WATER QUALITY VERSUS PROCESS MONITORING CHARLES CITY COUNTY, VA PROJECT

Anish Jantrania (photo) and Allen Knapp

Anish Jantrania
Technical Services Engineer
Virginia Department of Health
Richmond, VA 23219, USA
Anish.Jantrania@vdh.virginia.gov

Allen Knapp
Program Manager
Virginia Department of Health
Richmond, VA 23219, USA
Allen.Knapp@vdh.virginia.gov

Anish R. Jantrania is a Technical Services Engineer at the Virginia Department of Health in Onsite Sewage and Water Program. In the past, he worked as engineering consultant. Anish Jantrania has a B.E., M.S. and Ph.D. in Agricultural Engineering and an M.B.A. . He has served on the board of directors for the National Onsite Wastewater Recycler's Association (NOWRA) and has served on the technical review committee for revising the U.S. EPA Onsite Design Manual. He currently serves on the NOWRA Model Performance Code primary committee and evaluation committee.

Abstract

The Virginia Department of Health (VDH) is investigating the effectiveness of a performance-based regulatory framework when onsite/decentralized systems are installed and operated under US EPA management levels four and five. One of the important aspects of a performance-based regulatory framework is the development and implementation of an effective performance monitoring, inspection, review, and reporting (PMIRR) regimen. Performance monitoring of an onsite wastewater system may include *water quality monitoring* (effluent samples and analysis) and *process monitoring* (pump/blower run-time, soil/site conditions monitoring and indicator parameters monitoring). The PMIRR regimen needs to be efficient and cost-effective, and it must allow the regulatory agency to determine whether the permitted onsite system achieves the performance standards established for public health protection and environmental quality protection. Charles City County in Virginia has signed an agreement with VDH to be the entity responsible for onsite/decentralized wastewater systems that will be installed to serve a special group of homes within the county. VDH has agreed to regulate the systems under this agreement using a performance-based regulatory concept instead of the existing prescriptive regulations for installing and operating onsite systems. A PMIRR regimen was included in the agreement between VDH and the county; however, the costs for monitoring system performance using a conventional water-quality monitoring model initially appeared to be quite high and potentially unaffordable to the county. VDH applied for and obtained a grant from the US EPA to develop an alternative PMIRR regimen for performance monitoring by determining the relationship between water quality and process monitoring schemes. This paper and presentation will give details on the Charles City County project and preliminary information gathered from the grant project.

Introduction

Throughout the 19th and 20th centuries, small onsite/decentralized wastewater systems have been part of the US wastewater infrastructure. However, these onsite/decentralized systems have typically been viewed as a temporary means for managing wastewater until an offsite/centralized system can be brought into an area. Outhouses and septic-tank effluent drain field systems were the most common onsite/decentralized systems used in the 20th century.

About 25% of the population in the United States is served by an offsite/centralized wastewater system. The US EPA estimates that more than one-third of new construction is occurring in areas that are not served by offsite/centralized wastewater systems. This means that onsite/decentralized systems are increasing in numbers, even considering that centralized sewer services are sometimes extended to areas that were once served by onsite/decentralized systems. The US EPA and state agencies agree that onsite/decentralized systems, appropriately managed and regulated, are a part of the nation's permanent wastewater infrastructure.

The use of typical onsite septic-tank effluent drain field systems is regulated in most states by a prescriptive set of regulations that specify the requirements for soil and site conditions as well as the design and size of onsite systems. The basic assumption behind such a prescriptive regulatory system is that if soil and site conditions meet the regulations, and if the system is designed and sized following the regulations, then the system will operate in a satisfactory manner with minimum maintenance and essentially no monitoring. Millions of septic tank effluent drain fields have been permitted and installed throughout the nation in this manner, and their performance has been taken for granted.

In the last decade, the nation has witnessed incredible innovation in the onsite treatment industry, and many in the industry have recognized the need for proper operation and maintenance for onsite systems on a permanent basis. Considering the fact that the soil and site conditions suitable for septic systems are not found everywhere, it becomes obvious that the time has come to thoroughly investigate the effectiveness of performance-based regulations for use of managed onsite systems. It is important in any performance-based regulatory system to determine and document the impacts of the wastewater system on environmental quality and to take steps necessary to keep those impacts within the permitted parameters. Taking performance for granted should not be a choice for regulating use of onsite systems in the 21st century.

Onsite/decentralized wastewater systems differ in many ways from offsite/centralized wastewater systems, most importantly in terms of their size and the method of discharge after treatment. Onsite/decentralized wastewater treatment systems are typically smaller in size (gallon per day capacity) compared to centralized systems (million gallon per day). Also, onsite/decentralized treatment systems are typically designed to discharge treated effluent into a land-based effluent dispersal system (such as soil absorption system or spray irrigation system), whereas most centralized systems discharge directly into a stream or surface water body. Both of these characteristics of onsite/decentralized systems—smaller size and use of land-based dispersal systems—pose unique challenges for traditional management and regulatory entities.

