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Low-Impact Wastewater Systems

House Bill H.70, "An Act Relating to the Permitting of Low-impact Wastewater Systems," proposes allowing alternative wastewater systems consisting of alternative toilets and greywater management for hand-pumped or hand-carried water to accommodate low-impact lifestyles.[1] Vermont's current system does not allow for low-impact wastewater systems, such as alternative toilets, in personal residences, which some individuals who are perusing low-impact lifestyles would like to be able use. Traditional systems of obtaining potable water and managing wastewater are designed to handle large volumes and can be expensive. This report evaluates the different types of low-impact wastewater systems proposed in regards to their environmental and public health impacts. Additionally, an overview of other state's legislation pertaining to alternative wastewater systems is outlined.

Definitions

The EPA defines "blackwater" as "any waste from toilets or urinals," and "greywater" as "wastewater that has been used for washing, laundering, bathing, or showering."[2] Blackwater and greywater together are considered wastewater. Low-impact wastewater systems must dispose of all wastewaters, although they may be through different structures (such as composting toilets for blackwater and constructed wetlands for the greywater). Together, alternative toilets and low-impact greywater systems comprise low-impact wastewater systems. Bill H.70 proposes allowing such a system at a domestic residence.

Alternative toilets primarily consist of composting toilets, incinerating toilets, and vault privies. Composting toilets are defined by the EPA as "system[s] contain[ing] and process[ing] excrement, toilet paper, carbon additive, and sometimes, food waste."[3] An incinerating toilet is a "self-contained unit consisting of a traditional commode-type seat connected to a holding tank and a gas-fired or electric heating system to incinerate waste products deposited in the

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[1] Vermont House of Representatives, "Vermont House Bill 70: An act Relating to the Permitting of Low-impact Wastewater Systems," accessed February 12th, 2020, https://legislature.vermont.gov/bill/status/2022/H.70.

[2] U.S Environmental Protection Agency, *Black and grey water management*, June 2021, https://www.epa.sa.gov.au/environmental_info/water_quality/programs/grey_and_black_water_discharge.

[3] U.S. Environmental Protection Agency, *Water Efficiency Technology Fact Sheet: Composting Toilets*, September 1999, https://www.epa.gov/sites/production/files/2015-06/documents/comp.pdf.

holding tank."[4] Finally, the EPA defines a vault privy as a "modern outhouse" which is "set over a watertight tank," often made of concrete, plastic, or fiberglass.[5]

The regulation of greywater disposal systems varies greatly between states and some states' departments do not acknowledge greywater at all.[6] States that do have code regarding greywater management sometimes allow for an alternative system that does not require a septic tank. Generally, these alternative approaches, such as a leaching field, filtering, or re-use of greywater in the household after filtration have a lesser environmental impact than traditional septic systems.[7] The proposed legislation is considering leaching fields for hand-carried or hand-pumped greywater.

Low-Impact Greywater Systems

Low-impact greywater systems dispose of wastewater from showers, sinks, and washing machines. This is separated from blackwater, which is from toilets. Greywater systems must be hooked up to a septic system or soil disposal system to be disposed of properly because it contains harmful substances. Nitrogen, phosphorous and pathogens such as viruses and bacteria are of particular concern.[8] State-approved greywater disposal systems are necessary to prevent environmental harm and risks to public health.[9] Soil filtration systems work because greywater that can seep into soils filters properly and does not pose risks.[10]

There are three levels of greywater treatment: in the first, settleable and suspended solids are removed; in the second, biodegradable organic matter is removed; and in the third, nutrients are removed and the wastewater is disinfected.[11] Untreated greywater should not be directly spread on plants. Untreated greywater can still cause public health and environmental

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[4] U.S. Environmental Protection Agency, *Water Efficiency Technology Fact Sheet: Incinerating Toilets,* September 1999, https://www.epa.gov/sites/production/files/2015-06/documents/incinera.pdf.

[5] Kansas Department of Health and Environment, *Water Conserving Toilets and Holding Tanks*, 2020, https://www.kdheks.gov/nps/lepp/ChVIIIWaterConservingFinal.pdf.

[6] Greywater Action, "Greywater Codes and Policy," accessed February 18th 2021, https://greywateraction.org/greywater-codes-and-policy/.

[7] Greywater Action, "Greywater Codes and Policy," accessed February 18th, 2021, https://greywateraction.org/greywater-codes-and-policy/.

