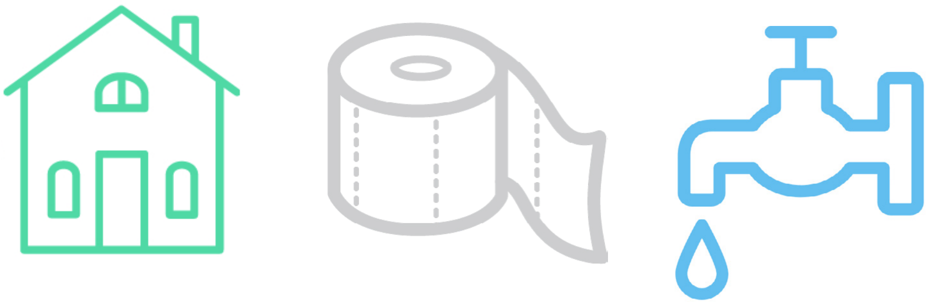
VILLAGE SANITATION PILOT STUDY

UNITING LAND USE PLANNING, COMMUNITY DEVELOPMENT, AND ECO-SANITATION IN SOUTHEASTERN VERMONT.



WESTMINSTER AND DUMMERSTON, VT

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ACKNOWLEDGMENTS

We thank the following funders for their support of the Village Sanitation Pilot Study: High Meadows Fund, Canaday Family Charitable Trust, Vermont Natural Resources Council, and the Long Island Sound Futures Fund of the National Fish and Wildlife Foundation.

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VSPS PROJECT SUMMARY

The Village Sanitation Pilot Study (VSPS) was a collaborative wastewater planning effort to explore environmentally sound and practical wastewater solutions in Vermont villages. This partnership between the Rich Earth Institute, the Windham Regional Commission, and Nutrient Networks engaged neighbors in two villages in the Windham Region (Westminster West and West Dummerston) to assess, at a neighborhood scale, the feasibility of innovative wastewater solutions to respond to septic system challenges and to facilitate compact village development in Vermont.

Many state and local planning goals in Vermont aim to focus growth in compact village centers. However, the majority of village centers rely on individual on-site (septic) systems to handle wastewater treatment and disposal. Due to challenging site conditions, many villages are unable to expand or add new septic systems. This means it can be difficult or impossible to renovate or construct new buildings, which impedes the goal of compact development. Septic systems can also impact both environmental and public health by releasing nutrients and pathogens to groundwater. Climate change may exacerbate each of these challenges while also increasing growth pressure on villages.

This study was the first to comprehensively assess the possibility of eco-sanitation options to help address village wastewater challenges in Vermont. In each village, site visits were conducted with participants to gauge the feasibility of a variety of composting and urine-diverting toilet systems. Of the options considered, a urine diverting flush toilet was identified as one of the more feasible options for retrofitting existing buildings. Urine diverting flush toilets reduce nutrient pollution by capturing nutrients before they enter the wastewater stream, generating a renewable source of fertilizer. These toilets reduce the volume and strength of wastewater, but the effect of urine diversion on septic system performance is not well understood, and research is needed to understand how urine diversion could help with septic siting challenges in Vermont villages.

Composting toilets have an even greater impact on the volume and strength of wastewater and Vermont allows a reduction in septic leach field size where composting toilets are installed, which could help with village septic siting challenges. However, composting toilets were found to be less feasible in this study because many of the historic buildings lack adequate basement or crawlspace to install large composting units. Smaller composting toilet systems would be technically feasible, but participants were concerned about greater maintenance needs for these types of systems, especially participants planning for aging in place. Composting toilets could be more viable in other situations, such as new construction and/or in buildings that have staff to assist with maintenance.

Through this feasibility study, the project partners explored the connection between ecological sanitation, community development, and environmental health. The study made it clear that there is significant community concern about wastewater issues and interest in eco-sanitation options. Following the feasibility study, many participants have decided to move forward with installing urine diverting flush toilets. These pilot installations will be the next step in assessing the potential of eco-sanitation to address village wastewater needs. Additional research and policy changes can build on these findings to ensure that eco-sanitation is part of the solution to Vermont's village wastewater challenges.

The goals of the VSPS:

1. **Explore opportunities for eco-sanitation to achieve wastewater goals in Vermont villages:**
    a. *Support compact development by reducing the burden on septic systems*
    b. *Protect public health by reducing septic system failure*
    c. *Protect water quality by reducing nutrient pollution*
2. **Work directly with the community to identify solutions that are both technically feasible and culturally acceptable in each location.**
3. **Identify infrastructure, regulations, and other next steps needed to support implementation of the options chosen by the community.**

PART 1: INTRODUCTION

Vermont's Planning Goals

The planning responsibilities of Vermont's State agencies and municipalities include such critical areas as economic development, infrastructure, housing, and the environment. Spanning all four of these areas, one of Vermont's codified planning goals is "to plan development so as to maintain the historic settlement pattern of compact Village and urban centers separated by rural countryside" (24 VSA §4302). The Vermont Natural Resources Council (2008) outlines a path to achieve this goal through smart growth principles, which emphasize "the efficient use of land, infrastructure, and resources" within existing neighborhoods in order to reduce the fragmentation of rural open space and prevent suburban sprawl.

In order for these old neighborhoods to grow, they will need to "increase allowable densities within areas designated for growth," and "maximize infill potential on vacant land and re-development opportunities" (Ibid). However, limited capacity for wastewater infrastructure is a significant barrier to increasing density in many Vermont villages. A 2006 report compiling input from planning commissioners and planners across Vermont identified wastewater as the single most common obstacle to development in growth centers (Munson, 2006, cited in Markarian, 2007). Inadequate wastewater management hinders pathways for increased density within rural communities.

Currently, over 200 villages in Vermont lack community sewer systems. The Vermont Department of Environmental Conservation (DEC) has formed an inter-agency Village Wastewater Initiative Committee to facilitate the implementation of wastewater solutions. Together with the Northern Border Regional Commission, the DEC is working to identify cost effective wastewater solutions for the villages of Wolcott, East Burke, and West Burke, with the goal of providing models for other villages throughout Vermont. However, these models are not anticipated to include eco-sanitation options such as composting or urine-diverting toilets. This VSPS therefore fills a research gap in considering eco-sanitation at the community scale in the state of Vermont.

Wastewater Challenges in Vermont Villages

Wastewater management is essential for protecting water quality and public health. In the United States, wastewater is generally managed either with centralized sewers and treatment plants, or by on-site systems, which include modern septic systems (a septic tank and leach field), as well as outdated septic systems with leach pits, and cesspools. Centralized sewered systems are expensive, require a large number of users to distribute the costs, and require access to a suitable receiving stream or river. This is partly why most Vermont villages utilize on-site treatment. Vermont has the highest proportion of homes served by septic systems in the US, with 55% of households currently using them, compared to a national average of about 20% (EPA, n.d.).

This reliance on septic systems presents a major challenge to Vermont's goal of compact village settlement. Many Vermont villages must contend with a combination of topographical, geological, and geographical factors which limit septic system installation and expansion. Additionally, septic systems present two water quality challenges: first, they are not designed to remove nitrogen, and therefore are a regular source of nitrogen leaching to ground and surface waters. Second, septic systems can fail, releasing pathogens and additional nutrients into ground and surface waters.

While the general assumption of our wastewater infrastructure is that it is functioning properly, septic tanks and their leach fields are invisible to us, and so residents may not be aware of performance issues, or maintenance and renovation needs.

Village density challenges

Most of Vermont's villages were built before modern wastewater management was standardized. Villages were often built in locations with challenging site conditions, such as on steep slopes, near wetlands, or in flood zones. Adding to those challenges, Vermont soils tend to be thin, with shallow bedrock layers and high groundwater tables. All of these factors can be problems in siting conventional septic systems. In Windham County specifically, slope, seasonal high groundwater table, and soil permeability are some of the primary limitations to septic system development (Sheehan, 1986).

In addition to these geophysical constraints, most villages rely on individual drilled wells, shallow dug wells, or springs for drinking water, all of which require setback distances from septic systems. Furthermore, historic village buildings and homes are often situated on small lots. For all of these reasons, many villages have limited available space to add new septic systems or expand existing ones. This constrains new construction, in-fill development, and expansion or new uses for existing buildings.

In 2007, Vermont updated and standardized septic regulations across the state and grandfathered in all existing on-site wastewater systems (VT ANR, 2007). However, construction of new systems, and most changes to these existing systems, must meet current standards (VT ANR, 2019). Creative wastewater solutions are therefore needed to enable village growth in Vermont.

Nutrient pollution from septic systems

Conventional septic systems can be effective at infiltrating wastewater and removing pathogens, but they are not intended to significantly remove nutrients from wastewater. Even when operating as designed, septic systems are a regular source of nitrogen leaching into groundwater. Depending on soil conditions, anywhere from 15-80% of nitrogen entering the system is released in the form of nitrate (Andersen 2006). New, advanced treatment systems include additional components designed to reduce nitrogen leaching, but these systems often present a financial barrier to adoption because of higher costs of engineering, equipment, and installation. Furthermore, these advanced treatment systems are novel and may not yet work reliably. In Rhode Island, one study found that 25-30% of advanced systems did not meet the nitrogen removal targets they were intended to reach (Lancellotti et al. cited in Mihaly, 2017). Nitrogen leaching from a septic drain field contaminates groundwater, which can affect public health and also contributes to downstream nutrient pollution in surface waters.

Nitrogen and phosphorus are the primary causes of nutrient pollution in surface waters like ponds, lakes, rivers, bays, and estuaries. Excess phosphorus is of greater environmental concern in freshwater systems, whereas excess nitrogen is of greater concern in marine waters. For this reason, most water quality improvement efforts in Vermont are focused on phosphorus, rather than nitrogen. However, Vermont has some obligations to reduce nitrogen loading in the Connecticut River watershed as part of the Total Maximum Daily Load (TMDL) limits for nitrogen in the Long Island Sound under the federal Clean Water Act. The current implementation plan for the

Connecticut River TMDL does not include septic systems. However, because septic systems comprise a large fraction of wastewater treatment in Vermont, it is possible that they could be included in future plans to meet nitrogen reduction goals.

Septic systems also release phosphorus. However, phosphorus is much less mobile than nitrogen and rarely travels far from the drainage field, especially in non-calcareous soils (US EPA, 2013; NESC, 2013). For this reason, properly sited and functioning septic systems in Vermont are not usually considered a source of phosphorus to ground and surface waters. Several analyses have found that septic systems in Vermont do not contribute significant amounts of phosphorus to freshwater lakes and ponds (VT DEC, 2017). In fact, standard septic systems are far better at removing phosphorus than municipal wastewater treatment systems with phosphorus removal technology (Ibid). However, phosphorus may be more likely to reach surface waters in septic systems that experience failure (NESC, 2013).

Septic system failures

If not properly designed, installed, and maintained, septic systems can fail to work as intended. When septic systems fail, untreated sewage can back up into buildings or effluent can pond on the ground surface, causing odor nuisance and risking direct human exposure. Septic failure can also be invisible, releasing higher than normal pathogen counts and additional nutrients to groundwater, and to surface waters via groundwater. Septic system failure may be caused by any of the following (Lindbo et al, 2014):

- Overloading the system with too much wastewater
- Inadequate or no maintenance (such as regular septage removal)
- Poor design or installation
- Physical damage from driving, building, or paving above the system
- Tree or plant roots clogging the drain pipes
- Soil saturation from stormwater runoff or increased precipitation
- Rising water tables
- Deterioration of materials; aging

While septic systems may be classified as either functioning or failing, septic system failure can be gradual, and septic systems fall along a spectrum of better or worse performance. Septic systems may be more or less effective at removing nutrients and pathogens depending on a variety of factors, including the system age, maintenance, and specific site conditions (Adegoke and Stenström, 2019).

Impacts of Climate Change on Septic Systems

Climate change has significant implications for septic systems in Vermont. Across the region, increased and more extreme precipitation may result in more frequent septic system failure, due to rising groundwater tables, increased soil saturation, and erosion (Mihaly, 2018). Climate change may also bring population growth to Vermont from more heavily impacted coastal areas, increasing both demand and contamination risks for groundwater supplies.

Conventional septic systems in Vermont require a minimum separation distance from the bottom of the drainfield to the seasonal high water table in order to adequately treat wastewater (Mihaly, 2018, VT DEC 2019, § 1-903). Increased precipitation from climate change may cause the groundwater table to rise, reducing the depth of the unsaturated zone (Mihaly, 2018). With less unsaturated soil volume for septic effluent to percolate through, more nutrients and pathogens could enter the groundwater (Ibid). Additionally, increased soil saturation could reduce percolation rates, risking backups into buildings or effluent ponding on the ground surface (Ibid).

Climate change has already increased both the total amount of precipitation and the severity of individual events, and these trends are expected to increase. “Since 1965, annual precipitation has increased by 7 inches, and the number of days per year with precipitation of 1 inch or more has nearly doubled” (VT DOH, 2018). In 2011, Tropical Storm Irene resulted in widespread septic damage in Vermont due to both high groundwater levels and river or stream erosion (Pealer & Dunnington, 2011).

Finally, as sea level rise subjects coastal populations of Northeastern cities to more frequent and severe flooding, Vermont may become a “receiving state” for regional climate migrants (Galford et al., 2014). Executive Director of the Windham Regional Commission Chris Campany (2019) implores Vermont village planners to take this possibility seriously: “As coastal communities in New England explore ‘managed retreat’ in the face of rising sea level, what will that mean for interior New England?” This remains an open question that must be carefully considered in planning for the future of wastewater treatment in Vermont.

Septic systems are thus situated at the intersection of a number of major dynamics that climate change is bringing to Vermont. Because climate change will exacerbate the challenges associated with septic systems, it is imperative to consider alternative wastewater solutions.

Vermont’s high proportion of septic systems is not only a major challenge, but is also an opportunity for innovation. The decentralized nature of the septic system problem lends itself well to the community-scale solution of eco-sanitation.

Eco-Sanitation

Ecological sanitation, commonly referred to as “eco-sanitation”, or “eco-san,” offers one response to addressing the challenges of a changing climate, changing population dynamics, and the shortcomings of conventional wastewater management. It is an approach to sanitation that manages human “waste” through safe methods that reduce pollution, protect human health, and promote the recycling of nutrients and organic matter back to agriculture. Eco-sanitation is used as:

> ***“...an umbrella term to capture a variety of practices for managing organic material, water, and other resources in a manner that sustains their value, protects public health, and avoids negative impacts to social and environmental systems. Rather than disposing of food scraps or human feces and urine, Ecological Sanitation allows for the collection, processing, and beneficial use of these resources in a closed cycle” (Nutrient Networks, 2019).***

Two of the common tools used in eco-sanitation are composting toilets and urine diversion, which may be used separately or together. Both tools reduce or eliminate flushing and keep human waste separate from wastewater, thereby reducing strength and volume of remaining wastewater. The separated urine and/or feces require processing, and can then be used as a fertilizer or soil amendment, reducing the need for conventional fertilizers.

There are many types and configurations of composting and urine diverting fixtures which offer a range of options for the implementation of eco-sanitation. They each have different advantages depending on the application, for example in a retrofit compared to new construction, or a public facility compared to a private residence. Composting or urine diverting fixtures can constitute all or some of the fixtures in a given building, and they can either be combined with conventional systems for treating the remaining wastewater, or utilize alternatives.

Composting Toilets

Composting toilets collect human waste and toilet paper and convert this material into a stable compost. Composting toilet systems include a wide variety of toilet options (dry, urine diverting, foam flush, microflush, or vacuum flush) and composting vessel options (self contained, batch, or large capacity). Systems may combine urine and feces or divert urine to a separate storage tank. Many systems utilize a small fan to maintain aerobic conditions, evaporate excess liquid, and maintain downward air flow from the toilet to exhaust odor. Another commonality is the addition of a bulking material like pine shavings. This material helps maintain compost structure and porosity, absorbs liquid, and serves as a carbon source for beneficial microbes. Composting toilet systems range from very simple container-based systems where the material is processed outside of the commode, to larger systems where the toilet is directly connected to a large processing vessel. Composting toilet systems can significantly reduce the volume, pathogen load, and nutrient content of a building's wastewater stream.

