The Vermont Legislative Research Service

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Decentralized Wastewater Management Systems

Approximately, 55% of Vermont homes have decentralized wastewater systems, which is the highest of any state in the US.[1] A decentralized wastewater system simply refers to a system that is not part of a larger system, such a municipal waste treatment facility. Due to low development density in most of Vermont, it is not feasible for many small municipalities to have collective waste treatment systems, thus decentralized systems are more prominent.

Alternative wastewater treatment systems, which include composting toilets and other aerobic systems, have been permitted in Vermont since 2000. A permit is required for the construction of new wastewater systems and the modification of existing systems.[2]

This report will discuss alternative wastewater treatment systems specifically for private residences, not those intended for municipal or industrial purposes. Technical information about wastewater treatment systems is provided and organized according to the primary, secondary, and tertiary phases of waste management. The report then discusses alternative systems approved in Vermont and the associated legislation and permitting processes, as well as legislation in other states.

[1] Environmental Protection Agency, "Water: Septic (Onsite / Decentralized) Systems: Frequently Asked Questions," Washington DC, March 8, 2013, accessed March 29, 2015, http://water.epa.gov/infrastructure/septic/FAQs.cfm#faq4.

[2] Vermont Department of Housing and Community Affairs, "Wastewater Solutions for Vermont Communities," January 2008, accessed March 31 2015, http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cd/planning/DHCA%20WW%20Guide%20final.pdf.

Definitions

In the EPA's *Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems*, "blackwater" is defined as "the term given to domestic waste water that carries, animal human, or food wastes." The handbook defines "gray water" as "domestic wastewater composed of wash water from sinks, showers, washing machines (does not include toilet wastewater)."[3]

The State of Vermont Agency of Natural Resources Department of Environmental Conservation Wastewater Management Division, defines blackwater as "sanitary waste or used water from any building or structure or campground, including, but not limited to, carriage water, shower and wash water, and process wastewater…storm water shall not be considered wastewater." Graywater is defined as "wastewater from normal domestic activities such as bathing, clothes washing, food preparation, and cleaning but excluding wastewater from toilets."

Additionally EPA provides definitions for primary, secondary and tertiary wastewater water treatment. Primary treatment is defined as "consisting of primarily physical process (settling or skimming) that remove a significant percentage of the organic and inorganic solids from wastewater." Secondary treatment is defined as "treatment [that] depends on biological action to remove fine suspended solids, dispersed solids, and dissolved organics by volatilization, biodegradation, and incorporation into sludge." Tertiary treatment is defined as, "advanced treatment [that] uses a variety of biological, physical, and chemical treatment approaches to reduce nutrients, organics, and pathogens."[4]

Primary Wastewater Treatment Systems

Conventional Septic Systems

In a conventional septic tank all the waste from a household runs into the anaerobic septic tank; the solid waste sinks to the bottom, forming sludge. Solid waste is anaerobically fermented in the septic tank, which eventually dissolves solids into liquid waste. The contaminated liquid is then pumped out of the tank and further treated by a connected secondary treatment component.[5]

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[3] Environmental Protection Agency, "Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems," Washington, DC, 2005, accessed March 28, 2015, http://water.epa.gov/aboutow/owm/upload/2005_12_20_septics_onsite_handbook_fs.pdf.
[4] Environmental Protection Agency, "Wastewater Management," Washington DC, October 16, 2008, accessed March 28, 2015. http://www.epa.gov/tribalcompliance/wwater/wwwastedrill.html.
[5] Environmental Protection Agency, "Water: Septic (Onsite / Decentralized) Systems: The Basics," Washington DC, September 14, 2014, accessed March 28, 2015, http://water.epa.gov/infrastructure/septic/the-basics.cfm.

Septic tanks can fail for a number of reasons, which include poor design, insufficient maintenance, inadequate soil on site, steep sloped landscape, or high groundwater table. When a septic tank fails, untreated sewage is released into the environment. A failed system can release as much as 76,650 gallons into the surrounding groundwater.[6] This introduces excess nitrogen, phosphorous, and organic matter, which can alter surrounding ecosystems in many ways. Poorly treated wastewater also has the potential to release disease-causing pathogen and nitrates into surface and groundwater.

