systems as feasible or practical and contractors in the area did not install them.

The project also demonstrated that a drip field can be built where there is little soil initially. As a result of this grant project, the director of Stone County Health Department, the local regulatory agency, placed greater emphasis on wastewater concerns and hired a full-time sanitarian dedicated entirely to wastewater regulation.

The project addressed the issue of maintenance and management of onsite systems through the formation of the Ozarks Clean Water Company (OCWC) in 2004. OCWC owns and operates individual and clustered decentralized wastewater systems as the RME using EPA's Management Model 5 Program, removing the maintenance responsibility from the individual property owner. The grantee considered this program the most feasible model for OCWC since it is most comparable to a city sewer program where the homeowner or property owner is only responsible for the monthly bill payment. Due primarily to convenience to the homeowner, RMEs were found by the grantee to be an excellent means to properly managing individual septic systems on a community level.

In the past, the few installers with experience in advanced treatment systems, such as drip irrigation systems, did not generally recommend these systems or install them due to maintenance concerns. The adoption of renewable operating permits requiring maintenance provided a solution to this problem. As a result of this grant project, the Stone County Health Department recognized the importance of requiring better regulations on wastewater treatment systems and changed their ordinance to reflect EPA's Management Model 3 Program management system, requiring a renewable operating permit for advanced treatment systems.

One of the most important components of the grant project was the two-way communication between the public and the project team. To facilitate communication and public outreach, the TRLWQ board authorized the formation of a community involvement group. The group was composed of a diverse group of local citizens and stakeholders such as homeowners, realtors, bankers, septic tank pumpers, resort owners, developers, educators, senior citizen groups, and environmental groups.

Present Site Conditions

The project is still in operation. OCWC continues to provide wastewater infrastructure operation and maintenance, and it now also provides similar services for drinking water. There are over 800 customers that receive sewer and/or water services from OCWC, compared to approximately 300 at the end of the demonstration grant project. OCWC merged with a local not-for-profit sewer company in August 2017. This resulted in an increase from about 800 to over 2,000 customers who receive sewer/water services from OCWC.

There are now 18 different cluster systems with more continuing to be added. All original systems from the demonstration grant project are still in operation. Advanced treatment systems with effluent drip irrigation are now standard in the area. Plants growing near the drip systems have been shown to uptake nutrients from the effluent. Feedback from locals shows a change in perception regarding advanced treatment systems and drip irrigation.

The Health Department passed an ordinance requiring septic systems to be inspected prior to selling a home with responsibility for any needed repair/replacement falling to the homeowner. The lake continues to be cleaner and clearer every year with 50 feet visibility in spring 2017, the clearest in 30 years. Today, Clean Water State Revolving Fund (SRF) programs are used for funding septic system remediation projects.

Project Participants and Resources

- David Casaletto, President/CEO, Ozarks Water Watch (formerly Program Coordinator, TRLWQ): www.ozarkswaterwatch.org
- Table Rock Lake Water Quality Inc. Table Rock Lake Water Quality Decentralized Wastewater Demonstration Project. Final Technical Report. December 2007. https://www.epa.gov/sites/default/files/2015-06/documents/tablerock_report_0.pdf
- EPA's Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, March 2003: https://www.epa.gov/sites/default/files/2015-06/documents/septic_guidelines.pdf

A Rural Community Approach to Decentralized Wastewater System Management

Grantee: Town of Warren

Grant Amount: 1,500,000 ✓ Year Completed: 2005

Grantee Purpose: Protect local rivers and swimming areas from increased levels of harmful bacteria caused by failing septic systems and improper septic system management.

Proposed Project: Develop and implement a comprehensive decentralized wastewater management plan through active public involvement and a thorough needs assessment.

Project Overview

Warren, Vermont, is a traditional New England rural town with an 18th century historic mill village at its center. Two scenic recreational rivers flow through the village. In the 1990s, signs of impaired water quality forced the Town of Warren, the grantee, to produce a sewer feasibility study. The study was inconclusive, but residents remained concerned with potential impacts from failing septic systems. Subsequent water quality studies illustrated consistent bacterial contamination in some parts of the river. The community created a Wastewater Advisory Committee (WAC) to guide the assessment and evaluation processes to determine the root cause of the water quality issue. WAC also served as a critical advocate for building public support for this project. The grantee's path to becoming the Responsible Management Entity (RME) for decentralized wastewater management provides lessons for other small communities and rural towns.

The grantee's process included:

- Assessing the condition and suitability of existing septic systems and their impacts on local water resources;
- Determining and constructing the most cost-effective combination of options, including managing onsite systems, using innovative treatment technologies, and constructing or expanding offsite cluster systems;
- Creating and executing a wide-ranging decentralized wastewater management program, including remote monitoring technologies, a publicly acceptable user fee structure, and onsite system management; and
- Initiating, but ultimately not implementing, a low-interest property owner loan program for onsite system repairs and upgrades in support of the management program.