Urine Diversion

Urine diversion is the separation of urine from feces at the toilet, before they mix. This source separation is often achieved using waterless urinals or toilets with a divided bowl, in which the forward part of the bowl drains separately from the rear part. Urine diversion can be coupled with dry composting toilets or with flush toilets. Both flushing and dry divided bowl toilets function best when users sit down to urinate. Therefore, they may be co-installed with urinals for those who prefer to stand.

Urine makes up less than 1% of the volume of wastewater, but contains approximately 80% of the nitrogen (N) and 50% of the phosphorus (P) found in wastewater (Freidler et al., 2013; NESC 2013). Capturing these nutrients by diverting urine before it enters the wastewater stream helps reduce nutrient pollution. These elements are also primary plant nutrients; recycling them reduces the need for synthetic fertilizer. Since the production and distribution of synthetic fertilizer is a significant source of greenhouse gases, urine diverting systems offer a long-term resilient model for human waste management and agricultural practices.

Greywater

Greywater refers to the wastewater from a building that does not come from the toilets. Major sources include sinks, showers, washing machines and dishwashers. Greywater can contain pathogens and nutrients, but typically far less than the "blackwater" from toilets. For this reason it can be processed differently, and may have different regulatory requirements. Currently, 19 states allow various types of alternative greywater treatment or recycling systems (Sharvelle, 2013). Alternative greywater treatment systems can include filtration systems that replace septic tanks, vegetation/wetland systems, and alternative leachfield technologies such as drip irrigation (BC DHE 2020).

PART 2: PROJECT PARTNERS

The Windham Regional Commission (WRC), the Rich Earth Institute (Rich Earth), and Nutrient Networks identified overlapping goals within two seemingly different interests: community planning and eco-sanitation. The idea of the VSPS feasibility study was born from the aforementioned context of community planning and nutrient pollution in Vermont, and in the Windham region in particular.

Windham Regional Commission

The WRC is a regional planning commission that serves 27 municipalities in Windham, Windsor, and Bennington Counties of southeastern Vermont. Because Vermont lacks county-level government, regional commissions such as WRC work cooperatively with municipalities to address regional issues (such as natural resource planning, community development, land use planning, and village vitality).

The Windham Regional Plan (2014) finds that changing land use and population patterns are a challenge to meeting regional development goals. Growth has not been well directed towards the areas with adequate infrastructure to support larger population sizes. In characterizing this development trend, the Plan identifies faulty or lacking wastewater infrastructure as a major barrier:

> ***"Many of the region's villages have very limited infrastructure to support future growth, with most lacking adequate water supplies and septic disposal options...Failed septic systems can harm the quality of life and threaten public health and environmental quality. In many such cases, septic system failures are not easily remedied due to the close proximity of other existing on-site septic and water systems or to poor soils."***

In this context, this pilot project study aligns with the Windham Regional Plan's specific policies to:

> ***"Plan for and develop public infrastructure, including water and sewer systems, that promotes and enables greater densities in development centers, including regional centers, villages, resort centers, commercial/industrial sites, and growth areas as identified by town plans.***
>
> ***Support environmentally sound and affordable wastewater treatment, including research regarding the viability of alternative on-site management systems such as composting toilets and gray water recycling.***
>
> ***Educate town representatives and the public about the importance of adequately investing in the maintenance of existing public wastewater infrastructure and, where appropriate, the construction of new systems to protect public health.***
>
> ***Support programs to assist with the replacement of failed on-site sewage disposal systems."***

To address land use patterns and wastewater infrastructure needs, eco-sanitation provides a flexible solution that reframes the land use problem as an opportunity for both improving water quality and reclaiming nutrients for sustainable agriculture.

Rich Earth Institute

The Rich Earth Institute is a nonprofit research and demonstration organization based in Brattleboro and serving Windham County residents in urine diversion and nutrient recovery work. Funded by the EPA, USDA, Water Environment and Reuse Foundation, National Fish and Wildlife Foundation, and the National Science Foundation, Rich Earth conducts scientific research that supports its vision of a "world with clean water and fertile soil achieved by reclaiming the nutrients from our bodies as elements in a life sustaining cycle."

Rich Earth's Urine Nutrient Reclamation Project (UNRP) is a community-scale effort with over 150 people donating urine for research, and four participating farms applying urine to their hay fields. With a 10-year permit from the Vermont Agency of Natural Resources Residuals Management Program, Rich Earth pasteurizes the urine to create a Class A "Exceptional Quality" agricultural amendment.

Nutrient Networks

Nutrient Networks is a 501(c)(3) nonprofit organization established to advance and implement the practice of ecological sanitation and sustainable resource management. Based in West Wareham, MA, Nutrient Networks provides education, planning, and implementation of eco-sanitation throughout New England and beyond. Services range from site evaluation and option assessments to system design and planning, as well as installation, construction integration, and operation and maintenance training. These services, in addition to educational workshops and trainings, help promote safe and effective composting and water management techniques that divert valuable nutrients out of the waste stream, reduce pollution of land and water, and work towards closing the food-nutrient cycle.

Nutrient Networks provides in person site visits to discuss and identify what ecological sanitation systems meet the technical and social needs of a given site and situation, including residential retrofits, residential new construction, public facilities, and green building projects. They also have a strategic partnership with the Rich Earth Institute and collaborate on regulatory development for emerging technologies, and work together to install and pilot innovative urine diversion systems.

Community Partners

In January 2018, the WRC and Rich Earth developed a Call for Letters of Interest (LOI), recruiting communities to submit a letter to be considered for this VSPS feasibility study. The selection process was designed to be competitive, since there were many benefits to being the village that would be part of the Pilot Study.

Benefits for the town and village:

- Village center planning related to wastewater systems.
- Understanding of wastewater management issues confronting home and business owners.
- First steps towards the development of a larger wastewater feasibility study, if needed.

Benefits for participating residents:

- Free eco-sanitation consultation (identifying viable alternatives to conventional wastewater management).
- Access to professional and scientific resources related to wastewater management.
- Consultation on the potential for reduction of homeowner maintenance costs.
- Ability to participate in research about wastewater systems on a neighborhood scale.
- Pioneering a potentially revolutionary human waste management practice.

By the end of February 2018, the VSPS partners received two very strong letters from the West Dummerston and Westminster West villages, located in the Town of Dummerston and the Town of Westminster, respectively. While the original intent was to only involve one Windham region village as a partner, the WRC and Rich Earth agreed that including both would ultimately make the study stronger. Since the VSPS examines the intersection of community development, landscape health, and eco-sanitation, incorporating two different communities into the study was beneficial.

Village of Westminster West

Comprised of the West parish of the Town of Westminster, the village of Westminster West consists of over thirty households and public buildings nestled between north-south ridges at the headwaters of the East Putney Brook, a tributary of the Connecticut River. Much of the northeastern area is covered with deep, moderately sloping, medium textured soils well suited for pastureland or woodland uses.

Westminster West includes a variety of ecological landscape features (i.e. marshes, forests, fields), including generations of beaver activity which have left a series of beaver meadows and wetlands. Many of the houses in the village lie next to the East Putney Brook; others are along one of the half a dozen smaller streams which flow into the main brook within the village limits.

Aerial view of the Village of Westminster West

Local Planning

The following are Westminster Town Plan Goals (as outlined in the 2015 Westminster Town Plan), that relate to the community and planning issues addressed in this VSPS study:

"To plan development so as to maintain the historic pattern of compact village centers separated by rural countryside, working toward an ongoing and respectful relationship among the four villages in our Town while at the same time honoring the uniqueness of each."

"To recognize the critical importance of preserving our natural resources and to implement specific measures to guarantee for future generations: clean surface and ground waters, monitored fragile areas, sensitivity to scenic corridors and perpetual protection of our extensive wildlife, our forest and plant life, our soils, topography, and mineral deposits. To identify, protect and preserve educational, scientific, historic and cultural features that can include structures, sites, or districts and archeologically sensitive areas."

"To maintain and improve the quality of air, water, wildlife and land resources."

"To encourage the efficient use of energy, the development of renewable energy resources, and the recycling, reduction and reuse of waste."

"To plan for, finance and provide an efficient system of public facilities and services to meet future needs so as to assure and maintain a healthful environment for our people; and to address any changing social needs of the community with clearly defined information available to all and resultant decisions for changes in our Town Plan and/or ordinances, keeping the individual's needs in mind but favorable to the citizenry as a whole."

This indicates a municipal commitment to sound development practices, and to the appropriate community development that is important both within these smaller communities, and regionally.

The 2015 Town Plan further identifies the importance of these septic considerations, stating:

"Problems exist in the Village of Westminster and Westminster West due to relatively high densities, growth of the Villages and services normally provided by a village are severely limited because of the difficulty of developing good water supplies and properly disposing of waste water."

To address these challenges, the Town Plan outlines the following Policies and Recommendations related to sewage disposal.

"Sewage Disposal Policies:

1. To encourage environmentally sound and affordable waste water treatment.
2. Sewage disposal systems shall be designed and constructed in consultation with a qualified state licensed professional engineer or technician in accordance with applicable State and local regulations."

"Sewage Disposal Recommendations:

1. The Town will implement policies to manage water consumption in order to lengthen the life and efficiency of wastewater treatment facilities. (Planning Commission)
2. The Town will encourage the use of alternative on-site disposal systems such as composting toilets and grey water recycling where feasible and appropriate. (Zoning Administrator, Planning Commissionand Development Review Board)
3. The Town will support installation of community wastewater treatment facilities wherever feasible and cost effective, such as villages, clustered housing developments, and other similar sites. (Planning Commission and Development Review Board)

4. The Town will encourage homeowners who have out-of-date sewage disposal systems and leach fields to upgrade their systems. (Health Officer)
5. The Town will encourage the State to find more effective and less expensive ways to handle sewage, especially for private homes. (Planning Commission)
6. The Town shall explore the feasibility of and development plan for a municipal sewage disposal system that would serve a commercial area in the vicinity of Exit 5 off Interstate 91 and the Town Garage. (Planning Commission)"

Landscape Context: Soil Types, Wetlands, and Flood Zones

The 2015 Westminster Town Plan characterizes its municipalities' soil as follows:

> ***"The soils of the Connecticut and Saxtons River valleys are deep, medium textured, nearly level alluvial or outwash soils. They are generally free of stones and in places are poorly drained. These areas are well suited to dairy farm and cropland uses. Some locations provide good sources of sand and gravel. Excess wetness may interfere with sewage disposal systems.***
>
> ***Much of the northeastern quarter of the Town and the valley south of Westminster West Village is covered with deep moderately sloping medium textured soils with numerous surface stones except where cleared. The soils are sometimes acidic and occasionally influenced by limestone. These areas are well suited to pasture cropland, apple orchard, or woodland uses. A compact subsurface layer may be present which interferes with sewage effluent."***

Soils and wetlands maps of Westminster West show that while there is a good deal of soil type variation in the Village (typical of these post-glacial landscapes), wetlands and hydric soil type are a significant and important feature in this area. Westminster West was settled in this relatively flat area high up in the headwaters of this sub-basin. As noted in the Town Plan, these areas can be potentially problematic to the appropriate function of soil-based sewage disposal systems.

Because East Putney Brook bisects the Village, many of the buildings and their septic systems are within the 100-year flood zone, including many of the participants in this project.

Maps of the soil types, wetlands, flood zones, and nitrate leaching risk can be found in the "APPENDIX" on page 35.

Village of West Dummerston

West Dummerston is a small village located within the Town of Dummerston. Situated on a relatively steep slope on one side of the West River, West Dummerston consists of approximately 35 buildings including single-family homes, a post office, historic church, community center, library, and fire station.

The Town of Dummerston does not have any municipal water or wastewater treatment systems. Of the various villages that are located in Dummerston, West Dummerston has one of the densest concentrations of residences. During one of the homeowner site visits, historical anecdotes were shared that included conflict over shared septic systems, financial constraints to upgrading systems, and concern over drinking water quality impacted by septic systems.

In West Dummerston village, wastewater infrastructure capacity has functionally reached its maximum. The village is challenged by an inability to install new septic systems or expand existing leach fields, primarily due to small lot sizes:

"Water supplies in areas of dense development are especially vulnerable to contamination due to the cumulative effects of building on small lots with septic systems and drinking water wells in close proximity to one another, many of which were designed prior to the establishment of State-level standards. Siting systems to meet the state regulations is a particular challenge in West Dummerston Village where small lots make it difficult to meet isolation zones" (Dummerston Town Plan, 2018).

With the spatial requirements of both the septic systems and drinking water wells, there is not enough available space or system capacity within the village for new development or increased density. As a result, all potential growth has been halted until wastewater solutions can be identified. During two of the homeowner site visits, the issue of a vacant condemned house within the village was discussed. Both homeowners identified onsite wastewater constraints as a barrier to renovation and sale of the property.

Aerial view of the Village of West Dummerston

Local Planning

The Dummerston Town Plan (2018) identifies two action steps to address the town's Policy 1.4 to "protect the water supplies in Dummerston so that they remain clean and potable." These actions are to "support collaborative wastewater planning efforts" and to "explore funding for a wastewater capacity study in West Dummerston Village."

In addition to this specific wastewater goal, this VSPS addresses a number of other goals outlined in the Dummerston Town Plan (2018). Of particular concern is the goal to *"promote intensive land uses and development only in areas where adequate public services and facilities are available."* Wastewater infrastructural challenges are currently the primary obstacle to this goal. Additionally, the Town Plan identifies that the primary housing goal is to *"create flexibility and diversity in Dummerston's housing stock."* Current housing in Dummerston is "predominantly owner-occupied, single family detached units." As a result there is a need to expand affordable housing offerings through in-fill development of small single-family homes, small multi-family units, and rehabilitation of existing buildings. However, the plan identifies that a lack of access to public water and wastewater services presents a barrier to achieving these housing goals.

The participatory process of the VSPS supports the town's goal to *"engage townspeople in protecting natural resources."* By becoming early adopters of eco-sanitation technology, townspeople would be able to engage in protecting local water bodies through the daily practice of urine diversion and/or composting toilets. The installations proposed in this study would provide individuals with the opportunity to participate in a system that prevents downstream pollution as a part of their everyday lives. Implementing these systems would thus also support Dummerston's goal to *"protect surface and ground water quality and quantity for drinking and other domestic uses, for fish and wildlife habitat, and for recreational use."*

Landscape Context: Soil Types & Flood Zones

Most of the buildings in West Dummerston are situated on Windsor Loamy Fine Sand, with 2 to 8 percent slopes. Most of the land area with this soil type has already been developed. Surrounding this area, steep slopes from Black Mountain and shallow, unstable soils limit geographical expansion. These soils are either impermeable or are subject to over-saturation or erosion.

Although the Village is situated alongside the West River, it is outside the river's 100-year flood zone.

Maps of the soil types, wetlands, flood zones, and nitrate leaching risk can be found in the "APPENDIX" on page 35.

PART 3: METHODS & PROCESS

Community Participation & Visioning

Because this feasibility study is at the intersection of land use planning, eco-sanitation implementation, and community development, public outreach and community participation were an important part of the project. To emphasize this point from the outset, the project partners designed a project timeline with regular community meetings to help develop a neighborhood cohort among the participants in the VSPS. The WRC and Rich Earth asked that the prospective towns identify a local point person to facilitate conversations and communications between the organizational partners and the enrolled participants.

Westminster West Response

In Westminster West, the community point person submitted a strong Letter of Interest that identified fourteen households that were interested in participating, along with three public buildings (the Westminster West School, the Westminster West Congregational Church, and the Westminster West Library). The narrative provided in their LOI highlighted and emphasized the general ethos of environmental stewardship that existed within the community which would be a strong asset to the project. They wrote:

> ***"This tight knit community has widespread interest and concern about the health of the local environment and the world beyond it. The founders of the Windmill Hill Pinnacle Association live in this village and for over a year the Living Earth Action Group has held weekly meetings at the Westminster West Congregational Church to discuss local, national, and global environmental challenges. In addition to the members of the Living Earth group, and many of their neighbors, the church, library, and village public school have all elected to participate in this study…***
>
> ***Researchers will find an engaged population that is open to (and in many cases enthusiastic about) thinking outside the box on the matter of domestic waste disposal and simultaneously reducing human impact on the natural aquatic environment."***

West Dummerston Response

In West Dummerston, there were eleven households identified within the community that were interested in enrolling as participants in the VSPS. The narrative in the LOI emphasized the limitations of the conventional septic systems and their potential shortcomings in their village, and also acknowledged potential environmental impacts:

> ***"Currently, two homes pump wastewater uphill to the leach field sites because of space restrictions. A conventional municipal wastewater treatment solution would be prohibitively expensive because of the small number of households in the village.***

The participating homeowners are enthusiastic about this pilot study, because they are aware that, although some conventional septic systems have been successfully replaced since State regulations took effect, it is likely that eventually some households will find it impossible to replace and meet the new State requirements. Residents appreciate the neighborhood feel of the village, but understand that the conventional systems packed this close together could be affecting groundwater quality as well as nutrient levels in the West River. This group is interested in alternative solutions for wastewater that will help ensure the Village can continue to thrive."