Aerobic Treatment Systems

Aerobic treatment systems are an alternative option on sites that have limited space and/or lack ideal soil. These types of primary treatment systems work similarly to traditional septic tanks except air is introduced to the waste water in the tank. Aerobic systems have the ability to carry out a higher level of wastewater treatment than traditional systems. This difference in performance is a result of the oxygen that is present in the system which creates a stable environment for aerobic microbes, which are more efficient at breaking down organic matter than anaerobic microbes (which are found in traditional septic systems).[7]

Aerobic systems have a higher capacity to remove biochemical oxygen. Rates of suspended solid removal are similar between aerobic and traditional systems. Aerobic systems are successful at carrying out nitrification. The EPA defines nitrification as "a microbial process by which reduced nitrogen compounds (primarily ammonia) are sequentially oxidized to nitrite and nitrate."[8] Since the system allows for a higher standard of treatment the effluent that is released is cleaner which allows for the possibility of smaller leach fields or leach fields that have a longer lifespan. Smaller leach fields and less contaminated effluent result in lower environmental impacts. Generally, aerobic systems are more expensive, require electricity, and include more mechanical parts and therefore greater possibility of these components breaking and requiring maintenance.[9]

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[6] Lee, Brad; Jones, Don; Peterson, Heidi, "Home & Environment: Septic System Failure," Purdue University: Department of Agronomy and Department of Agricultural and Biological Engineering, West Lafayette, Indiana, accessed March 28, 2015, https://www.extension.purdue.edu/extmedia/henv/henv-1-w.pdf

[7] U.S. Environmental Protection Agency, "Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems," accessed March 28, 2015. http://water.epa.gov/infrastructure/septic/upload/onsite_handbook.pdf

[8] U.S. Environmental Protection Agency, "Nitrification," Washington D.C., August 2002, accessed March 30 2015, http://www.epa.gov/ogwdw/disinfection/tcr/pdfs/whitepaper_tcr_nitrification.pdf

[9] U.S. Environmental Protection Agency, "Decentralized Systems Technology Fact Sheet Aerobic Treatment." Washing, D.C: Office of Water, 2000, accessed March 28, 2015, http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_aerobic_treatment.pdf

Secondary Wastewater Treatment Systems

Media Filters

The effectiveness of wastewater treatment systems can be compromised when soil structure is not ideal. Limiting factors include shallow soil, groundwater, or bedrock. Media filters can be used to increase effectiveness of treatment of effluent. Common media include sand, peat bio filters, and textile fibers. Wastewater from the primary treatment is evenly applied in recurrent doses to the top of the bed of chosen media. The wastewater is physically treated by the media and biologically treated by the microorganisms attached to the media. Media filters are highly effective at nitrification and bacterial removal and result in uniform wastewater treatment. Media filters are an additional secondary treatment step that can be included in a wastewater treatment system. The remaining liquid must be additionally passed through a leach field, leaching chamber, at grade system, mound system, or a grave less system (all explained below).[10]

A disadvantage of the installation of media filters is that greater site area is required. It is an additional component to a conventional septic system, therefore the area for the septic tank and the leach (or other alternative) still required. Additionally, media filters are not effective at treating waters that have high turbidity (high density of suspended particles).[11]

Biological Filtration

Biological filters are also an optional secondary treatment component. Biological filtration requires biologically active carbon filters which allow for biodegradation and particle removal. The filtration works aerobically. Biological filtration performance is highly dependent on temperature, contact time, backwash operations, and water quality parameters like pH, alkalinity, turbidity and biodegradable dissolved carbon. A common problem with biological filtration is filter sloughing, which can result in taste and odor problems and release of bacteria in released water. High calcium carbonate can result in decreased performance as well as iron and magnesium precipitation. Pretreatment to minimize the concentration of these elements can prevent these problems from occurring.[12]

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[10] Vermont Department of Housing and Community Affairs, "Wastewater Solutions for Vermont Communities," January 2008, accessed March 28, 2015, http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cd/planning/DHCA%20WW%20Guide%20final.pdf.

[11] Environmental Protection Agency, "Wastewater Technology Fact Sheet Intermittent Sand Filters," EPA 932-F-99-067, Office of Water Washington, D.C., September 1999, accessed March 28, 2015, http://water.epa.gov/aboutow/owm/upload/2005_07_14_isf.pdf.

[12] Environmental Protection Agency, "Water Treatability Database: Biological Filtration," 2015, accessed March 28, 2015, http://iaspub.epa.gov/tdb/pages/treatment/treatmentOverview.do?treatmentProcessId=1174340674.