[8] Massachusetts Department of Environmental Protection, *Using Composting Toilets and Greywater Systems in Massachusetts*, April 2005, https://www.mass.gov/doc/composting-toilets-greywater/download#:~:text=Title%205%20(310%20CMR%2015.289,contained%20units)%2C%20unless%20DEP%20has.

[9] A. Gross et al. "Environmental impact and health risks associated with greywater irrigation: a case study," *Water Science & Technology* 52, no 11 (2005): 168.

[10] Peter L. M. Veneman and Bonnie Stewart, "Greywater Characterization and Treatment Efficiency," final report for *The Massachusetts Department of Environmental Protection* (December 2002): 26.

[11] Dilip Ghaitidak and Kunwar Yadav, "Characteristics and treatment of greywater—a review," *Environmental Science and Pollution Research* 20 (May 2013): 2799.

concerns. Certain chemicals and substances in greywater can impact plant health.[12] Treatment of greywater may occur at a domestic residence with the correct materials and state-approved systems.

To avoid the use of a septic tank, the most efficient way of treating greywater is through leach fields. One way to do so is through a subsurface drip distribution—this system is a "pressurized wastewater distribution system that delivers small, precise doses of effluent through small diameter, flexible polyethylene tubing with small in-line emitters."[13]

Another way to release greywater through leach fields is through constructed wetlands. These systems are low cost, effective, and simple, and correctly treat greywater. Most constructed wetlands use several layers of material that the water filters through, which is adjusted depending on the quantity and quality of water. In one kind, the "recirculating vertical flow constructed wetland," the wastewater flows from the collection system to the plant root zone of the wetland where it then flows into the "three-layer bed into the reservoir," which provides passive aeration. After this, the water is recirculated several times through the bed to achieve the "desired purification."[14] This system properly disposes of greywater.

Disposal of Blackwater

Composing toilets

Blackwater must be properly disposed of to ensure public health standards. Composting human solid waste is an option if the composting process is done correctly. However, it is a complicated process that takes time, attention, and energy, and if done incorrectly, the health of the landowner and surrounding landowners may be at risk.

Most commercial composting toilets have a container in which the solid waste drops directly and is contained for the correct amount of time. These toilets are sold by various companies and come with instructions on proper use. However, while "some manufacturers and distributors claim a pathogen reduction to 'safe' levels, pathogen levels may vary greatly according to the operation and maintenance of the specific unit" and the homeowner must be able to plan disposal of waste accordingly.[15]

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[12] Suzie Reichman and Adam Wightwick, "Impacts of standard and 'low environmental impact' greywater irrigation on soil and plant nutrients and ecology," *Applied Soil Ecology* 72 (July 2013): 201.

[13] Vermont CVR 12-033-001 https://dec.vermont.gov/sites/dec/files/dwgwp/rorules/pdf/Wastewater-System-and-Potable-Water-Supply-Rules-April-12-2019.pdf.

[14] Gross et al., "Small scale recirculating vertical flow constructed wetland," 487.

[15] M. Mettler, "The Use of Composting and Incinerating Toilets in One and Two Family Dwellings," *Environmental Public Health Division* at the Indiana State Department of Health (2012): 1.

Another option for disposing of blackwater material is for it to be put into a leach field. Leach fields are "the portion of a soil-based wastewater system used to disperse wastewater into the soil," according to the Vermont Department of Environmental Conservation.[16] The solid waste is buried into a leach field, which is permanent. However, soils must be suitable for such activity, adhering to the rules put forth by the Vermont Department of Environmental Conservation which means they are deep enough and allow for proper percolation. There remains a risk for water contamination from this process if the leach field is improperly placed relative to the groundwater location and level.