In-home Site Visits

Site Visit Methodology

Site visits were conducted for each building. These visits provided an opportunity for project partners and participants to work together to identify feasible systems, considering technical specifications, sanitation needs, and personal preferences. Each visit also served as a one-on-one educational opportunity to present how systems work and the multiple benefits they offer. Together we evaluated the merits of various technologies based on installation requirements, technical features, maintenance requirements, cost, projected use, and regulatory and permitting considerations.

For each site, Nutrient Networks collected information about building use, available space, structural layout, and existing infrastructure in order to identify how different systems could be retrofitted into existing spaces or incorporated into future construction. The management and beneficial use of compost and/or diverted urine was also discussed, including on-site options as well as potential community scale recycling. Written site visit reports summarizing observations and recommendations were provided to each participant.

Site visits lasted between one and three hours, depending on the number of bathrooms, complexity of building configuration, and the number and complexity of questions asked by participants. Site visits typically began with participants and a Nutrient Networks planner sitting down and walking through a prepared slideshow on a laptop computer. The slides covered introductory information about nutrient pollution, conventional septic systems, and photos and technical details of various types of composting and urine diverting fixtures and systems. Participants were asked about their existing septic system, including information on age, type, current or past issues, and pump-out frequency.

Existing bathrooms were then assessed to determine the technical feasibility of retrofitting various fixtures. If basement or crawl space was accessible, Nutrient Networks also evaluated those spaces for retrofit considerations. Once the bathrooms and other areas of homes and buildings were toured, Nutrient Networks discussed feasible options, installation processes, maintenance requirements, and approximate costs with participants.

Ecological Sanitation Options

Participants were introduced to a wide range of composting toilet technologies. These included smaller container based systems that require users to swap out bins as they get full, to larger composting units where the composting unit is directly connected to the toilet and requires less handling. The majority of the composting toilet systems discussed were urine diverting, or had urine diverting options. The project also evaluated urine-diverting flush toilets and urinals. Technologies and products covered during the educational component of the site visit included the following:

Composting systems (all human waste)

- Loveable Loo
- Separett (multiple models)
- Envirolet (multiple models)
- SunMar (multiple models)
- Full Circle
- Clivus Multrum (foam flush, dry toilet, vacuum flush, urine-diverting options)
- Advanced Composting Systems / Phoenix (foam flush, dry toilet, vacuum flush, urine-diverting options)

Urine-diverting fixtures (urine only)

- Wostman EcoFlush toilet
- Dubbletten toilet
- Sloan waterless urinal
- Kohler waterless urinal

Alternative sanitation options were discussed in the context of the existing septic system. If there were recent or known issues with the septic system, an inspection was recommended in order to inform decisions about installing alternatives. For those that had known or potential issues with their current systems, alternative greywater systems were discussed, including greywater filters, vegetated systems, and alternative leachfield technologies. For those with relatively new septic systems in good working condition, we did not focus our discussions on alternative greywater management.

Observations & Results: Westminster West

A total of 16 site visits were conducted in Westminster West. These included 13 homes, one church, one library, and one auxiliary school building. All 16 visits identified at least one feasible option for retrofitting at least one bathroom. Many visits yielded multiple fixture and systems options to be taken under consideration. These options are presented on the following page.

Trends in technical observations

- 6 out of 16 participants stated suspected performance issues or concerns with the existing septic system, including slow draining fixtures, possible leach field failure, pump failure, infiltrating stormwater, aging system, and overcapacity
- 3 out of 16 participants did not know the location or age of their leach field or leaching pit
- 6 out of 16 properties were noted for septic proximity to a wetland
- 9 out of 16 properties were noted for flooding potential or past experience with flooding
- 8 out of 16 participants had upgraded or modified their septic system since taking ownership
- 8 out of 16 homes had accessible basements or crawl spaces directly below the bathroom; 8 out of 16 had limited access or limited clearances in crawl space or basement
- Limited access to plumbing
- The Wostman EcoFlush toilet stood out as the most technically feasible as well as most desirable system among participants

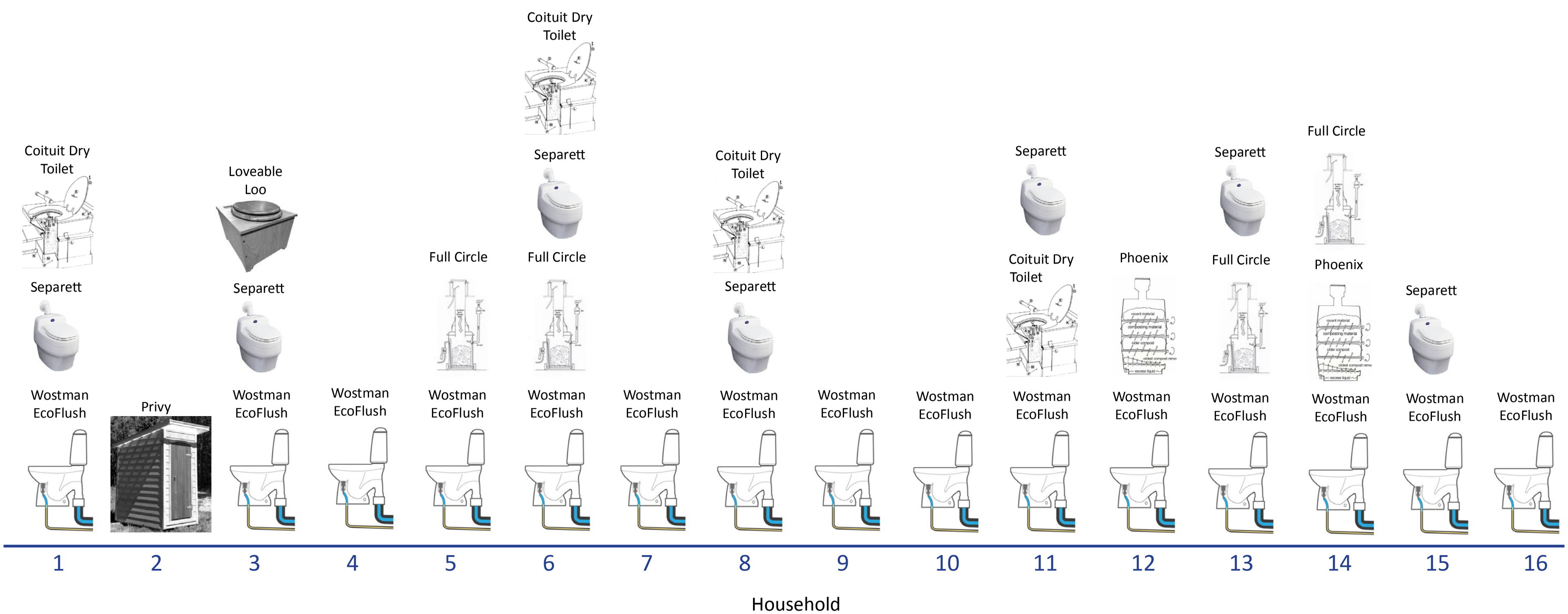
Trends in participant response

- Majority of participants were open minded and stated they would be willing to adopt an eco-toilet
- Participants expressed motivation partly driven by the ability to take individual responsibility to improve environmental health
- Participants were interested in learning more about how water and nutrients move through the village; general curiosity about their watershed
- Nearly all participants had not previously lived with any kind of alternative toilet, and had limited experience with using them elsewhere
- 8 out of 16 participants discussed potential renovation or construction plans, including guest, rental, studio, or other built space

Stated concerns of adopting an alternative system

- Required maintenance; particularly as it relates to ‘aging in place’
- System cost
- Potential impact on home value or complications if selling property in the future

Feasible eco-sanitation options at each site in Westminster West



Observations & Results: West Dummerston

A total of nine site visits were conducted in West Dummerston. These were all residential applications. Eight out of the nine visits identified at least one feasible option for retrofitting at least one bathroom, indicated in the figure on the following page. The one visit that did not yield a recommendation for retrofit was a newly constructed high performance home. As was the case in Westminster West, the Wostman EcoFlush stood out as the most technically feasible and desirable fixture option discussed.

Trends in technical observations

- 3 out of 9 participants stated suspected performance issues or concerns with the existing septic system, including possible leach field failure, aging/deteriorating system
- 1 out of 9 participants did not know the location, age, or type of leaching system
- 5 out of 9 participants had upgraded or modified their septic system since taking ownership
- 6 out of 9 homes had accessible basements or crawl spaces; 3 out of 9 had limited access or non-existent crawl spaces or basements
- 4 out of 9 homes had relatively accessible plumbing; 5 out of 9 homes presented limited or challenging plumbing accessibility
- most septic systems had spatial constraints, either when installed or in consideration of future upgrades
- many properties would have difficulty replacing septic systems that would comply with current rules
- two participants had relatively new septic systems, one of which included advanced treatment of effluent
- most properties did not have significant suitable landscape appropriate for on-site urine application, and would require Rich Earth to pump out and transport urine fertilizer for use elsewhere
- The Wostman EcoFlush toilet stood out as the most technically feasible as well as most desirable system among participants

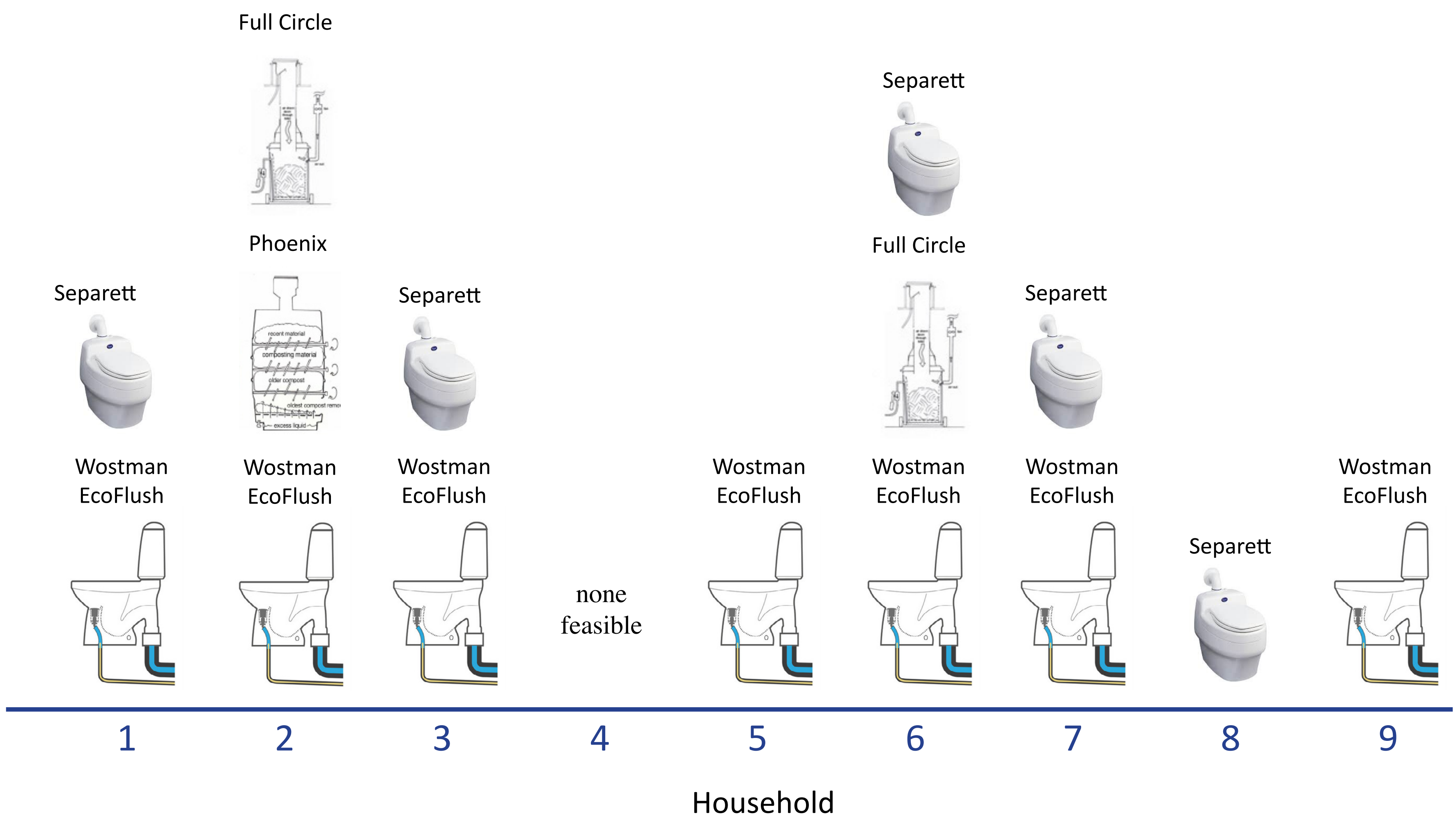
Trends in participant response

- Concern over drinking water impacts from septic systems
- Majority of participants were open minded and stated they would be willing to adopt an eco-toilet
- Participants were motivated by doing something with a dual benefit of solving the wastewater issue facing the town as well as supporting sustainable agriculture
- Participants were willing to take on reasonable renovations to retrofit eco-toilets

Stated concerns of adopting an alternative system

- System cost
- Required maintenance
- Potential impact on home value or complications if selling property in the future
- Ease of use, with family and guests in mind

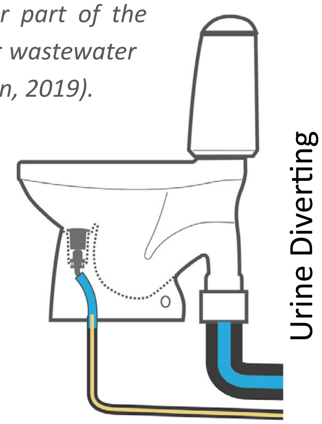
Feasible eco-sanitation options at each site in West Dummerston



Technically Feasible & Socially Acceptable Options

Systems were discussed and evaluated with consideration for both technical feasibility as well as social acceptability for a given site. Results included systems that met both of those criteria, and one outlier where no options were identified. Systems that met only one of the two criteria were not included. For example, while many participants would have liked to install a large capacity composting toilet, this was often not possible because of the lack of basement space. Smaller composting systems were found to be technically feasible at several sites, but the maintenance task of transferring solids bins was undesirable. In both towns, the Wostman EcoFlush, a urine diverting flush toilet, was identified as both a technically feasible and desirable fixture in the most number of sites compared to other systems.

The Wostman EcoFlush toilet uses a divided bowl to divert urine for resource recovery and to conserve water. The front part of the bowl is plumbed separately to a urine collection tank, while the rear part of the bowl is plumbed to the regular wastewater system (Image Source:Wostman, 2019).



Technical feasibility of the Wostman is attributed to a few unique features. The primary advantage is that it uses existing septic or sewer connections for flushing feces and toilet paper, and therefore does not require space for a solids composting system. The Wostman can divert urine either by gravity to a storage tank below, or by means of an automatic pump to a storage tank located on the same level as the toilet. Because the fixture has a similar configuration as a conventional flush toilet, it typically requires less modification to install compared to composting systems.

There are also specific characteristics of the Wostman that make it more socially acceptable. Made from porcelain, it appears very similar to conventional toilets. This familiarity alone may make it more appealing. The Wostman's lower maintenance needs compared to other systems was also an advantage, especially for those concerned about the physical maintenance needs of dry composting systems. When compared to other options, the Wostman presents a low-maintenance system that still allows for nutrient recovery, viewed by most as a dual benefit.

One other consideration for evaluating feasibility of various options is system cost. The average cost estimate for installing a Wostman and urine storage tank was $2,561, plus estimated maintenance and urine pumpout fees of $125-175 annually. These costs do not include permitting fees or any additional costs incurred in meeting permit requirements, which could add substantially to the cost. Cost estimates for smaller composting systems were similar to the Wostman, while estimates for larger composting systems were greater.