Leach fields

Leach fields distribute wastewater into a series of trenches or a bed of gravel (6-12 inches underground) through a sequence of perforated pipes and is the most conventional secondary treatment option. The water can be delivered to the pumps by gravity or by an additional pump. The wastewater is treated by slowly percolating through the gravel and soil. There are a number of factors to consider in order to determine whether a leach field is appropriate for a given site, including area available at the site in question, quality of the soil on site (percolation rates), and depth to the water table. Leach fields take up a large amount of site area since they are made up of multiple trenches but they can be used at level or moderately sloping grounds.[13]

Leaching Chambers

Leaching chambers are an alternative to the traditional perforated pipe leach field structures. Leaching chambers consist of a series of arches made of polyethylene, which establish a draining area with greater volume than tradition leach fields. The structure allows for effluent to flood the surface water, which allows treatment by bacteria and oxygen before the effluent begins to percolate downward. Leaching chambers do not have any mechanical parts and therefore require minimal maintenance. Leaching chambers have a greater average life expectancy (20 years) compared to traditional leach fields (15 years). These chambers eliminate the need for gravels. Installation is done at a lower depth, which maximizes the amount of soil available for infiltration and decreased the impact on the site. Leaching chambers require the same site considerations as leach fields but require less site area and cannot be used on inclines greater than 10%.[14]

At Grade and Mound Systems

At grade and mound systems are alternative options to conventional leach fields when soil conditions are not adequate to allow for the processes of a leach field to be effectively carried out. These systems can be used in areas with high groundwater tables but must be installed at sites with minimal slope. The perforated pipes and gravel are placed at the ground surface for an at grade system. The perforated pipes and gravel are placed in a bed of sand, above original ground surface, for mound systems. Installation results in a smaller impact on the site because

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[13] Vermont Department of Housing and Community Affairs, "Wastewater Solutions for Vermont Communities," accessed March 28, 2015, http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cd/planning/DHCA%20WW%20Guide%20final.pdf.

[14]Environmental Protection Agency. "Decentralized Systems Technology Fact Sheet Septic Tank Leaching Chamber," Washing, D.C: 2000, accessed March 28, 2015, http://water.epa.gov/infrastructure/septic/upload/septic_tank_leaching_chamber.pdf.

less excavation is required. Mound systems generally have higher construction and installation costs. Additionally systems require pumps or siphons; more mechanical moving parts results in greater maintenance requirements of the system.[15]

Gravel-less dispersal technologies

Gravel-less dispersal technologies work the same way as traditional leach field but use plastic or multi-media infiltration systems instead of the gravel/pipe system. These alternative technologies are lighter and more flexible and therefore easier to install and the system can be installed at a lower depth than traditional leach fields. The perforations by which the wastewater exits are encased prevents these openings from being blocked by soil. Additionally, these systems can handle a higher influx of wastewater, which allows for smaller leach field sizes. Additionally these systems have a higher contact area in which effluent is released and therefore treatment is more efficient.[16]

Filtrate Effluent Dispersal Systems

Spray Dispersal Systems

Spray dispersal is the uniform distribution of effluent to soil surface with the use of sprinklers. The dispersed effluent can be used for the purpose irrigation of crops or recreation areas. Spray dispersal is a surface dispersal method and therefore carries risks of human contact with odors, contaminants, and pathogens. Therefore, dispersal systems are generally required to have large buffer zones and fences. Prior to dispersal minimal waste water treatment includes primary, secondary and tertiary treatment. Disinfection for tertiary treatment is generally carried out by the use of chlorination or UV light. Spray dispersal systems have a dosing tank containing a pump that releases the effluent on a timer. These systems can function at a residential and community scale. Since the system requires a pumping system, a source of electrical power is required. Spray dispersal is generally not used with systems that produce less than 1,000 gallons of wastewater a day. If the system is working properly little to no odors should exist.[17]

Drip Dispersal Systems

Drip dispersal systems work similarly to drip irrigation. Drip systems consist of filters to remove solids, network of drip tubes to disperse the effluent, tanks to hold effluent, and controllers to regulate flow of the system. Drip dispersal can be implemented on sites with thin soils or poor percolation rates. The shallow required installation depth of these system allow for greater

[15] Vermont Department of Housing and Community Affairs, “Wastewater Solutions for Vermont Communities.”
[16] Vermont Department of Housing and Community Affairs, “Wastewater Solutions for Vermont Communities.”
[17] Water Environment Research Foundation, "Spray Distribution," accessed March 28, 2015. www.werf.org/c/DecentralizedCost/D3_Spray_Distributio.aspx

oxygen availability, which allows for greater level of treatment before effluent is dispersed. The system can be installed on moderately sloped sites. Alternatively, drip dispersal systems are more expensive than traditional systems due to the many moving parts that require continued maintenance. Perforation of the drip tubing has the potential of becoming clogged, which can result in system failure.[18]