Virginia is a state on the mid-Atlantic coast of the US, south and west of Washington, DC. The Virginia Department of Health (VDH) is the state agency responsible for regulating the use of onsite/decentralized wastewater systems in Virginia, and VDH is interested in investigating the

effectiveness of a performance-based regulatory framework combined with US EPA management models four or five via several pilot projects with local governments.[1] One of the important aspects of a performance-based regulatory framework is a performance monitoring, inspection, review, and reporting (PMIRR) regimen—making sure that the treatment systems actually perform the way they are expected tol. The PMIRR regimen needs to be efficient and cost-effective and it needs to allow the regulatory agency to assure the public that the permitted onsite systems meet the performance standards required for protecting public health and environmental quality.

Charles City County Project

Many homes in Virginia lack indoor plumbing. There is a government program (Indoor Plumbing Rehabilitation) that offers financial assistance to homeowners for upgrading their homes and adding indoor plumbing. The National Rural Community Assistance Program (NRCA, 1995) report on the lack of complete plumbing in rural America ranked Virginia as the state with the second-highest number of rural households without complete plumbing (30,003 out of a total of 685,317 rural households without complete plumbing in the country) and the second-highest number of people living in households without complete plumbing (82,915 out of 1,893,915 total rural population). Charles City County, a relatively small county in eastern Virginia, has its fair share of rural households without complete indoor plumbing. The county is addressing this issue by working closely with local, state, and federal agencies that are involved with the funding and regulation of the various aspects of this issue.

In order to find cost-effective wastewater solutions for citizens with indoor plumbing problems, Charles City County signed an agreement with VDH in March 2002 establishing a pilot project that will utilize onsite/decentralized wastewater systems under US EPA model four or five management models. In return, VDH agreed to regulate the onsite/decentralized systems installed and operated under the agreement using a performance-based regulatory concept instead of the traditional prescriptive regulations. The current regulations for onsite systems in Virginia (VDH, 2000) have been set aside and are replaced with a Memorandum of Agreement (MOA) between the State Health Commissioner and County Board of Supervisors (VDH, 2002). The MOA clearly defines the role of the county as a Responsible Management Entity (RME) that will own and operate the decentralized wastewater systems used for managing wastewater generated by the households after rehabilitation and installation of indoor plumbing. The MOA sets performance standards for wastewater treatment and dispersal based on protecting public health and the environment; it explains the reasons for the agreement, defines the scope of the agreement, includes the variance letter from the State Health Commissioner, and defines ownership and responsibilities; and it establishes monitoring, reporting, permitting, recordkeeping, and enforcement processes.

A PMIRR regimen was developed by both parties with the MOA and incorporated as part of the agreement (Appendix-A of the MOA). However, that PMIRR regimen needs to be validated in terms of its costs as well as in terms of its effectiveness in identifying performance problems in

[1] The US EPA (2003-a) guidelines for management of onsite/decentralized wastewater systems specify five model management programs that range from the basic model one, with emphasis on inventory and awareness of maintenance needs, to models four and five where utility operation, maintenance, and ownership of onsite systems is recognized.

time to avoid adverse impacts on public health and environmental quality. Since regulating the use of small, decentralized wastewater systems based on performance and impacts on public health/environmental quality is a new concept for which little practical information is available, both the county and the associated regulatory agencies (VDH and the Virginia Department of Environmental Quality) have decided to closely study the initial PMIRR regimen that is part of the MOA for the Charles City County pilot project. In 2002, VDH and the county responded to a request for proposal from the US EPA for a grant to study the PMIRR regimen and determine if there are alternatives to the 'conventional' water-quality monitoring processes that are required under the current MOA. VDH was awarded a $150,000 grant from the US EPA in October 2003 to support the project (US EPA 2003-b).

A team of nine members representing the county and various state and local government agencies has been formed to implement the grant project. The grant funding will allow the county and VDH to conduct an intense monitoring and inspection scheme for two of the three decentralized wastewater systems that comprise the Charles City County pilot project and determine, based on statistical and other relevant analysis of the monitoring results, an *optimum* scheme for PMIRR. Two types of monitoring schemes will be implemented—water quality sampling and process monitoring. The performance monitoring project is designed to investigate the use of online monitoring devices typically employed in small wastewater treatment systems to monitor parameters such as dissolved oxygen, pH, temperature, oxidation/redox potential, electrical conductivity, turbidity, flow, etc., that may indicate the performance of the treatment systems. Such online monitoring may effectively reduce the need for intense water quality monitoring, i.e., sampling and analysis of effluent, to ensure the performance of treatment and dispersal systems. And, finally the proposed project will also investigate monitoring tools and techniques available for tracking the movement of effluent after it is discharged into land based effluent dispersal systems.

Performance Standards versus Performance Monitoring

The MOA between Charles City County and VDH specifies the performance standards for decentralized wastewater systems in terms of effluent limits, effluent dispersal area, and customer issues. At the minimum, the county is expected to treat wastewater to reduce BOD_5 and TSS to less than 30 mg/l, fecal coliform to less than 10,000 cfu/100 ml, and ammonia-nitrogen to less than 2 mg/l. The county also has an option to treat wastewater to a higher standard (BOD_5/TSS $\leq$ 10 mg/l and fecal coliform $\leq$ 20 cfu/100 ml) if the soil and site conditions dictate the need for higher quality effluent prior to subsurface dispersal.