In cases where both the Wostman and a large composting system were identified as possibilities, participants tended to prefer the Wostman because of its lower cost. However, for sites where an older septic system is more likely to need replacing, installing a dry composting toilet system may have financial advantages. Similarly, dry composting systems may be advantageous for future construction and renovations, as they would allow reduction in the size of the septic system under current Vermont regulations.

Well Water Testing

Well water tests are an important source of information about the status of village water systems. As part of the VSPS, the Vermont Department of Health offered free well water tests to all project participants. The tests were part of the Vermont Village Wastewater Solutions Initiative, which assists villages without community wastewater systems.

Homeowners who participated received individual test results, providing information on the quality of their drinking water, and indirectly, about their septic system. To protect privacy, the VSPS partners did not receive individual test results, only aggregated results from each community. These collective data were used to help understand whether there were problems with on-site waste management in either village.

All Vermont certified drinking water laboratories, including the Health Department Laboratory, are required to submit drinking water test results to the Health Department, where they become public information. As the WRC and Rich Earth contacted homeowners in the two villages about this opportunity, they were careful to be clear about this requirement and any implications it could have for the homeowner. Results from well tests help the Vermont Health Department get a better understanding of the quality of well water throughout the State, especially in compact village centers where septic systems may be close to drinking water wells and affect water quality. The Health Department aggregates water quality test results by town to create maps and tables for drinking water contaminants. The aggregated data are published on the Environmental Public Health Tracking portal at: www.healthvermont.gov/tracking.

Contaminant Testing & Process

The Vermont Health Department recommended three test kits for the VSPS:

1. Bacteria (total coliform and E. coli)
2. Gross alpha radiation
3. Inorganic chemicals (arsenic, chloride, copper, fluoride, hardness, iron, lead, manganese, nitrate, nitrite, sodium and uranium)

Homeowner wells were tested by two representatives at RCAP Solutions, Inc. and the Vermont Department of Health. Testing was scheduled for two days in the winter of 2019, and interested homeowners were instructed that they need not be present for the collection of the samples inside their homes (the testing team only needed access to the tap water).

Westminster West Results Summary

Total Coliform and E. coli

Of the 10 bacteriological samples taken in Westminster West, 3 came back positive for total coliform. One of those wells is a shallow dug well, while the other two are drilled wells. None of the tested wells were positive for E. coli.

Gross Alpha Radiation

Of the 10 tap water samples taken in Westminster West, 8 of them were non-detect (<1.5 pCi/L) for gross alpha activity. The remaining two samples were 2.82 pCi/L and 5.09 pCi/L. The adjusted gross alpha for these samples are both below the drinking water limits (maximum contaminant level, or MCL) for adjusted gross alpha (AGA) of 15 pCi/L. For the higher sample, which had a uranium result of 2ug/L, AGA = 3.75 pCi/L. Since uranium levels were also low, no more testing or treatment is necessary until the next recommended testing interval (5 years).

Inorganic Chemicals

No problems were found in the inorganic compound test of well water samples. Of the three wells testing positive for total coliform, none had issues with nitrate or chloride (commonly associated with failing septic systems). Another well had measurable nitrate levels (4.5 mg/L), but well within the limit of 10 mg/L. One well had fairly high iron levels (0.26 mg/L), just below the MCL of 0.3 mg/L.

West Dummerston Results Summary

Total Coliform and E.coli

Of the 6 samples taken in West Dummerston (4 wells, 2 springs), none were positive for total coliform or E. coli.

Gross Alpha Radiation

Of the 6 samples taken in West Dummerston, 4 were non-detect (<1.5 pCi/L) for gross alpha activity. Two had gross alpha detected at low levels (1.51 and 1.58 pCi/L), well below the drinking water limits. Since uranium levels were also very low, no more testing or treatment is necessary until the next recommended testing interval (5 years).

Inorganic Chemicals

No major issues were noted for the 6 samples taken in West Dummerston. One of the wells was slightly harder than the others and had slightly higher nitrate and chloride levels, but nothing above recommended drinking water standards.

Water Testing Discussion

All of the water quality tests showed levels of coliform bacteria, gross alpha radiation, and inorganic compounds that were within safe drinking water standards. These well water measurements are therefore not an indicator of septic system failure for the participants or in the villages as a whole. The three Westminster West wells that tested positive for total coliform bacteria had no issues with nitrate or chloride, which are commonly associated with failing septic systems. So, the project partners reasoned that septic system failure may not be the source of bacteria in these wells.

GIS Modeling of Septic Suitability

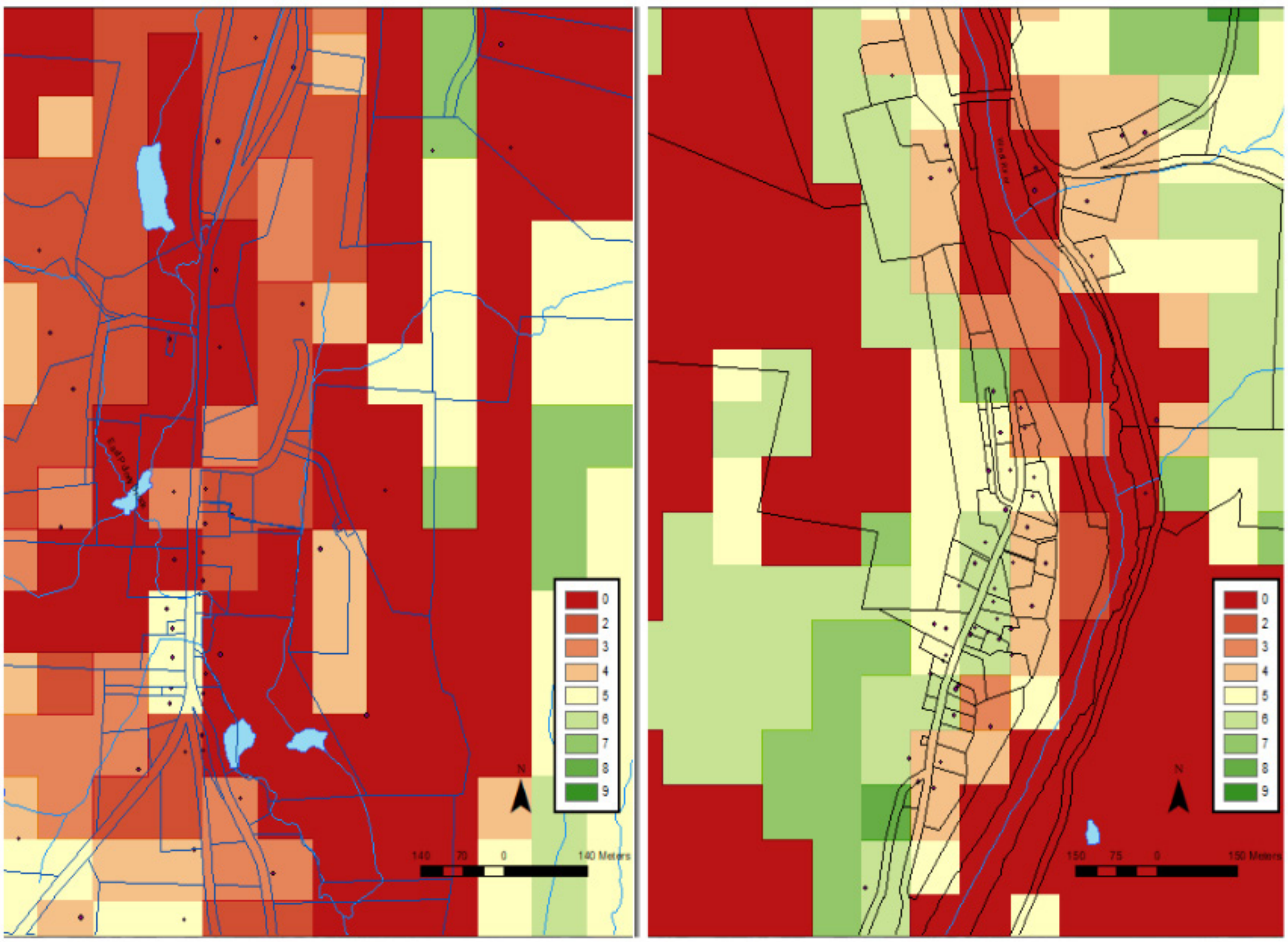
Part of the effort undertaken by the Windham Regional Commission was to conduct a GIS model of septic suitability in both villages. This model combined soil ratings, slope data, hydrography data, infrastructure data, and land use utilization to identify areas where septic systems are likely to be feasible.

The model used the following spatial data and criteria:

- Soil ratings; Soil septic suitability ratings based on Vermont regulations
- Areas that have steep slopes; Maximum allowable slope for a leach-field area
- Areas that are near water bodies (per Vermont regulation, leach fields must be 50 feet from lakes, ponds, and/or streams. For septic, distance must be 25 feet)
- Areas that are close to major roadways and housing developments (per Vermont regulation, leach fields must be 10 feet from roadways and 25 feet from any property line. For septic, distance must be 5 feet from roadways and 10 feet from any property line).
- Areas that demonstrate clustered development defined by Vermont land use data sets

The following maps show the results of this model. Suitability for septic systems is calculated on a scale of 0 to 9. Areas valued at 0 are at the areas of lowest suitability and are displayed as the color red, and areas with a value of 9 are at the areas of highest suitability and displayed in green. Higher values indicate areas that are on less steep slopes of suitable land-use types, have greater than marginally suitable soils, are farther from roadways and housing development, and away from existing water bodies (i.e. lakes, rivers, and streams). The model also identifies unsuitable areas where septic may already be located.

Generally speaking, this model demonstrates that there are few suitable areas for on-site wastewater in these two communities. However, it is important to consider that the model is only a prediction of septic suitability. To determine actual suitability, site-specific test pits and more rigorous septic analysis would need to be conducted. Nonetheless, this model does convey the relative suitability between these two communities: West Dummerston is generally more suitable for septic systems than Westminster West. This is likely due to the presence of hydric soils and wetlands in Westminster West.



Results of septic suitability modeling for the villages of Westminster West (left) and West Dummerston (right). Less suitable areas have a lower score (red); more suitable areas have a higher score (green).

PART 4:
IMPACTS & IMPLICATIONS

In both towns in this study, a urine-diverting flush toilet was the option most commonly identified as both technically feasible and desirable to participants. In this final section we examine how urine diversion with flush toilets could help address village wastewater challenges, and look at next steps needed to install urine-diverting fixtures such as the Wostman EcoFlush in villages in Vermont.

While composting toilets were not practical as retrofits in many of the homes visited, their installation is greatly simplified in new construction. Given the performance benefits of composting toilets over urine-diverting toilets (the capture of all human waste and toilet paper, instead of just urine), and the fact that Vermont regulations already include septic system size reductions relating to composting toilets, these systems should be considered where practical.

Could urine diversion and composting toilets help solve Vermont's village wastewater challenges?

Village density

Many of the village development challenges in Vermont are caused by small lot sizes, high water tables and shallow bedrock, which make it difficult to site conventional septic systems. To solve this problem, eco-sanitation would need to reduce or replace the need for a conventional septic system. Vermont's septic regulations already have a provision relating to composting toilets used in conjunction with septic systems. Buildings that use composting toilets instead of flush toilets are permitted to reduce the size of the leach field by 25%, in recognition of the reduced wastewater volume (VT DHCA, 2008; VT DEC, 2019: § 1-803). While this is helpful, a greater allowance would go further to ease septic siting challenges, and has precedent outside of Vermont. Massachusetts permits up to 50% reduction in leach field size in conjunction with composting toilets, as well as the option to replace the tank with an approved filtration system (MA DEP, 2016: 15.262).

Vermont also allows reductions in both leach field size and depth to groundwater/bedrock for other alternative septic technologies, such as media filters and aerobic treatment systems. This is because in these systems the waste has already been partly treated before it is released into the drainfield.

At present, there are no specific design allowances for septic systems used in conjunction with urine-diverting flush toilets. These toilets reduce both the volume and strength of wastewater flow entering a septic system. Given the precedents for modifying septic system requirements for composting toilets and advanced onsite treatment systems, it is possible that urine diversion could receive similar allowances. Research is needed to quantify how much water is saved by urine-diverting flush toilets. Research is also needed to understand whether diverting urine out of domestic wastewater (leaving the remaining wastewater with lower biological oxygen demand (BOD) and ammonia levels) could affect septic tank and leachfield performance.

Nitrogen pollution from septic systems

Urine contributes approximately 80% of the nitrogen in wastewater. Separating urine at the source is therefore a simple way to remove the majority of nitrogen from wastewater, which in turn reduces nitrogen loading to ground and surface waters. Although nitrogen leaching from septic systems is not currently regulated in Vermont, this may change in the future in order to meet Connecticut River Total Maximum Daily Load (TMDL) requirements for nutrient pollution in the Long Island Sound watershed. We anticipate that urine diversion will be significantly less expensive than other nitrogen-removing septic technologies. It could therefore be an affordable way for septic system owners to reduce nitrogen leaching without replacing their systems.

Septic system failure

At this time, knowledge about the potential for composting or urine-diverting toilets to reduce septic system failures is limited. It is plausible that reducing the ammonia content and BOD of wastewater could improve functioning and extend the service lifetime of a system. For example, if dry composting toilets replace all or most flush fixtures connected to a system, the rate of sludge accumulation in the septic tank could be significantly reduced. This would in turn reduce the needed frequency of pumping. Additionally, because one of the causes of failure is wastewater overload, reducing the volume of wastewater entering the system could help prevent some types of failures. More research is needed to better understand additional effects, both positive and negative, that composting/urine diverting toilets may have on septic system performance.

Implementing urine diversion in Vermont villages

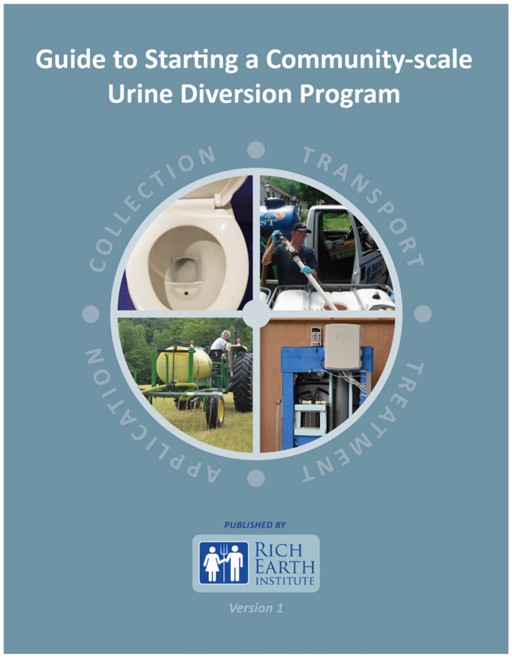
Many of the participants in the VSPS were so enthusiastic about the project that they have decided to move forward with implementing urine diversion. At the time of writing, Rich Earth and Nutrient Networks are preparing to pilot Wostman EcoFlush toilets in at least five residences in Westminster West, along with the Westminster West Public Library. These installations are being funded in part through grants from Patagonia and the Long Island Sound Futures Fund. Future installations will also be offered to residents in West Dummerston.

Each building will be retrofitted with a new urine-diverting toilet connected to a urine storage tank, which may be located either in the basement or outside of the building. Some installations will include a pump to automatically move urine from the toilet to the storage tank. Users will be instructed on proper use and maintenance of the toilets, which includes cleaning as needed with a non-toxic citric acid solution. Annual inspection of pipes and other components is recommended.

Implementing urine diversion on a community scale is beneficial because it concentrates maintenance and collection needs, making these services more efficient and economical. Because of their proximity to Brattleboro, the towns in this study will be able to partner with Rich Earth Institute to pump out urine tanks, process the urine, and distribute the product to local farmers. If urine diversion is implemented in other regions of the state, partnerships with local farmers or gardeners will be needed, along with a plan for treating and transporting the fertilizer.

Urine diversion will reduce nitrate leaching to groundwater by removing the majority of nitrogen from wastewater entering septic systems. Three of the properties in this study had measurable nitrate levels in their water, though they were well within the safety limits. Although not a concern at this time, proactive nitrate removal can help ensure that nitrate does not become a problem in these wells in the future. Due to the close proximity of each town to waterways, reducing nitrate to groundwater will also likely reduce nitrate entering the West River and East Putney Brook. The effect of urine diversion on septic systems is less well understood. Septic system research in conjunction with these installations can help improve our understanding and inform the extent to which urine diversion could aid with Vermont's village density challenges.