Additional Alternatives

Constructed Wetland

In Vermont proposed constructed wetland systems are considered on a case-by-case basis. The system must meet the effluent requirement,30 mg/l BOD5 and 30 mg/l TSS. In a constructed wetland, aquatic vegetation is planted on a lined rock bed, which is very effective at treating effluent. Constructed wetlands require less site area than traditional methods and can be installed in areas with high water tables. Compared to traditional systems, constructed wetlands have higher installation costs, require more maintenance, and have an unknown effective lifespan.[19]

Composting Toilets

Composting toilets are "alternative on-site waste treatment systems" that utilize decomposition to treat human waste.[20] Decomposing organisms break down the primarily solid waste through competition and heat, thus eliminating pathogens. The overarching benefit of utilizing a composting toilet is that it keeps fecal matter and graywater separate, thus reducing the contaminants in graywater and the opportunity for contaminating groundwater sources.

In addition to keeping types of wastewater separate, composting toilets can transform human waste into fertilizer. After approximately two years of decomposition in the composting chamber below the toilet itself, the final product is “reduced to only 5 percent of its original volume, [and] has the odor, appearance, and bacterial content of topsoil."[21] Additionally, the

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[18] Ohio Environmental Protection Agency, “Drip Distribution Systems,” Ohio: EPA, Division of Surface Water, 2008, accessed 28,2015, http://www.epa.state.oh.us/portals/35/guidance/pti5.pdf.

[19] State of Vermont, Agency of Natural Resources, “Wastewater System and Portable Water Supply Rules,”

[20] Franey, Tara, “Composting Toilets: Alleviating Regulatory Barriers to an Integrated Green Solution,” Land Use Institute Vermont Law School, accessed March 30 2015, http://www-assets.vermontlaw.edu/Assets/land-use-institute/NEWEA_paper_final_1.pdf.

[21] Thayer, Chris, “The Appalachian Mountain Club Clivus Mutltum Composting Toilet,” Backcountry Sanitation Manual, Appalachian Trail Conference, 101-102, accessed March 30 2015, http://atfiles.org/files/pdf/atcsanitation.pdf.

final liquid that collects in the chamber below the lower hatch evolves from its original form to a stable fertilizer that is "safe enough to meet quality standards for swimming water."[22]

Legislation

Across the board, states require permits for any installation, repair, or replacement of wastewater treatment systems. States differ on specific requirements for alternative wastewater treatment systems and associated permitting processes.

Vermont

Universal Jurisdiction, The Clean Slate Bill: Vermont passed the Clean Slate Bill, effective May 18, 2008. This piece of legislation implemented what is known as Universal Jurisdiction over sewage and wastewater. Universal Jurisdiction requires a State Water and Wastewater Permit for construction of all new single-family homes and the replacement and repair of water supply or wastewater disposal systems. Additionally, the Clean Slate Bill has an exemption that grandfathers all existing systems (buildings, campgrounds, lots, waste water systems, and potable water supplies) built prior to January 1, 2007 from acquiring a State Water and Wastewater Permit. Failed systems require a repair permit and the failed system must be added as a defect to the property title. Annual inspections and reporting of system failures are required under the General Permit. The Aquatic Permitting Criteria requires sampling for nutrient parameters.[23]

Permitting Process: Quoting a 2011 report from Stone Environmental Inc., in order for a wastewater permit to be administered, the homeowner must demonstrate that the system's discharge:

- *will not significantly alter the aquatic biota of the receiving waters*
- *will not pose more than a negligible risk to public health*
- *will be consistent with existing and potential beneficial uses of the waters*
- *will not violate Water Quality Standards.*[24]

The system must have documentation that proves compliance with the Aquatic Permitting Criteria, the Reliability Permitting Criteria, and the Public Health Protection Criteria as stated in

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[22] Thayer, Chris, "The Appalachian Mountain Club Clivus Mutltum Composting Toilet"
[23] Lorentz, Karen, "New Septic Rules Potentially Affect Residential Sales," Rutland Business Journal, July 1, 2007, accessed March 28, 2015, http://www.vermonttoday.com/apps/pbcs.dll/article?AID=/20070701/RBJ/70802009
[24] Stone Environmental Inc., "Appendix D: Vermont Regulations for Soil-Based Wastewater Treatment Systems," Waitsfield, Vermont, January 2011, accessed March 13, 2015, http://www.waitsfieldvt.us/docs/assessment_of_wastewater_options_waitsfield_sei_report_appendixd.pdf

the Indirect Discharge Rules. The General Permit requires annual inspection of the wastewater system. Additionally nutrient sampling is required under The Aquatic Permitting Criteria.[25]