Image 38: Mad River in Warren. (Photo courtesy of the final grantee report)

Technology

The grantee conducted a needs assessment that indicated a need for offsite solutions. The grantee selected a range of sites, which included: three properties where the existing system was suitable with minor upgrades for maintenance access; six properties that could upgrade their systems onsite; and 95 properties to be connected to offsite cluster systems. With several properties using onsite solutions, the grantee concluded the two town-owned cluster systems provided adequate capacity for existing properties. The Warren Elementary School advanced decentralized wastewater system served as a positive example of innovative and alternative system technologies for the town and state. Many systems utilized remote monitoring technology.

Table 16: Demonstration project systems and treatment technologies.

Brooks Field Cluster System (46 properties)	• Uses Septic Tank Effluent Pump (STEP) systems with low pressure and gravity sewers for wastewater collection • 30,000 gallons per day
Luce Pierce Road Cluster System (3 properties)	• Uses Septic Tank Effluent Gravity (STEG) system with gravity sewers to the dispersal field pressure distribution pump system • 2,000 gallons per day
Warren Elementary School	• ORENCO Systems Inc. recirculating AvantexTM textile filters and shallow gravel-less dispersal system which is time-dosed • 3,500 gallons per day

Costs

The final grantee report outlines total costs and funding sources for this project. The grantee reported EPA funds amounted to $1,500,000 with a total project cost of $4,662,000. In addition to the EPA demonstration project grant, the town received additional funding from an EPA State and Tribal Assistance Grant, a Vermont State Pollution Abatement Grant, State Revolving Fund (SRF) Loans, and town meeting allocations.

For individual homeowners, 70 percent of the initial base connection fee are fixed operations and maintenance (O&M) costs. The remaining 30 percent is determined by metered water use. For a typical three-bedroom residence, the grantee reported user fees in 2005 were approximately $45 per month. As of 2020, the user fees are about $65 per month, according to the Town of Warren.

Monitoring Results

The Freeman Brook and Mad River both run through Warren. The town reported that a volunteer organization, Friends of the Mad River, have collected water samples since the 1980s. Their sampling information sparked concern as higher levels of bacterial concentrations were found at the base of the waterways after flowing through the town. Sampling results in 2000 indicated excellent water quality; therefore, surface water monitoring was discontinued. The grantee determined that the prior sampling events may have been too infrequent to be considered statistically significant.

Groundwater monitoring was constructed at alternative treatment system sites and larger cluster system sites. Fifty-five tests were completed on shallow and drilled wells. About one third of those tests indicated bacterial contamination, although none exceeded permit limits.

The town's sewage office collected effluent sampling at the Warren Elementary School system and Brooks Field system in 2002. At the school system site, in 2001, the grantee sampled at the septic tank outlet and treatment system outlet, with results indicating the system remained within its permissible limits.

The grantee used radio-based remote monitoring throughout this project. Remote monitoring allowed for the service provider to be notified immediately should any issues arise. The grantee did not include monitoring data in the final report.

Lessons Learned

The grantee determined communities facing pollution challenges need a new way to evaluate the environmental and public health impacts from decentralized wastewater systems. A range of possible solutions can be identified for consideration through sampling and analysis. The grantee collected better information on onsite conditions through active public involvement in the needs assessment. The grantee's community engagement resulted in support for proposed solutions and a positive local bond vote.

The grantee reported legal difficulties to the site selection of cluster systems. More sites were proposed but could not obtain secured legal agreements. While several properties used onsite solutions, the two cluster systems provided adequate treatment capacity for existing properties with a small amount of growth built in.

Present Site Conditions

The Town of Warren and Stone Environmental Inc. provided an update for this grant project in 2020.

- The systems installed for this demonstration grant project are still in use today. Over the last few years, additional parcels have been added to the system. For example, the Brooks Field cluster system now serves 70 properties, as compared to the 46 properties when the project concluded. Some were converted from single septic systems into smaller cluster systems (i.e., from a single residence to 2-3 homes).
- Friends of the Mad River continue to sample local waterways. Water quality meets requirements for the region.
- Vermont onsite wastewater permitting regulations now include a process for reviewing and approving innovative and alternative technologies that did not exist before the demonstration project.
- Stone Environmental prepares Water Quality Evaluation Reports on behalf of the town when the Brooks Field System's indirect discharge permit is due for renewal (every five years). In 2012 and 2017, all permitting criteria were met and there were no exceedances.

Project Participants and Resources

- Town of Warren, VT. *Warren, Vermont: A Different Approach for Managing Wastewater in Rural Villages*. Final Report. 2005. https://www.epa.gov/sites/default/files/2015-06/documents/warren_report_1.pdf
- Stone Environmental Inc. *Summary Water Quality Evaluation, Brooks Field Indirect Discharge System, ID-9-0278-1.* Final Report. June 2012.
- Stone Environmental Inc. *Summary Water Quality Evaluation, Brooks Field Indirect Discharge System, ID-9-0278-1.* Final Report. June 2017.

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