Participants who are not installing Wostman toilets as part of this program may still be interested in future composting or urine diverting toilet installations. As with any significant financial decision, changes may happen years down the road, beyond the scope of this project timeline. For some participants it may make more sense to time installations with future home renovations or with septic system replacement. We hope to follow up with all participants in 5-10 years to better understand how the VSPS impacted long-range decision making about eco-sanitation.



Rich Earth's Urine Collection and Treatment Program

Community-scale urine diversion is possible in Windham County villages because of the services that the Rich Earth Institute has developed. Rich Earth currently offers services for urine collection, pasteurization, and field application. In 2019, Rich Earth prevented over 10,000 gallons of urine from entering the waste stream, diverting it for use on four local farms.

Rich Earth supports residential urine collection through a pump-out service. A pumper truck collects urine from home storage units and transports the urine to Rich Earth's processing facility, where it is stored and pasteurized. While urine rarely contains pathogens, this pathogen management strategy is necessary to eliminate the risk of any potential fecal cross-contamination. Finally, the urine is delivered to four local farms, where it is applied with a custom fertilizer applicator. Currently, demand for urine fertilizer in the region is much greater than the available supply.

For communities outside Rich Earth's service area, starting a similar urine collection project may be an option. Rich Earth recently published a Guide to Starting a Community-scale Urine Diversion Program (Atlee et al., 2019), which details the methods, equipment, and lessons learned in creating the first such project in the US. Rich Earth is also developing new technologies that will help simplify the urine treatment and distribution process in other communities. These include small-scale pasteurization, filtration, and concentration equipment to produce a condensed, ready-to-use fertilizer product.

Precedents for Village-Scale Urine Diversion

Rich Earth Institute is one of a handful of programs around the world that are actively developing methods and technologies for all the stages of the urine cycle, from source to fertilizer. In addition to its Brattleboro-based program, which processes urine into fertilizer for use on several local farms, Rich Earth has collaborated with the University of Michigan's Civil and Environmental Engineering Department for long-term testing of a urine-diverting toilet and urinal in a public restroom in a major engineering building.

While Rich Earth operates the first community-scale urine diversion program in the United States, there is a wide range of other pilot studies as well as active urine diversion projects already in operation around the world. There are at least 38 different urine diversion pilot projects or studies in Europe and Australia, ranging from rural communities in Sweden to large buildings in Zurich (Lienert and Larson, 2009; Abeysuriya et al, 2013). Many of these studies emphasize the importance of meaningful community engagement throughout the planning and installation process (Mitchell et al., 2011; Abeysuriya et al, 2013). There have also been significant developments for community-scale urine diversion in China, including one project that has provided over 685,000 urine diverting toilets to rural households (Kvarnström et al., 2006: 13). Additionally, within the US, some eco-villages already employ various community-wide ecological sanitation systems. These projects set the precedent for the implementation of community-scale eco-sanitation systems in Vermont.

Policy & Regulations

In order to integrate nutrient recovery and innovative technologies into our existing wastewater management systems, cooperation is needed between state officials, local select boards, planners, town staff, and septic designers. In addition to cross-sector collaboration, planning must ensure compliance with state and federal regulations, regional plans, and community desires, all while contending with the new challenges of climate change.

Regulation of Urine Diverting and Composting Toilets

Composting toilets are explicitly allowed under current Vermont wastewater regulations, but urine storage tanks are not yet described in the rules. For this reason, the Rich Earth Institute is working with the wastewater office of the Vermont DEC to receive an Innovative/Alternative approval for standardized designs for urine storage tanks, which could create a pathway for permitting such installations throughout the state of Vermont.

The available urine-diverting flush toilets are all from Europe, and they currently lack the certifications required by US plumbing codes. The Rich Earth Institute has received approval from the Vermont Plumbers Examining Board to install a Wostman urine-diverting toilet in a public building on a trial basis.

Plumbing and wastewater regulators faced with applications for the installation of urine-diverting toilets and storage tanks can now also draw from the “Water Efficiency and Sanitation Standard for the Built Environment (WE•Stand)” supplemental building code, published by the International Association of Plumbers and Mechanical Officials (IAPMO) and American National Standards Institute (ANSI). This document “contains the first set of comprehensive codified requirements for the installation, safe use and maintenance of composting and urine diversion toilet fixtures applicable to commercial and residential applications” (IAPMO, 2017). It is an official part of the Uniform Plumbing Code, and because it is an ANSI document it can also be considered by regulators in states such as Vermont that operate under the International Plumbing Code.

One clear way for eco-sanitation to help solve village density and development challenges is for wastewater regulations to allow reductions in leach field size when used in conjunction with composting or urine-diverting toilets. This is already the case for composting toilets; as mentioned above, Vermont allows a 25% reduction in leach field size if all toilets in a building are converted to composting toilets. However, this is lower than the 50% size reduction allowed in Massachusetts. Massachusetts regulations also include an option to use an approved filter in lieu of a septic tank. Increasing Vermont’s allowed leach field reduction would go further to help some property owners site leach fields on small or challenging lots. There is currently no similar provision to adjust leach field size based on the use of urine-diverting toilets, and research is needed to better understand the relationship between urine diversion and septic system performance, and whether a size reduction is warranted.

Finally, state and local governments may want to consider incentives to help villages transition to new systems. Policy options include loans, subsidies, tax credits, or rebates to encourage adoption. For example, the town of Colchester, Vermont addressed their funding gap for improving and maintaining their wastewater systems by establishing “a local, low-interest loan program specifically for decentralized wastewater system repairs and replacements” (Mihaly, 2018).

Regulation of Composted Human Waste as Fertilizer

Composting toilets and composted human waste are regulated under the Vermont Agency of Natural Resources Wastewater System and Potable Water Supply Rules. Current rules do not specify design criteria for the composting system. The rules give two options for ‘disposing’ of composted material; shallow burial onsite in an area that meets the requirements for a septic leach field, which requires a permit, or disposal at a landfill (VT DEC, 2019: § 1-929).

Because so many properties in Vermont have limited areas that are suitable for septic systems, this means that in many cases, landfilling is the only legal option to dispose of the compost from composting toilets. However, Vermont’s Universal Recycling and Compost law (Act 148) discourages the disposal of organic matter in landfills (though it does not prohibit landfilling of sewage sludge and septage) (Kelley and Twohig, 2018: 8). Creating new legal avenues for property owners to safely use their own properly-composed waste on-site would meet the spirit of the statewide composting law, provide a beneficial soil amendment to the property owner, and reduce the costs of operating a composting system. It would not be without precedent; Massachusetts currently allows compost removed from composting toilets to be buried onsite under 6" of soil, after it has been held within the composting toilet or a secondary composter for at least two years (MA DEP, 2005). On-site application in Massachusetts does not require a permit (Ibid).

Regulatory concerns relating to the products from composting toilets might be addressed by setting standards for the design and maintenance of composting toilets. These standards could be based on the WE•Stand supplemental building code discussed above (IAPMO, 2017).

Regulation of Urine as Fertilizer

Vermont regulation of urine-derived fertilizer is primarily concerned with pathogens and heavy metals. Fortunately, urine is naturally very low in both types of contaminants. For this reason, World Health Organization guidelines allow untreated urine to be used as fertilizer, if the urine is collected and used within a single household and 30 days pass between fertilization and consumption of the crops (WHO 2006). When urine is collected or used outside of a single household, further treatment is recommended (Ibid). Pasteurization at 80°C (176°F) for 1.2 minutes is more than sufficient to destroy any pathogens found in urine, as it is an EPA-approved method for sanitizing sewage sludge, which contains far more pathogens than urine. Heavy metals are not a concern with urine, and repeated testing over several years by the Rich Earth Institute has shown that levels of heavy metals in urine are approximately 1000 times below EPA limits.

The Rich Earth Institute is currently permitted to distribute pasteurized urine to farmers and gardeners for use throughout the state of Vermont. The permit is issued through the Residuals Management & Emerging Contaminants Program of the Vermont DEC. This program regulates the agricultural reuse of a variety of residual materials, including wood ashes, paper fibers, and biosolids made from sewage sludge. Rich Earth's permit specifies treatment for pathogen reduction and heavy metal limits similar to class A, or exceptional quality (EQ), biosolids in accordance with both the EPA Part 503 Biosolids Rule and Vermont Solid Waste Rules. However, while the pasteurized, urine-derived product meets the standards for EQ biosolids, it is not classified as a biosolid. This reflects the fact that, while urine requires sanitization before public distribution, it is a substantially different substance from biosolids.

Under current Vermont regulations, in order to permit a small urine pasteurizer mounted on a 4' x 8' utility trailer, the Rich Earth Institute had to follow the same process that is used for permitting sewage sludge composting facilities serving municipal wastewater treatment plants. The application was complex and extensive, with many sections that were not relevant to urine treatment, and required weeks of effort and significant financial expenditure on application fees and public notices. Creation of a modified permitting process specifically for urine treatment would result in the same level of protection of human health and the environment, but be more accessible to other communities wanting to begin diverting and processing urine for beneficial reuse.

Policy recommendations

1. **Regulate source-separated urine as a distinct substance from mixed wastewater and sewage sludge**

   a. **Adopt rules governing urine-diverting toilets, plumbing, and collection tanks**
   Urine and mixed wastewater are currently not differentiated in Vermont regulations, though they are distinct in terms of pathogen levels, dissolved nutrient concentration, flow rates, physical characteristics, and potential for beneficial reuse. Given these differences, developing rules specific to urine would facilitate urine diversion while still protecting human health. Language and principles around plumbing, storage tanks, and venting requirements could be adopted from the IAPMO/ANSI WE•Stand code.

   b. **Create a separate permitting process for using urine as a fertilizer**
   Currently, to sanitize urine and provide it to a farmer, one must obtain the same type of permit as a municipal sewage sludge treatment facility. This permitting process is complex and expensive. Since urine has far fewer contaminants than sewage sludge, and can be treated with a small, mobile pasteurizer, a separate and streamlined permitting process would be appropriate, and would help facilitate urine recycling.

2. **Increase options for on-site use of compost from composting toilets**
   Due to strict permitting requirements, landfilling is the only legal and practical option for many property owners to dispose of the compost from composting toilets. Adopting a rule similar to Massachusetts regulations would facilitate the beneficial reuse of compost from composting toilets.

3. **Allow greater reduction in septic leach field size for buildings with composting toilets**
   Vermont currently allows a 25% reduction in leach field size for buildings with composting toilets, while Massachusetts regulations allow a 50% reduction. Allowing a greater reduction in leach field size in Vermont would help address some of the difficulties with siting septic systems on small or challenging lots.

4. **Additional policy changes as determined by future research**
   Future recommendations might include changes in septic requirements when used in conjunction with urine-diverting flush toilets, depending on research results.

Future Research Needs

1. **Identify impacts of urine diversion on septic performance**
   Urine diversion reduces the ammonia and BOD of wastewater, and also reduces flow volume. Research is needed to understand how this may impact septic tank size and leach field requirements, as well as system performance/longevity.

2. **Evaluate performance of urine-diverting flush toilets and user experience**
   As a continuation of this VSPS, follow-up visits and feedback from participants are important for identifying both successes and challenges with urine diversion in the Vermont village context. For these pilot installations, we are planning a minimum of one annual inspection of each installed toilet and plumbing system to check in with participants and troubleshoot any issues that may arise. With additional research funding, we would like to conduct formal interviews and/or surveys of early adopters to gain a better understanding of changing perspectives on urine diversion and experiences with this innovative toilet technology (see Mitchell et al., 2013). We also hope to follow up with all VSPS participants in 5-10 years to understand how the VSPS may have impacted long-range decision-making about eco-sanitation.

3. **Identify and develop greywater management options**
   As composting toilets become more widely considered for use, there is an opportunity for innovative greywater treatment systems to take the place of conventional septic systems for the remaining wastewater (BC DHE, 2020). Currently, there are limited greywater systems available in Vermont. Development and regulatory approval of additional greywater treatment technologies would facilitate the implementation of combined greywater/composting toilet systems.

Conclusion

There are three main challenges associated with septic systems in Vermont villages: siting/village density constraints, nutrient pollution, and system failures. The Village Sanitation Pilot Study demonstrated that there is significant community and individual interest in eco-sanitation options to help address these challenges. Working together, project partners and participants identified urine-diverting flush toilets as the most commonly feasible option for retrofitting existing buildings. Of the three septic system challenges, urine diverting flush toilets help with nutrient pollution by directly removing the majority of nutrients from wastewater. However, their effect on septic system performance and rate of failure is less well understood, and needs further research.

Composting toilet options have the potential to address all three septic system challenges, and thus could be part of the solution for protecting water quality while promoting compact village development in Vermont. In this study, composting toilets were generally found to be less feasible than urine-diverting flush toilets because of a lack of adequate basement/crawl space for large collection systems, and greater maintenance needs for smaller systems. However, composting toilets would be more viable in other situations, such as in new construction and/or in buildings with staff to handle maintenance needs.

At the time of writing, urine-diverting toilet pilot installations are being planned for Westminster West, with possible expansion to West Dummerston. These pilot installations will be the next step in assessing the potential of eco-sanitation to address village wastewater needs. Proposed research in conjunction with the installations will help identify challenges, evaluate user experiences, and measure septic system impacts of urine diversion. Additional research and policy changes can build on these findings to ensure eco-sanitation is part of the solution to Vermont's village wastewater challenges.

The suite of novel eco-sanitation solutions evaluated through the VSPS have not been explored significantly in previous village wastewater conversations at the state or local level. We hope the activities and documentation of this study, and the consequent urine diverting pilot projects, will spark the imagination of stakeholders throughout the state of Vermont. Innovative wastewater management is the linchpin to achieving Vermont's goals of compact village development and clean water. Our intention is to point to the potential for eco-sanitation to play a part in creating this future in our state.

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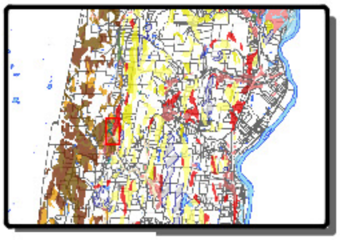
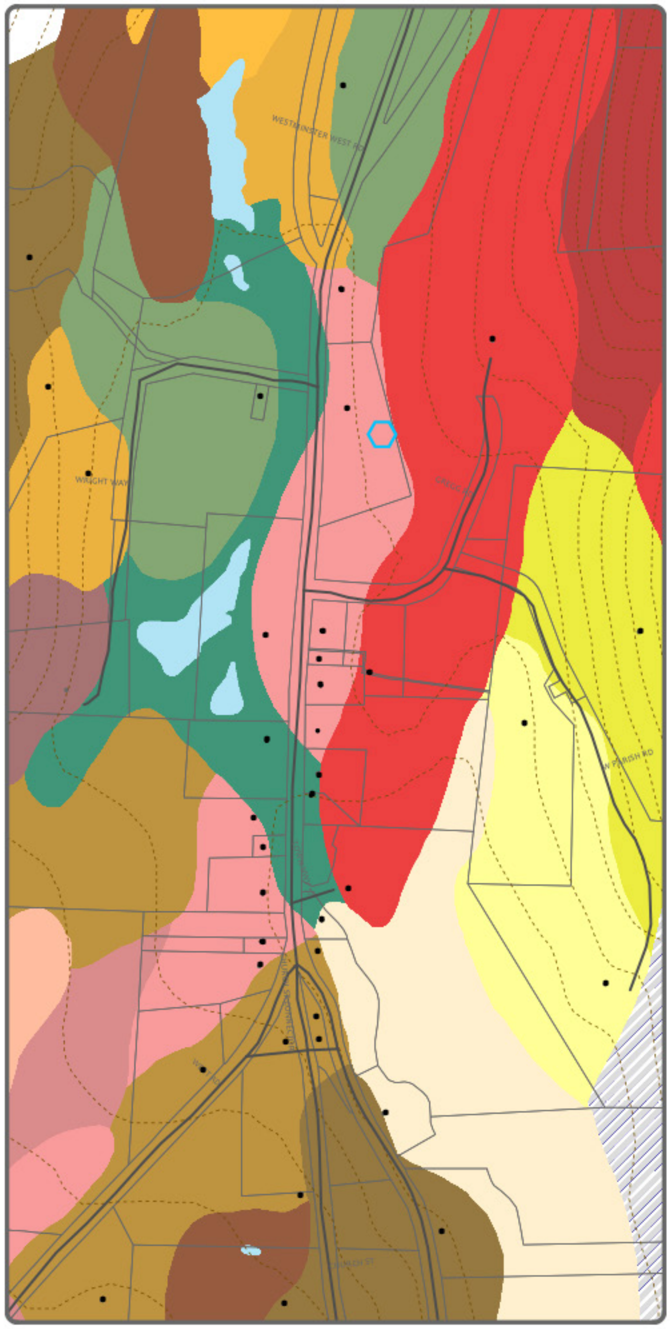
Soil Types

Village of
Westminster West, VT





- Buildings
- Streets
- Contour (20 feet)
- Public Water Sources

Soil Types

- Fine Sandy Loam, 1 Percent Slope, Wooded Area
- Fine Sandy Loam, 3 to 8 Percent Slopes, Forested
- Fine Sandy Loam, 8 to 15 Percent Slopes
- Fine Sandy Loams, 8 to 15 Percent Slopes, Very Stony
- Fine Sandy Loams, 8 to 15 Percent Slopes, Rocky
- Fine Sandy Loam, 8 to 15 Percent Slopes, Very Rocky
- Fine Sandy Loam, 15 to 25 Percent Slopes, Very Rocky
- Sandy Loam, 2 to 8 Percent Slopes, Forested
- Sandy Loam, 8 to 15 Percent Slopes
- Sandy Loam, 15 to 25 Percent Slopes
- Loamy-skeletal, 15 to 25 Percent Slopes, Very Rocky
- Loamy-skeletal, 25 to 70 Percent Slopes, Very Rocky
- Coarse-Loam, 8 to 15 Percent Slopes, Very Stony
- Coarse-Loam, 25 ro 70 Percent Slopes, Very Stony
- Loamy Fine Sand, 2 to 8 Percent Slopes
- Peat
- Water
- <Null>

This map depicts information about the kinds and distribution of soils on the landscape of Westminster West. The data used is from SSURGO certified soil data.