New Hampshire

The individual designing, installing, repairing, or replacing a subsurface sewage system is required to hold a permit issued by the New Hampshire Department of Environmental Services.[26] The only permit exception is "that a homeowner may design and install or repair and replace a subsurface sewage disposal system for his/her own primary domicile." Even if homeowners are installing or repairing the systems on their own, “both an Approval for Construction and an Approval for Operation must be obtained,” prior to use of the septic system.[27]

Regarding alternative/innovative systems, all alternative wastewater treatment technologies are approved under Env-Ws 1024.[28] There is not a specific list of approved alternative wastewater treatment technologies. Instead, installation of alternative systems is determined on a case-by-case basis through the methodology established in statute 485-A:29, taking the distances from cemeteries and groundwater sources into account.[29] When a homeowner decides to implement an approved alternative he or she is required to have a “maintenance contract,”[30] this means that the owner of the Individual Sewage Disposal System (ISDS) must have a long-term service contract with a maintenance professional prior to installation approval.[31]

Additionally, there is not a funding program to assist homeowners in replacing failing wastewater treatment systems, "nor are there plans to develop one."[32]

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[25] Stone Environmental Inc., 2011.

[26] New Hampshire Department of Environmental Services, “Environmental Fact Sheet: Permitting Installers and Designers of Subsurface Sewage Disposal Systems,” 2012, accessed March 31 2015, http://des.nh.gov/organization/commissioner/pip/factsheets/ssb/documents/ssb-4.pdf.

[27] New Hampshire Department of Environmental Services, “Septic Systems: Approval for Operation,” accessed March 31, 2015, http://des.nh.gov/organization/divisions/water/ssb/permit_approval_operation.htm.

[28] State of New Hampshire, “Regulations Statutes & State Codes,” accessed March 31 2015, http://www.nesc.wvu.edu/septic_idb/newhampshire.htm.

[29] State of New Hampshire, “Chapter 485-A Water Pollution and Waste Disposal,” accessed March 31 2015, http://www.gencourt.state.nh.us/rsa/html/L/485-A/485-A-mrg.htm.

[30] State of New Hampshire, “Subdivision and Individual Sewage Disposal System Design Rules,” Regulations, Statutes, & State Codes, August 1999, accessed March 31, 2015, http://www.nesc.wvu.edu/septic_idb/newhampshire.htm.

[31] State of New Hampshire, “Chapter Env-Wq 1000 Subdivision and Individual Sewage Disposal System Design Rules,” New Hampshire Code of Administrative Rules, 87, accessed March 31 2015, http://des.nh.gov/organization/commissioner/legal/rules/documents/env-wq1000.pdf.

[32] State of New Hampshire, “Subdivision and Individual Sewage Disposal System Design Rules,” Regulations, Statutes, & State Codes, August 1999.

Massachusetts

In order to replace or install a new wastewater treatment system, all design and construction plans, composed by a hired engineer, must be approved by the Massachusetts Department of Environmental Protection (MassDEP) and possibly other departments.[33]

Massachusetts has divided alternative wastewater treatment technologies into three categories: general, provisional, and pilot. Technologies approved for general use include composting toilets, recirculating sand filters, and many other aerobic systems. Technology use approval must be issued by MassDEP. In addition to technology approval, MassDEP also needs to provide installation approval. The property owner must also show that the property has the capacity to handle a traditional septic system.[34]

A resident can bypass the approval process if he or she is planning to install a composting toilet that meets a set of guidelines established by the state. Massachusetts law permits the use of "self-contained, zero discharge, stand-alone composting toilets."[35] Zero discharge means that the "toilet does not produce an effluent that needs to be pumped out or discharged to a soil absorption system."[36] It is important to note that MassDEP approval is not the equivalent of a permit, but the step before acquiring a permit. To install a composting toilet that meets the aforementioned requirements, one still needs to obtain a Disposal System Construction Permit from the local Board of Health.[37]

The town of Concord offers loans of up to $30,000 to offset the cost of replacing failed septic systems, but there is no financial assistance available for switching to alternative systems.[38]

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[33] Town of Concord Massachusetts, "Replacing Your Septic System," accessed March 31, 2015, http://www.concordma.gov/pages/ConcordMA_health/SepticReplace.