As it stands, the Vermont Department of Environmental Conservation policy for disposing of blackwater from a composting or incinerating toilet is through "shallow burial at a location approved by the Secretary in a permit, provided the location meets the following requirements: (A) complies with the isolation distances and isolation zones required pursuant to § 1-912 for locating an in-ground each field; and (B) maintains a 3-foot separation between the bottom of the excavation for the contents to the seasonal high-water table and a 4-foot separation between the bottom of excavation for the contents to bedrock."[17]

If blackwater cannot be disposed of on private property, then it must be taken to a landfill or a wastewater treatment facility. In Vermont, there is only one landfill, so Vermonters who live far away from this site may be forced to transport the material a long distance to properly disposed of it. In addition, the landfill may refuse the solid waste. The other locations they may go to are local wastewater treatment sites, which can refuse said waste. If refused, the waste must be taken to the nearest facility that will accept it or to the landfill.[18]

Composting toilets generally need liquid waste to be removed separately from the solid waste and disposed of through greywater or septic systems. "Separate composting toilets" have a chamber beneath the toilet that filters excess liquid that then evaporates or is disposed of through greywater or septic systems, and "self-contained units" are composting toilets that automatically evaporates excess liquid while the decomposition of solid waste materials is taking place.[19]

Incinerating Toilets

Incinerating toilets can be either gas or electric. The waste in these toilets is incinerated until only a small amount of sterile ash is left, which must be emptied periodically.

The advantages of incinerating toilets are that they use no water, the ash can be disposed of into the trash, and they are generally odorless. These types of toilets can be particularly useful

[16] Vermont Agency of Natural Resources Department of Environmental Conservation, "Wastewater System and Potable Water Supply Rules," *Environmental Protection Rules* (April 2019): 10.
[17] Department of Environmental Conservation, "Wastewater System and Potable Water Supply Rules," 150.
[18] Eamon Twohig and Carl Fuller, interview by Rowan Hawthorne and Aidan Neilly, February 12, 2021.
[19] Massachusetts Department of Environmental Protection, *Using Composting Toilets and Greywater Systems in Massachusetts*, April 2005 https://www.mass.gov/files/documents/2016/08/qm/comptoi.pdf.

in remote areas where sewage systems are impractical or expensive to install due to shallow soil, severe cold temperatures, steep slopes and high groundwater levels.[20]

However, incinerating toilets have drawbacks as well. While they save water, they increase energy use which incurs both an added cost and air pollution.[21]

Vault Toilets

Vault toilets are emptied similarly to how septic systems are emptied. A septic company will empty the vault through a hose, which must be done periodically as the vault will fill up. Instead of having blackwater go to a septic system, vault privies eliminate the need for piping since the waste is held directly under the toilet in a vault system.[22]

Health Considerations of Alternative Toilets

Composting toilets must correctly manage aerobic decomposition of organic waste, which makes it safe to reincorporate into soil. Correct composting provides nutritional value and creates healthy soils. Composting human waste is a particularly hard process because of how long it takes to break down and how specific the conditions must be for this to happen. For there to be a high-end product that meets safety standards, the process must be highly managed and the process must include a "rapid temperature rise," stimulating the "thermophilic microbial consumption of organic matter." This consumption is what produces safe, high-end compost of human waste.[23]

To properly ensure that this reaction is occurring, the organic matter must have proper and continuous access to biodegradable carbon and nitrogen, in addition to oxygen and water. This substance must then experience "forced aeration, periodic mixing and watering in order to prevent inhibition and premature cooling." The proper temperature for such compost is 55ºC (or 131ºF) for between 3 days and 3 weeks before it may be allowed to cool down. This extended, hot temperature is what kills pathogens. However, the World Health Organization recommends a slightly lower temperature of 50ºC (122ºF) for between 7-30 days before allowing it to cool and cure for 2-4 months.[24] In addition, moisture levels need to be moderated

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[20] U.S. Environmental Protection Agency, *Water Efficiency Technology Fact Sheet: Incinerating Toilets,* September 1999, https://www.epa.gov/sites/production/files/2015-06/documents/incinera.pdf.
[21] U.S. Environmental Protection Agency, "Water Efficiency Technology Fact Sheet."
[22] "Portable Vault Toilet Service Unit," U.S. Forest Service Technology and Development Program, Brenda Land, last modified July 2004, https://www.fs.fed.us/t-d/pubs/html/04231304/04231304.html.
[23] Geoffrey B. Hill, Susan A. Baldwin, and Björn Vinnerås. "Composting toilets a misnomer: Excessive ammonia from urine inhibits microbial activity yet is insufficient in sanitizing the end-product," *Journal of Environmental Management* 119. (February 2013): 29-30.
[24] Hill, Baldwin, and Vinnerås. "Composting toilets a misnomer," 29-30.

to prevent anerobic conditions from forming or slowed microbial activity. This level needs to be between 40-60% water, which must be monitored frequently as well.[25]