0 125 250 375 500 Feet

N W E S

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019

100 - Year Flood Zone

Village of
Westminster West, VT

- Buildings .
- Streets
- Contour (20 feet)
- Water

Elevation

Value

830 Feet
500
0

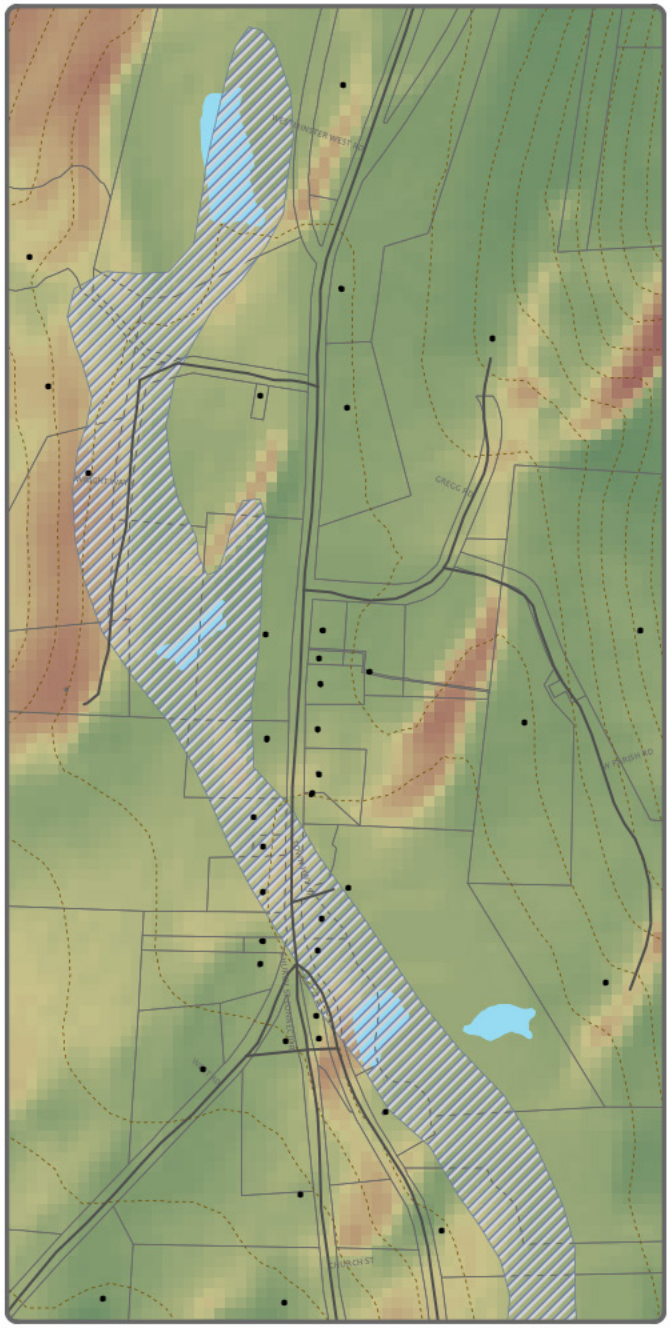
100 Year Flood Area
100 to 500 Year Flood Area

The flood zone as defined by FEMA is the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year, the 100-year flood.

0 125 250 375 500
Feet

N
W E
S

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



Nitrate Leaching Index

Village of
Westminster West, VT

- Buildings .
- Streets
- Contour (20 feet)
- Public Water Sources

Leaching Index (LI) Rating

Moderate — LI between 2 and 10 inches (Moderate) may contribute to soluble nutrient leaching below the root zone.
High
Very High — An LI greater than 10 inches (High) will contribute to soluble nutrient leaching below the root zone.
Water

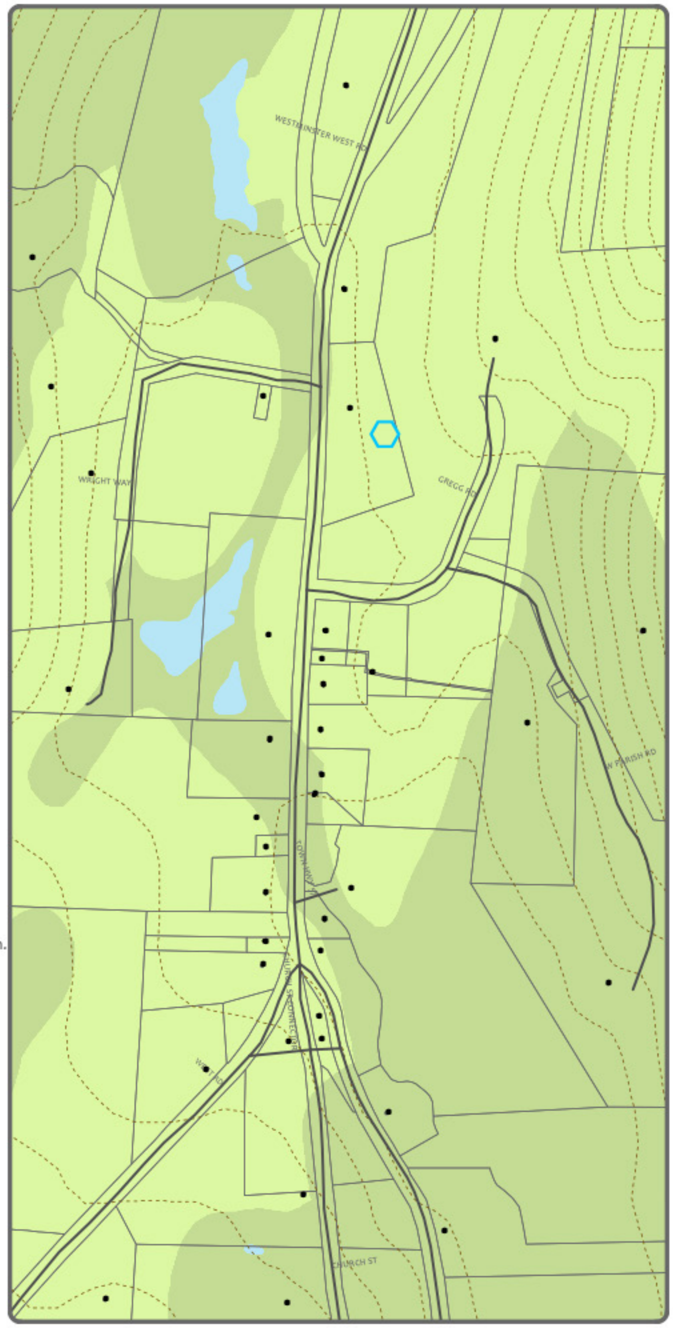
This map depicts information about the Nitrate Leaching (LI) Index in West Dummerston. Because Nitrate is soluble and mobileThe LI determines the degree to which nitrate percolates below the root zone in certain soils during saturation.

The LI does not account for irrigation. If irrigation is applied only to supply plant needs, there will be little additional loss below root zone. The data used is from USGS.

0 125 250 375 500 Feet

N W E S

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



National Wetland Inventory (NWI)

Village of
Westminster West, VT

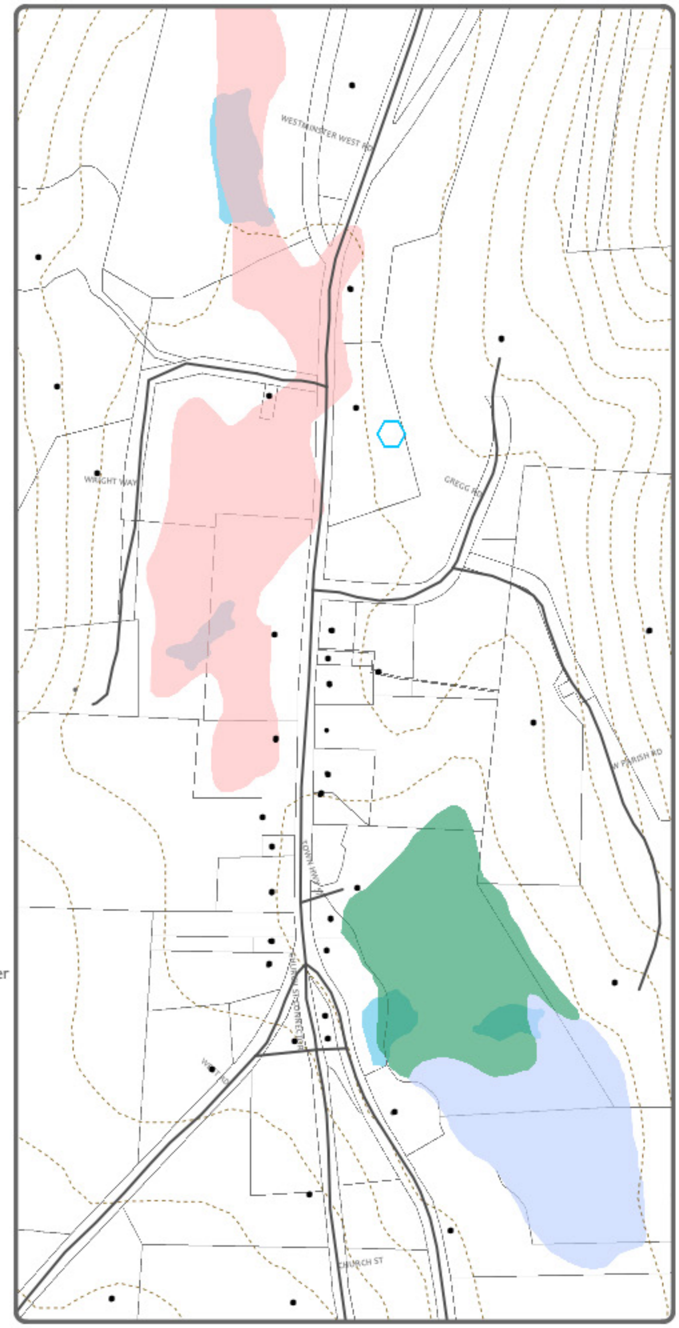
• Buildings .
Streets
Contour (20 feet)
Public Water Sources

Wetland Classification

Mixed Palustrine Emergent Wetland (Nonpersistent)
Mixed Palustrine Emergent Wetland (Persistent)
Palustrine Scrub/Shrub Wetland
Water

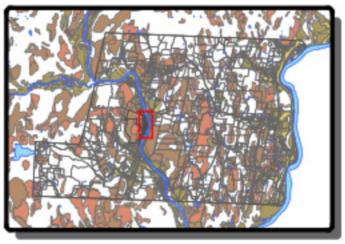
This map depicts information about the distribution of wetland types in Westminster West. The data used is from U.S. Fish and Wildlife Service certified National Wetland Inventory data.

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



Soil Types

Village of West Dummerston, VT



- Buildings
- Contour (20 feet)

Soils

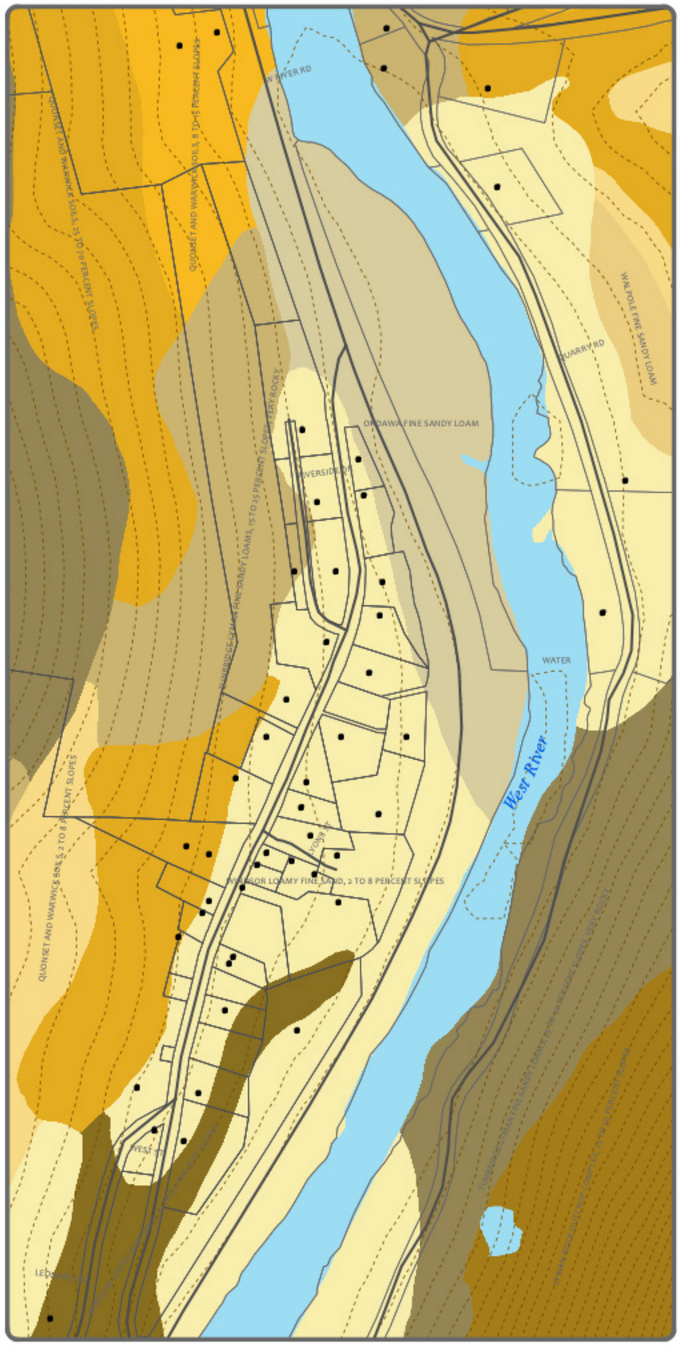
Soil Types

- Fine Sandy Loam
- Fine Sandy Loam, 0 to 8 Percent Slopes
- Fine Sandy Loam, 15 to 25 Percent Slopes, Very Rocky
- Fine Sandy Loam, 25 to 50 Percent Slopes, Very Rocky
- Fine Sand, 2 to 8 Percent Slopes
- Sandy Loam, 2 to 8 Percent Slopes, Forested
- Sandy Loam, 8 to 15 Percent Slopes, Forested
- Sandy Loam, 25 to 70 Percent Slopes, Forested
- Loam, 25 to 50 Percent Slopes
- Loamy Fine Sand, 25 to 60 Percent Slopes
- Water

This map depicts information about the kinds and distribution of soils on the landscape of West Dummerston. The data used is from SSURGO certified soil data depicting onsite sewage disposal ratings of Vermont soils.