[34] Massachusetts Executive Office of Energy and Environmental Affairs, "Summary of Innovative/Alternative Technologies Approved for Use in Massachusetts and Under Review," 2015, accessed March 31, 2015 http://www.mass.gov/eea/agencies/massdep/water/wastewater/summary-of-innovative-alternative-technologies-approved.html.

[35] Massachusetts Executive Office of Energy and Environmental Affairs, "Regulatory Provisions for Composting Toilets and Greywater Systems," 2015, accessed March 31, 2015, http://www.mass.gov/eea/agencies/massdep/water/wastewater/regulatory-provisions-for-compost-toilets-and-greywater.html.

[36] State of Massachusetts, "Chapter 176, Acts of 2002, Sec. 3," accessed March 31, 2015, https://malegislature.gov/Laws/SessionLaws/Acts/2002/Chapter176.

[37] Massachusetts Executive Office of Energy and Environmental Affairs, "Regulatory Provisions for Composting Toilets and Greywater Systems," 2015.

[38] Town of Concord Massachusetts, "Replacing Your Septic System."

Delaware

Delaware requires a valid permit from the Department of Natural Resources and Environmental Control in order to "construct, install, modify, rehabilitate or replace an on-site wastewater treatment and disposal system."[39]

Revised Septic System Regulations went into effect January 2014 and are intended to help Delaware reach its goal of achieving clean water and protect homebuyers from "acquiring malfunctioning septic systems."[40] The changes standardized the permitting process, thereby eliminating a great deal of confusion associated with case-by-case standards and permits. New regulations also "include [standardized] procedures for distributing treated wastewater for agricultural use and other authorized purposes."[41] One of the central changes, in addition to clarifying and simplifying the permitting process, allows homeowners to become certified to maintain their own septic systems after completing a homeowner training program.[42]

Additional regulations effective January 2015 established "statewide performance standards for all innovative/alternative systems," further clarifying and demystifying wastewater treatment system standards for residents.[43]

Finally, Delaware's Septic Rehabilitation Loan Program (SRLP) was created to assist eligible property owners in meeting regulatory requirements. "The program provides low interest or no interest loans to assist homeowners with the costs of replacing malfunctioning septic systems."[44]

Conclusion

As mentioned earlier, Vermont, even though it has a small population, has the highest number of decentralized wastewater treatment systems per capita in the United States. Thus, it is important to explore the private wastewater treatment options approved in Vermont and the

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[39] Delaware Department of Natural Resources and Environmental Control, Division of Water, Groundwater Discharges, "Regulations Governing the Design, Installation, and Operation of On-Site Wastewater Treatment and Disposal System," accessed March 31, 2015, http://www.dnrec.delaware.gov/wr/Information/GWDInfo/Documents/DelawareFinalOnSiteRegulations_01112014.pdf.

[40] State of Delaware, "Delaware's Revised Septic System Regulations (effective Jan.11 2014)," Division of Water, accessed March 31, 2015, http://www.dnrec.delaware.gov/wr/Information/GWDInfo/Pages/GWDS%20Design%20Install%20Operate%20Info%20For%20Proposed%20Wastewater%20Treatment%20Regulations.aspx.

[41] State of Delaware, "Delaware's Revised Septic System Regulations (effective Jan.11 2014)."

[42] State of Delaware, "Delaware's Revised Septic System Regulations (effective Jan.11 2014)."

[43] State of Delaware, "Delaware's Revised Septic System Regulations (effective Jan.11 2014)."

[44] State of Delaware, "Septic Rehabilitation Loan Program," Financial Assistance Branch, accessed March 31, 2015, http://www.dnrec.delaware.gov/fab/Pages/Septic-Rehabilitation-Loan-Program.aspx.

associated legislation and permitting processes. Due to the possible danger of a decentralized wastewater treatment system malfunction, specifically the threat of groundwater contamination, most states have strict and lengthy approval processes for installation of septic systems and alternative or innovative wastewater treatment systems. Differences in state legislation can provide Vermont with innovative ideas to improve private wastewater treatment, such as providing loan options to replace and repair malfunctioning systems. Vermont could also clarify and streamline the permitting process, thus making installation of new or alternative systems more accessible to the typical Vermont homeowner.

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This report was completed on April 14, 2015 by Erin Dickinson, Quin Mann, and Olivia Taylor under the supervision of Professors Jack Gierzynski, Robert Bartlett and Eileen Burgin in response to a request from Representative Teo Zagar.

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