The composting process is highly technical and requires constant monitoring to ensure that all pathogens have been killed and the compost rendered safe. Because this process is difficult, it is easy to skip steps or do it incorrectly, which results in unsafe compost. Hill, Baldwin, and Vinnerås cite seven studies that find that this occurs often, usually due to "poor design, overuse, insufficient maintenance, low temperatures, anaerobic conditions, and excessive urine."[26] Anaerobic conditions, which can develop when moisture level is not high enough, can sustain pathogens. Compost that does not meet correct standards can possibly transmit pathogens, cause the eutrophication of water systems, and have poison and kill plant life.[27]

The World Health Organization standards for fecal sludge that are not contained in a septic tank are that they are either taken care of by "transferring treatment technologies" such as composting or incineration, or allowed into a wet-pit leach field that does not have any possibility of contaminating the environment where it could reach humans.[28]

Policies in Other States

Massachusetts

Massachusetts' statutes require the state Department of Environmental Protection to develop an environmental code which includes rulemakings about sewage disposal.[29] The following are relevant regulations described by 301 Code of Massachusetts Regulations.[30] Composting toilets are allowed under narrow circumstances. Residential facilities are only permitted to install composting toilets for general use when homeowners can demonstrate the alternative system can provide equivalent environmental protection to conventional systems. Additionally, a composting toilet cannot be sited in a velocity zone (subject to high velocity wave action or seismic sources), coastal beach, barrier beach, dune, or in a regulatory floodway. The regulations require the composting toilet to produce no liquid byproduct and in the instance it does, byproduct must be discharged by a septic tank, leaching system or licensed septage hauler. The toilet must be able to hold composting material for a minimum of two years and

[25] Department of Environmental Protection, "Using Composting Toilets and Greywater Systems in Massachusetts," (April 2005): 2.
[26] Hill, Baldwin, and Vinnerås, "Composting toilets a misnomer," 30.
[27] Hill, Baldwin, and Vinnerås, "Composting toilets a misnomer," 30.
[28] World Health Organization, "Guidelines on Sanitation and Health," 2018, accessed February 16, 2021. https://apps.who.int/iris/bitstream/handle/10665/274939/9789241514705-eng.pdf.
[29] Mass Gen Laws Ann ch 21A § 13 https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter21A/Section13.
[30] https://www.mass.gov/doc/310-cmr-15000-title-5-of-the-state-environmental-code/download.

any residual material must be buried onsite under six inches of soil, an approved offsite location, or removed by a licensed septage hauler.

In conjunction with a composting toilet, an alternative greywater system is allowed. All proposed sites for greywater disposal must be evaluated by Soil Evaluator and the Approving Authority on conditions of: deep observation hole testing, soil profile determination, percolation testing, landscape position, and hydrogeologic properties. If conditions are sufficient, and only greywater will be processed, a filter system approved by the Board of State Examiners of Plumbers and Gas Fitters and/or the Department may be used in place of a septic tank and in combination with a soil absorption system.[31] Additionally, the size of the soil absorption system in new construction may be reduced by up to fifty percent, but residents must demonstrate that their property is capable of 100% leaching. Residential areas operating a composting toilet and greywater system in a nitrogen sensitive area are allowed a maximum loading rate of 660 gpd/acre.[32]

Inspections of composting toilets and greywater systems can occur any time or frequency the department deems fit. The Massachusetts government website outlines the advantages of alternative wastewater management including longevity and reduction in nitrogen content. [33]

Some Massachusetts's residents get their potable water from private wells which are not regulated by The Massachusetts Department of Environmental Protection or the U.S. Environmental Protection Agency. A very small percentage of these private wells can utilize hand pumps, but it is quite uncommon.[34]

Maine

The State of Maine's statutes designate the Department of Health and Human Services to create rulemakings regarding subsurface sewage disposal.[35] The following are relevant rules described by the Maine DHHS in Chapter 241.[36] Alternative wastewater systems including, but not limited to, composting toilets, incinerating toilets, and vault privies are allowed. Permits are required but a site evaluation is not, so long as the toilet does not discharge directly into the soil. These alternative systems must keep out insects and vermin with a mandatory "fly-tight, self-closing door and a self-closing toilet seat cover." Additionally, they must be ventilated in some way and maintain setback regulations. Alternative toilets can be used in conjunction with a primitive disposal, limited, or conventional disposal system.