0 125 250 375 500 Feet

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



100 - Year Flood Zone

Village of
West Dummerston, VT

- Buildings
- Streets
- Contour (20 feet)
- FEMA 100-year Flood Zone
- Water

Elevation

Value

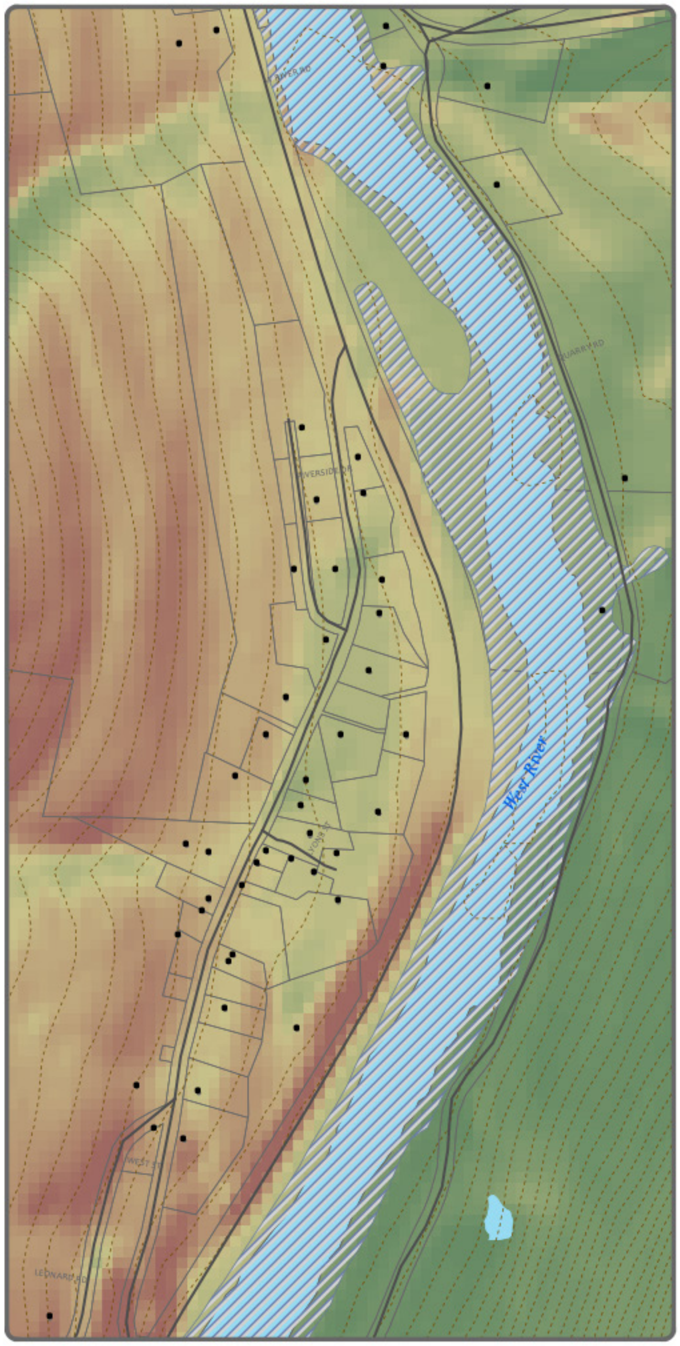
830 Feet
500
0

The flood zone as defined by FEMA is the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year, the 100-year flood.

0 125 250 375 500 Feet

N S E W

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



Nitrate Leaching Index

Village of
West Dummerston, VT

- Buildings
- Streets
- Parcel Boundaries
- Contour (20 feet)

Leaching Index (LI) Rating

Moderate	LI between 2 and 10 inches (Moderate) may contribute to soluble nutrient leaching below the root zone.
High	
Very High	An LI greater than 10 inches (High) will contribute to soluble nutrient leaching below the root zone.
Water	

This map depicts information about the Nitrate Leaching (LI) Index in West Dummerston. Because Nitrate is soluble and mobileThe LI determines the degree to which nitrate percolates below the root zone in certain soils during saturation.

The LI does not account for irrigation. If irrigation is applied only to supply plant needs, there will be little additional loss below root zone. The data used is from USGS.

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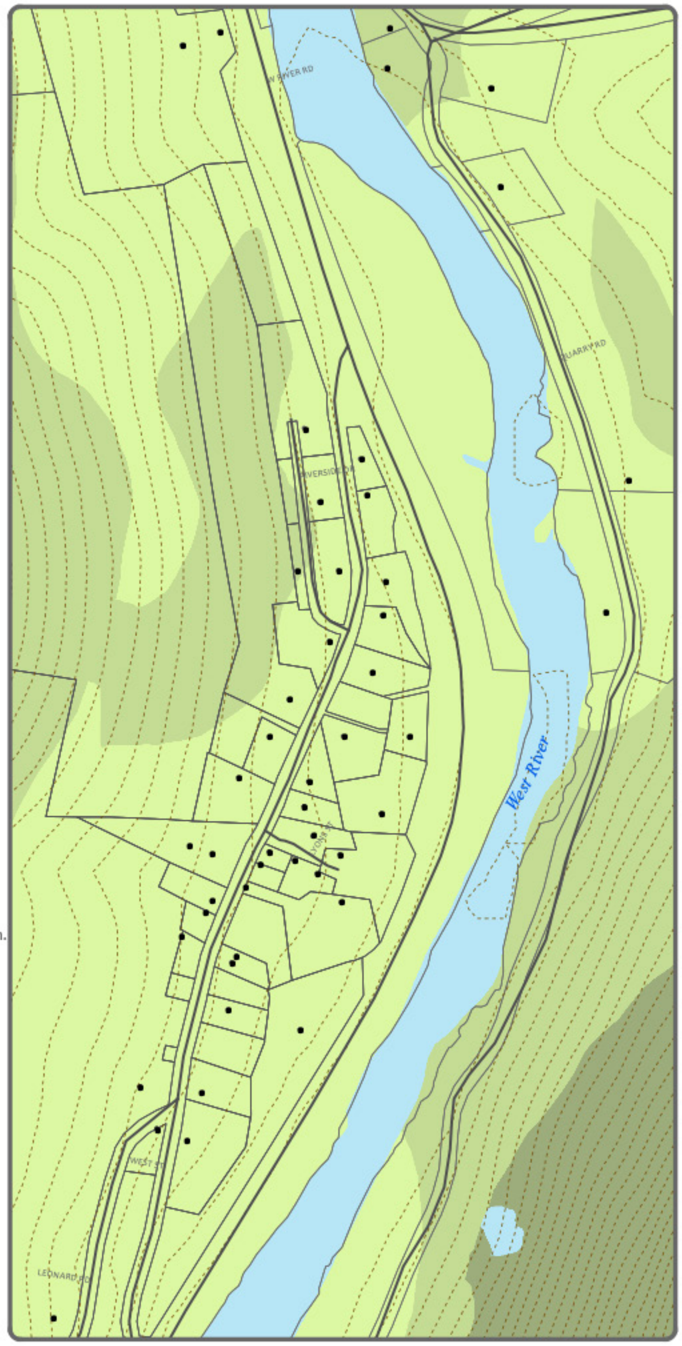
Windham Regional Commission
August 2019



National Wetland Inventory (NWI)

Village of
West Dummerston, VT

- Buildings
- Streets
- Contour (20 feet)

Wetlands

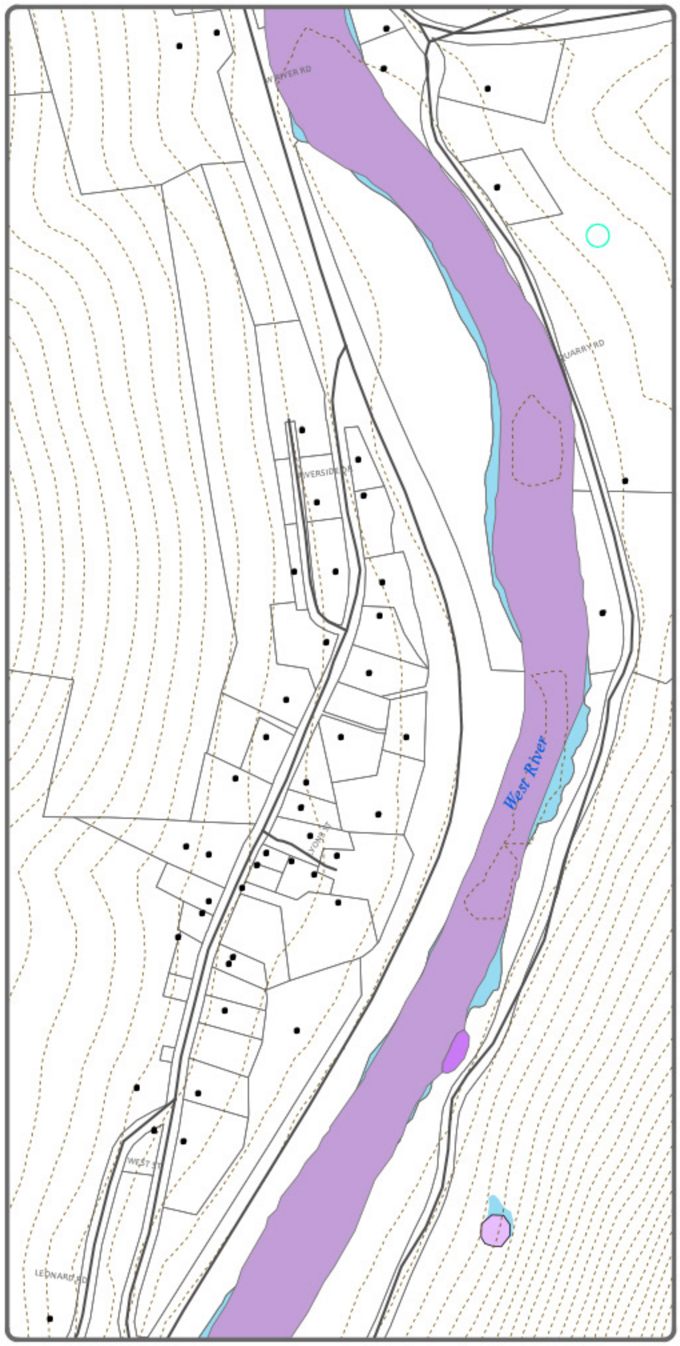
Wetland Classification

- Palustrine, Unconsolidated Bottom (Flooded - Excavated)
- Riverine Upper Perennial, Uncon. Bottom (Flooded)
- Riverine Upper Perennial, Uncon. Shore (Temporarily Flooded)
- Water
- Vernal Pool

This map depicts information about the distribution of wetland types in West Dummerston. The data used is from U.S. Fish and WildlifeService certified National Wetland Inventory data.

0 125 250 375 500
Feet

Christopher A. Gaynor
ECO Americorps
Windham Regional Commission
August 2019



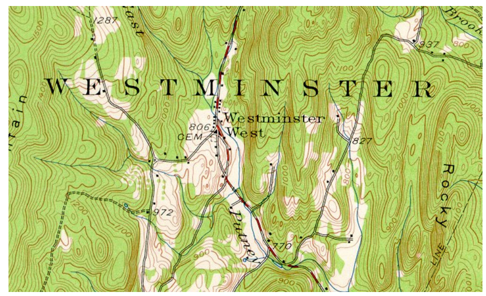
Village Sanitation Pilot Study
Site Visit Report

February 2019

Prepared for Lise Cavanaugh
Westminster West Public Library
3409 Westminster West Rd
Westminster West, VT

Prepared by Nutrient Networks

Project Overview



Villages are cultural and commercial centers of our communities. The inherent density and small lot sizes, however, make on-site wastewater systems challenging to install, upgrade, or expand. The Village Sanitation Pilot Study (VSPS) is a project assisting Westminster West and West Dummerston communities in exploring how eco-sanitation systems may provide vital infrastructure to help villages prosper. Through in-home visits, information gathering, technical review, environmental assessment, and mapping, the feasibility study will identify alternatives and evaluate their viability. Innovative and alternative systems assessed include urine diversion, composting toilets, and alternative greywater systems.

Nutrient Networks has conducted individual site visits with participating homes and properties. These visits offered an introduction to ecological sanitation systems, an opportunity for residents to ask questions about various systems, and assessed feasible options for potential retrofit or integration in future construction or renovation.

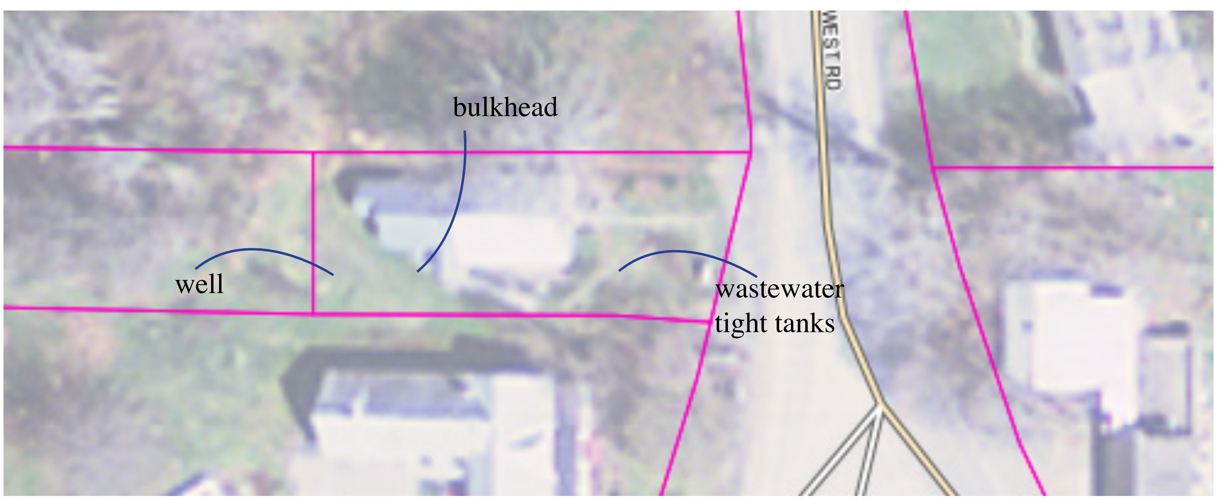
Site Visit Summary

Lisa Cavanaugh met with Conor Lally from Nutrient Networks on November 7th to discuss existing systems, alternatives available, and which of those are feasible and desirable. Together, we identified the Wostman Ecoflush as a viable option for retrofit. The following report documents the conversations and findings of the visit, recommendations, and additional information and resources.

Existing Systems and Conditions

The building that currently houses the Westminster West Public Library was built in 1936. The building was expanded in 2000 and included additional space, running water, and a bathroom with one flush toilet. Because of a small lot size and presence of wetlands, wastewater is directed to two holding tanks buried in front of the building.

The library offers many resources and programs, including after school and vacation programs, multicultural events, monthly book club, computer access, printing, and internet access. The library has experienced an increase in patronage over recent years. At the time of the 2000 renovation, the wastewater tanks were pumped out approximately once per year. Currently that frequency has grown to three times per year, at a cost of several hundred dollars per pumpout.

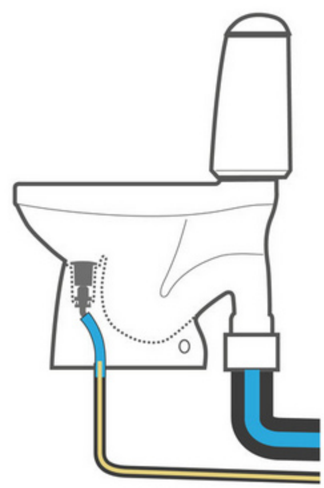


The library has a crawl space basement with a bulkhead stairwell opening of 39” wide. The floor to bottom of joist in the crawl space is 41”, and a height of 30” from floor to bottom of center beam.

Composting Toilet Options

Wostman EcoFlush

The EcoFlush is a porcelain urine diverting flush toilet made by Wostman, a Swedish company. The toilet has a divided bowl and works by flushing feces through the rear portion, which would be conveyed to the existing septic system. Urine is diverted through the front partition of the bowl from which it can be plumbed to a holding tank. The fixture is dual flush; .3 liters for urine only uses, and 2.5 liters for a solids flush. The urine partition is equipped with a water trap to prevent odor from escaping back into the bathroom.