Since the Charles City County pilot project is aimed solely toward addressing wastewater needs for existing *homes*, the MOA specifies that the county will design, install, and operate decentralized wastewater systems such that there is no net increase in the discharge of nitrogen from the project area. The county is also required by the MOA to design, install, and operate the effluent dispersal systems so that there is no net increase in ponding over that which occurs naturally on sites where dispersal systems are installed. The wastewater treatment system that Charles City County selected for this project includes a disinfection system, thus the effluent quality prior to discharge is expected to meet the higher of the two standards for fecal coliform ($\leq$ 20 cfu/100 ml).

The two concepts of performance monitoring that will be studied in this project are the water quality monitoring and process monitoring. Both of these concepts will be applied to the wastewater treatment plant (before discharge) and the effluent dispersal system (after discharge). The project team worked on developing a comprehensive list of items that the RME can monitor during its routine trips to the site or by using an on-line remote monitoring system (Table 1). A "√" mark for an item in the Table 1 indicates that the county (the RME) is planning to conduct that test. Note that the information presented in Table 1 may change as the project progresses. While the regulatory agencies are focusing on "monitoring" aspects, the RME is also looking into the use of advanced monitoring devices for actually operating the treatment plants using *feedback loops*.

The proposed project is expected to last for at least 24 months after onsite/decentralized wastewater systems are installed in Charles City County under the agreement. Information and experience gathered from the proposed project will be important in addressing the three issues outlined for onsite/decentralized wastewater treatment systems in the request for initial proposals. This project is intended to find answers for many of the questions that confront state and local regulatory agencies as they delve into establishing performance-based regulatory programs for onsite/decentralized systems. The information and data collected from the performance monitoring evaluation project is expected to be valuable in developing optimum PMIRR regimens for onsite/decentralized wastewater systems.

Table 1: Performance Monitoring Options

Wastewater Treatment Plant (Before Discharge)					**Effluent Dispersal System (After Dischrage)**				
Items to check for	Water Quality Monitoring		Process Monitoring		**Items to check for**	Water Quality Monitoring		Process Monitoring	
	Field Test	Lab Test	Spot Check	Continuous Check		Field Test	Lab Test	Spot Check	Continuous Check
Pump and blower on/off conditions			√	√	Standing water (ponding)			√	
Pump and blower run-time (per day)			√	√	Unusual conditions (wet spots, etc)			√	
Water level in tanks			√	√	Broken lines/fittings			√	
Alarm conditions			√	√	Odor (smell)			√	
Flow				√	Free water table			√	√
pH	√		√	√	Soil moisture			√	
Temp	√		√	√					
Dissolved Oxygen	√	√	√	√					
Electrical Conductivity	√	√	√	√					
Oxidation Redox Potential (ORP)	√	√	√	√					
Turbidity	√	√	√	√					
Clarity (visual)	√		√						
Odor (smell test)	√		√						
BOD_5		√							
TSS		√		√					
FOG		√							
Ammonia-N	√	√	√		Ammonia-N	√			
Nitrate-N	√	√	√		Nitrate-N	√			
TKN		√			TKN		√		
T-P	√	√	√		T-P	√	√	√	
Fecal Coliform		√			Fecal Coliform		√		
Chloride		√			Chloride		√		
Customer Complaints			√		Customer Complaints			√	

Note: “Field Test” means the operator or the lab testing for water quality in field; “Lab Test” means the water quality samples are taken to the lab for analysis; “Spot Check” means the operator and/or regulator checking for the item in the field; and “Continuous Check” means in-line instrument sensing and collecting data for the items in real-time and reporting to a central computer.

References

US EPA 2003-a, "Voluntary National Guidelines for Management of Onsite and Cluster (Decentralized) Wastewater Treatment Systems," EPA 832-B-03-001, US EPA Publication Clearinghouse, PO Box 42419, Cincinnati, OH 45242, Telephone 800-490-9198, Website http://www.epa.gov/owm/septic/pubs/septic_guidelines.pdf

US EPA 2003-b "Onsite-Decentralized Wastewater Treatment Systems Performance Monitoring," Grant Reference Number CP-983976-01-0, US EPA Region III, Philadelphia, PA 19103-2029.

NRCA, 1995, "Still Living Without the Basics," National Rural Community Assistance Program, 722 East Market Street, Suite 105, Leesburg, VA 20176, Telephone 703-771-8636.

VDH, 2000, "Sewage Handling and Disposal Regulations," Virginia Department of Health, Division of Onsite Sewage and Water Services, P.O. Box 2428, Richmond, VA 23218-2448, Website http://www.vdh.state.va.us/onsite/

VDH, 2002, "Memorandum of Agreement between the Virginia Department of Health and the Charles City County Board of Supervisors," Division of Onsite Sewage and Water Services, P.O. Box 2428, Richmond, VA 23218-2448.