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[31] Massachusetts Department of Environmental Protection, *Using Composting Toilets and Greywater Systems in Massachusetts*, April 2005, https://www.mass.gov/doc/composting-toilets-greywater/download#:~:text=Title%205%20(310%20CMR%2015.289,contained%20units)%2C%20unless%20DEP%20has.

[32] Mass 310 CMR 15.

[33] Massachusetts Department of Environmental Protection, *Massachusetts DEP Title 5 FAQ's,* June 2010, https://www.acton-ma.gov/DocumentCenter/View/882/Massachusetts-DEP-Title-5-FAQs.

[34] Commonwealth of Massachusetts, *"Private Well Guidelines,"* July 2019, https://www.mass.gov/doc/private-well-guidelines/download.

[35] 22 ME Rev Stat Ann § 42(3), https://www.mainelegislature.org/legis/statutes/22/title22sec42.html

[36] ME 10-144 CMR 241, https://www.maine.gov/dhhs/mecdc/environmental-health/dwp/documents/SubsurfaceWastewaterDisposalRulesProposal.pdf.

Maine also allows for primitive disposal systems equivalent to what the H.70 bill calls "low impact wastewater disposal system." The primitive disposal system, which consist of a leaching field, is permitted for no more than 25 gallons of greywater per day from no more than three hand carried or hand pumped fixtures. The size of the field is determined by what type of parent material profile exist on the site and a septic tank is not required.

Issues with Common Wastewater and Potable Water Supply Systems

Municipal piped systems are typically comprised of clean drinking water and regulated wastewater systems that ensure human waste is properly disposed and treated. These systems have their own issues.[37] As populations increase in urban and rural areas, waste output increases and wastewater systems that were designed many years ago are more likely to malfunction.[38] This discharge can then run off into water sources such as, lakes, rivers, and reservoirs. Furthermore, since these systems were created for much smaller populations, increased use can lead to back-siphonage which is caused by negative pressure in the water system. When back-siphonage occurs, polluted water gets drawn back into the water supply. From 1999-2002, 50% waterborne disease outbreaks were caused by water distribution systems throughout the United States.[39] Distribution systems are responsible for supplying thousands of residents with water, so a failed distribution center can lead to widespread issues within a community.

Most pipes for water distribution systems in the United States are within 30 years of their expected life span.[40] Aging pipes increase the chances of main breaks, which in turn, increases the likelihood of contaminated water.[41] Damage to aging systems is also more common in colder climates such as Vermont. In order to stay ahead of pipe failures, the federal and state governments will need to invest anywhere from $4.2 to $6.3 billion annually.[42] This figure is projected to rise as well to deal with the increasing number of failures with the aging pipes.[43] In Vermont, an urbanized area such as Burlington, presents a large fiscal challenge. In a 2013 article, Ernie Kelley, the program manager of wastewater for the agency of natural resources, watershed division said, "larger systems such as Burlington's would be too cost-prohibitive to replace all at once."[44]

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[37]Moe, Christine L. and Richard D. Rheingans, "Global Challenges in Water, Sanitation and Health," *Journal of Water and Health* 4, no. S1 (December 2006): 41-57.
[38] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 43.
[39] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 42.
[40] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 43.
[41] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 43.
[42] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 43.
[43] Moe and Rheingans, "Global Challenges in Water, Sanitation and Health," 43.
[44] Ken Picard, "Vermont sewage plants are Overflowing, but how much remains a mystery," *Seven Days,* July 17, 2013, https://www.sevendaysvt.com/vermont/vermont-sewage-plants-are-overflowing-but-how-much-remains-a-mystery/Content?oid=2243967.

Within just the past year (2020) there have been 110 sewage overflows due to wet weather in Vermont.[45] There were an additional 40 cases of overflow not caused by severe weather and 117 cases have been reported but not reviewed by the department of environmental conservation.[46] Per Vermont regulations, any sewage overflow must be reported within 12 hours from the water treatment facility, and there is an additional 12-hour window if the facility is unable to access phone or Wi-Fi at the time.[47] Even if these cases are caught and reviewed in a timely manner, it is still difficult to measure exactly how much waste has been discharged, and when these overflows are reported, the volume of waste is usually unknown.[48] This makes it harder to accurately trace the number of contaminants that could have run off into other water systems. Runoff and overflows are often a symptom of combined stormwater and wastewater systems that are considered to be outdated.[49] There is also the issue of illegal sump pumps and roof drains within some Vermont cities.[50] Although the likelihood of finding those who use illegal sump pumps is low, it would require too many resources to search for them.

Overflow and runoff issues are clearly prevalent in Vermont. With aging systems and reduced federal funding the problems will likely persist or get worse. There is also the question of what effects these overflows have on water quality and public health. Tracing how many gallons of waste has overflown, as well as where that waste has gone, is difficult. However, there has been steady progress in improving the situation since the 2016 clean water act. The clean water initiative project has given $194 million in efforts to raise the current water quality.[51] Furthermore, Vermont's government has devoted the majority of its clean water investments to wastewater at $61.2 billion over five years.[52] These improvements are just a small part of what is a 20-year plan that will continue to take up a large majority of state funds.

Finally, there is the issue of financial burden when looking at access to water. In rural areas there are fewer people buying into services that provide water and treat wastewater and limited infrastructure in place to do so. Consequently, the price to access clean water and have wastewater treated is much greater than that of an urban areas.[53] In rural areas homeowners

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[45] Department of Environmental Conservation, Combined sewer overflows and untreated discharges reported in date range," (n.d.), accessed February 18, 2021, https://anrweb.vt.gov/DEC/WWInventory/SewageOverflows.aspx.
[46] Department of Environmental Conservation, "Combined sewer overflows and untreated discharges."
[47] Picard, "Vermont Sewage plants are Overflowing, but how much remains a mystery."
[48] Department of Environmental Conservation, "Combined sewer overflows and untreated discharges."
[49] Picard, "Vermont sewage plants are Overflowing, but how much remains a mystery."
[50] Picard, "Vermont sewage plants are Overflowing, but how much remains a mystery."
[51] Emma Cotton, "$194 million in five years: Vermont chips away at clean water goals," *VT Digger,* Feb 15, 2021, https://vtdigger.org/2021/02/15/194-million-in-five-years-vermont-chips-away-at-clean-water-goals/.
[52] Agency of Natural Resources, Department of Environmental Conservation, "Clean Water Investments," accessed March 9, 2021, https://app.powerbigov.us/view?r=eyJrIjoiYTA0ODQ0MjMtZDBkMS00ODZjLTgxMWItYzE2ZmYwY2M2MDc4IiwidCI6IjIwYjQ5MzNiLWJhYWQtNDMzYy05YzAyLTcwZWRjYzc1NTljNiJ9.
[53] Rural Community Assistance Partnership, *Still living without the basics in the 21st century: analyzing the availability of water and sanitation services in the United States,* 2004, http://opportunitylinkmt.org/wp-content/uploads/2015/07/Still-Living-Without-the-Basics-Water.pdf. 38-40.

often use wells which are costly to build especially with environmental considerations such as soil quality and location.[54] The cost of traditional water systems will likely increase over time at a rate that is higher than inflation.[55] This is largely due to the costs of keeping up with sanitation practices that are vital in order to maintain safe drinking water. Urban areas tend to have cheaper access to water but those on or below the poverty line in rural areas tend to struggle in paying for water and plumbing services.[56]

Conclusion

Vermont homeowners most commonly receive their water piped from a municipality and dispose of both blackwater and greywater through a traditional septic tank. While certainly the most ubiquitously used water system, it occupies large areas, uses higher volumes of water, faces overflow, and can become expensive to construct. States that have made alternative wastewater systems legal have attempted to ensure the potential shortcomings are prevented. Both Massachusetts and Maine, examined in this report, approach this task differently. The proposed Vermont legislation, H.70, provides residents with alternative wastewater systems that may be better suited towards their needs but creates additional challenges in effective regulation.

This report was completed on March 15, 2021, by Hannah Dauray, Rowan Hawthorne, and Aidan Neilly, under the supervision of VLRS Director, Professor Anthony "Jack" Gierzynski in response to a request from Representative Kari Dolan.

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[54] Centers for Disease Control and Prevention, Beck, Joe, "Chapter 8: Rural Water Supplies and Water-Quality Issues," Centers for Disease Control and Prevention, October 1, 2009, https://www.cdc.gov/nceh/publications/books/housing/cha08.htm.

[55] Gasteyer and Vaswani, "Still living without the basics in the 21st century," 39.

[56] Gasteyer and Vaswani, "Still living without the basics in the 21st century," 39.