The EcoFlush is configured differently from a standard american toilet, with the main outlet positioned further back in the fixture. Because of this, the toilet can be sited in the same location as an existing fixture, but may protrude farther into the room if the existing toilet flange is used, unless a new penetration is made so the fixture sits closer to the wall. If the room allows the fixture to come further into the room, a small shelf behind the EcoFlush can be installed to close that gap. The EcoFlush has metric pipe dimensions, requiring adaptation to american pipe fittings.

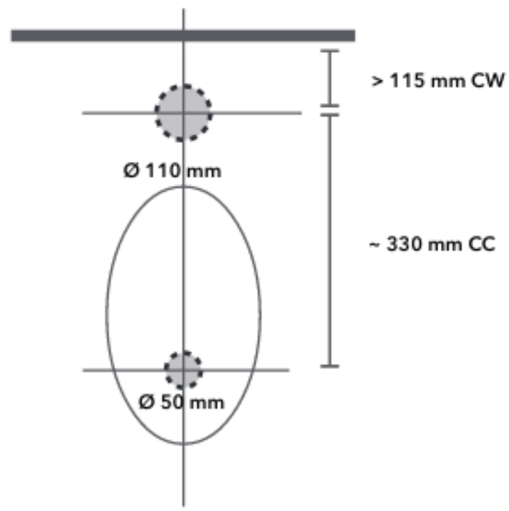
Urine would be plumbed through an 1-1/2” pipe to a holding tank, typically between 55 to 275 gallons. It is important to plumb the urine line with cleanouts to allow for inspection and access if needed for cleaning. A small vent line would need to be installed on the urine tank for pressure stabilization. Depending on available space and permitting requirements, urine tanks can be located either buried outside buried next to the foundation or sited within the basement. If sited in the basement, an access port may be necessary to allow for pump-out services. The urine tank can also be equipped with a float switch or high level alarm. A float switch can operate a pump to automatically direct urine to the septic system if capacity of the tank is reached.

The EcoFlush is cleaned in the same manner, and same frequency as a flush toilet. The urine line requires periodic inspection and cleaning to avoid clogging. A citric acid solution or extended plastic bristle brush can be used to clean the urine line.

Installation and Retrofit Considerations

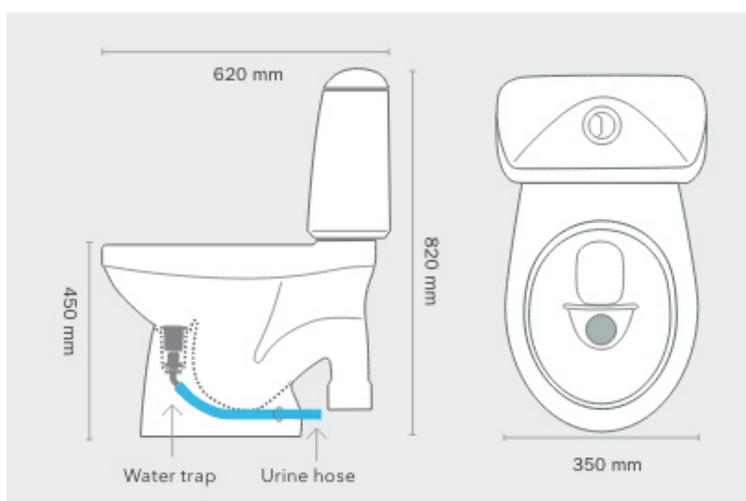
A new 3” hole would need to be cut through the tile to allow the Wostman to sit as far back as possible. The existing waste pipe and closet flange would bring the fixture too far forward in the room. A smaller hole, approximately 1-1/4” would be cut through the tile for the urine connection from the front side of the fixture. The Wostman would be positioned in nearly the same location as the current fixture.

There is ample space below the bathroom to plumb a new waste line and urine pipe. The new penetration for the Wostman would connect the existing waste line in the basement that connects to the tight tanks in the front of the property. The urine line would be plumbed to two tanks situated parallel to the center beam in the basement. A pump out pipe would connect the tanks to a port on the side of the south side of the building, accessible from the outside.



Because of the shallow basement, proximity to wetlands, and potential for flooding, it may be necessary to raise the tanks up on a platform, so that they are secured from upward movement by the floor joists. Entry and exit connections can be made high up on the sides of the tanks. A plumber may have to reroute one of the small copper water lines that currently runs where the urine tanks would be located.

We recommend a small overflow tank/pump be installed such that diverted urine in excess of the tank capacity would be automatically pumped into the existing tight tanks.



Greywater Management

There is little need to divert greywater at the library. It would be most prudent to continue to send greywater flows to the tight tanks for periodic pumpout.

Regulations and Permitting

Composting toilets are allowed throughout Vermont and are regulated at the state level through the Wastewater System and Potable Water Supply Rules, administrated by regional offices. Composting toilets can be used in place of conventional flush systems. Finished compost can be buried onsite, in a location, approved by the regional office, that meets the minimum site conditions for a conventional system. See link in references for more information on these regulations. Composting toilet installations are typically permitted by the regional office in charge of onsite wastewater permits. However, in situations where the modifications are to the plumbing system only, and no onsite application of finished compost or other recovered material will take place, modifications may not require a wastewater permit, but are subject to plumbing rules, which may or may not require a permit depending on the type of work and type of building (public vs. residential).

Nutrient Networks and Rich Earth Institute work closely with state and local regulators to ensure urine is transported, processed, and applied safely and effectively. Rich Earth Institute maintains a permit to transport, treat, and apply urine as a fertilizer throughout the state. We anticipate most of the potential installations stemming from this project would retain Rich Earth Institute services to periodically pump out the urine tank. Onsite use may be possible on a case by case basis. We also anticipate designing urine tanks and pumpout access to be compatible with conventional septic pumpout service providers.

Because urine-diverting systems are an emerging technology, we are currently engaged with state wastewater and plumbing officials to identify appropriate installation practices and approvals as demand rises.

Cost Estimates and Information

The following is general cost information for the purposes of planning and decision making. More specific cost estimates can be provided by Nutrient Networks or directly from manufacturers or distributors.

The following represents a conservative cost estimate.
Wostman EcoFlush Installation: $3,631

*see attached cost estimate

Recommendations and Conclusions

Based on site visit observations and conversations with Lise, the library is a good candidate for retrofitting an Wostman ecotoilet. An ecotoilet at the library would reduce wastewater accumulation in the tight tanks, lower frequency of pumpouts, as well as provide a demonstration and educational opportunity for the community. A Wostman installed at the library would allow community members, particularly those participating in the VSPS to see and use a local installation. As far as we know, this would likely be the first public library in the country to divert and recycle urine as a fertilizer.

We recommend, as one of the first steps towards an installation, an on site meeting with a plumber to review installation, define scope, and estimate plumbing labor.

References & Resources

Project Website
www.villagesanitationvt.com

Partner Websites
www.windhamregional.org
www.richearthinstitute.org
www.nutrientnetworks.com

Technologies:
www.wostman.se/en/ecoflush
www.separett-usa.com
www.cotuitdrytoilet.weebly.com
www.compostingtoilet.com
www.fullcirclecompost.org
www.oakson.com

Regulations
ANR DEC Wastewater System and Potable Water Supply Rules
http://dec.vermont.gov/sites/dec/files/dwgwp/wastewater/pdf/finalwspwsrules.effective2007.09.29.pdf

Vermont Plumbing Rules
https://firesafety.vermont.gov/sites/firesafety/files/files/rules/dfs_rules_plumbing_current.pdf

Books and Articles
Jenkins, J. C. (1994). The Humanure Handbook: A Guide to Composting Human Manure (First Edition ed.). Grove City, PA, USA: Jenkins Publishing.

George, Rose. (2008). The Big Necessity: The Unmentionable World of Human Waste and Why It Matters. New York, NY: Henry Holt & Co.

Cost Estimate

storage tanks	165 gal tank	1	$450.00	$450.00	plus shipping
	20 gal overflow tank	1	$100.00	$100.00	
	overflow pump	1	$130.00	$130.00	
	high level alarm	2	$75.00	$150.00	
	controller	1	$75.00	$75.00	
	overflow tubing	1	$16.00	$16.00	
Plumbing	1-1/2 abs pipe x 10ft	2	$4.70	$9.40	
	fittings	1	$30.00	$30.00	
tank stabilization	2x6x10	2	$7.00	$14.00	
	4x4x8	2	$9.00	$18.00	
	2x4x10	4	$6.00	$24.00	
	fasteners	1	$40.00	$40.00	
wostman	ecoflush	1	$900.00	$900.00	
				$0.00	
REI personnel	high level alarm	2	$50.00	$100.00	
NN personnel		10	$100.00	$1000.00	1/2 day cribbing and platform 1/2 day supplies 1 day tank connections and overflow
Plumber		6	$90.00	$540.00	
			Total Parts and Materials	$1956.40	
			Total Labor	$1640.00	
			Total Installation	$3596.40	

Letter of Interest

Village Sanitation Pilot Study
May 25, 2018

Westminster West Village, Vermont, USA

We pledge our willingness to work as a collaborative partner with the Rich Earth Institute and the Windham Regional Commission during the course of this Pilot Study.

The following Town of Westminster boards acknowledge and support the consenting homeowners of Westminster West in their attempt to be part of the Village Sanitation Pilot Study:

Westminster Chair of the Selectboard

Westminster Chair of the Planning Commission

Participants:
[identifying information removed]

We were able to contact most, but not all, homeowners in the village area, as delineated by the map. It is probable that more people are willing to participate.

Geography

The village of Westminster West -- which comprises the (old) West parish of the town of Westminster -- consists of 30+ households and community buildings nestled between parallel north-south ridges at the headwaters of the East Putney brook, a tributary of the Connecticut river. The village lies on and around marshes, forests and fields enhanced by centuries of beaver activity. At least half a dozen smaller streams flow into the main brook within the village limits and, at present, there are two large beaver ponds, dams and lodges -- one to the immediate north and the other immediately south of the village center. A great many of the houses in the village lie next to the brook which flows through the full length of the village, or one of several feeder streams.

Community readiness:

This tight knit community has widespread interest and concern about the health of the local environment and the world beyond it. The founders of the Windmill Hill Pinnacle Association live in this village and for over a year the Living Earth Action Group has held weekly meetings at the Westminster West Congregational Church to discuss local, national and global environment challenges. In addition to members of the Living Earth group, and many of their neighbors, the church, library, and village public school have all elected to participate in this study.

The majority of the property owners who have agreed to be part of the study were enthusiastic about doing so. A few were skeptical about the prospect of their urine being separated and stored, but they were interested in the benefits of the study and potential project. In addition, some septic systems are barely adequate for current use and are a limiting factor on further development. Many property owners expressed excitement at the prospect of learning new solutions to waste management.

The following are specific issues raised by participants when they were asked to consider benefits and concerns. Most frequent comments are listed near the top:

Benefits of this study and potential implementation, participant comments:

- Decrease the nitrogen and phosphorus, as well as other waste loads, on the groundwater, streams, wetlands of the village area and everything downstream.
- Villages are a good place for concentrated populations. Implementation will decrease the demand on septic systems and therefore allow an increase, or at least maintain, the current density.
- This is a very interesting way to handle waste. It is brilliant.
- Perhaps we will not have to pump our septics as frequently. Perhaps the septic systems will have greater longevity.
- We can be part of the solution instead of part of the problem.
- Our children will learn about the impact of their waste on the world around them.
- In a few cases, participants' septic systems are undersized or not complete. This will help minimize pumping and pollution.
- It is possible that participants who are unable to add a bedroom or office may ultimately be able to do so. Implementation may increase the capacity of the current septic.

Concerns raised by participants:

- Many participants raised the concern that drugs could be present in urine and therefore contaminate crops. Can hazardous situations be created by the project?
- Will there be space for my holding tank and will it freeze?
- About half of the participants said they wanted the system to be as easy and convenient as the current system.
- A few participants mentioned concern about ultimate cost of implementation.
- Will having a urine diverting system lower the resale value of my house? Will it effect taxation of house?

A request: Please no surprises. Hope that Rich Earth will keep participants informed of status of study when it is important to do so.

Summary:

The village of Westminster West is an ideal site for this pilot sanitation study because of its unique geography -- encompassing a single watershed, drained by the East Putney brook -- and because it is a compact and tight knit community with an impressive level of civic engagement and respect for the land. Researchers will find an engaged population that is open to (in many cases enthusiastic about) thinking outside of the box on the matter of domestic waste disposal and simultaneously reducing human impact on the natural aquatic environment.

Village Sanitation Pilot Study
Letter of Interest

A group of homeowners in West Dummerston Village in the town of Dummerston, Vermont submit this letter of interest to the Windham Regional Commission and the Rich Earth Institute to be considered for participation in a Village Sanitation Pilot Study. This group looks forward to working with the REI to come up with alternative proposals for wastewater treatment. There is no cost to the homeowners or the town and implementation of any proposals resulting from the study is not part of this project. Homeowners will share with REI personnel information about their septic systems and understand that this information will be kept confidential.

West Dummerston Village sits on a somewhat steep slope of the West River valley. It consists of about 35 buildings, mostly single-family homes. There is a Post Office, a church, a community center, a library, a fire station, and a few home businesses. There are numerous springs on the slope which provided water to homes in the past, though many now have drilled wells. The lot size varies from 1/10 acre to 2 acres with ½ acre being typical and a few lots that are over five, extending behind the other lots.

Describing the West Dummerston Village land use district, the Dummerston Town Plan states "In order to encourage compact settlement in the Village, the Town needs to consider current restraints created by inadequate water and septic needs." (p.17) All buildings are currently utilizing conventional individual septic systems except for one multi-household conventional system. The small lots can make replacement challenging. Currently, two homes pump wastewater uphill to the leach field sites because of space restrictions. A conventional municipal wastewater treatment solution would be prohibitively expensive because of the small number of households in the village.

The participating homeowners are enthusiastic about this pilot study, because they are aware that, although some conventional septic systems have been successfully replaced since state regulations took effect, it is likely that eventually some household will find it impossible to replace and meet the state requirements. Residents appreciate the neighborhood feel of the village but understand that the conventional systems packed this close together could be affecting ground water quality as well as nutrient levels in the West River. This group is interested in alternative solutions for wastewater that will help ensure the Village can continue to thrive.

Submitted by,

[identifying information removed]

The Dummerston Selectboard supports this initiative by West Dummerston Village residents.

The Dummerston Planning Commission finds this initiative is supported by the Dummerston Town Plan.

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Homeowner’s Enrollment Information Survey

This project is a **voluntary and non-regulatory feasibility study** that addresses challenges to homeowners and businesses, and impacts to water quality in our village and neighborhood centers.

As partners in this feasibility study, we will evaluate *how* things work, *if* they will work, and identify potential problems. Please answer **ALL** questions honestly and as accurate as possible to ensure the success of this study.

CONTACT INFORMATION

Name of Primary Contact person in household:

Number of person(s) in household:

Adult(s)? Children?

Physical Address:

Mailing Address (if different):

Primary Contact Phone Number :

Secondary Phone Number (if applicable):

Primary Contact Email Address:

Preferred Method of Contact (Circle One):

Primary Phone   Secondary Phone   Email

<u>HOME SYSTEM INFORMATION</u>

1. Are you aware of the location of your septic tank and leach field? (Circle One)

Yes No

2. Have you had maintenance problems with your system in the recent past? (Circle One)

Yes No

a. If <u>Yes</u>, what was it?

2. Have you had major work done on your septic system in the recent past? (Circle One)

Yes No

a. If <u>Yes</u>, what was it?

1. Do you know when your system was installed?

Yes No

a. If <u>Yes</u>, roughly when?

2. Are you concerned that your system isn't functioning properly?

Yes No

a. If <u>Yes</u>, what are you concerned about?

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2. Are you interested in having your drinking water well tested?

Yes No Unsure

Note: If <u>Yes</u>, action may need to be taken if contamination is found.

1. At this point, how likely do you think you'll be to adopt an eco-sanitation (composting toilet, urine diversion, greywater, etc) method?

    a. Definitely < 9 8 7 6 5 4 3 2 1 > Not likely

<u>YOUR COMMUNITY VISION</u>

Take the opportunity to reflect on the characteristics of *your* community and think of the potential *your* community has to be even better. In a few words, to the best of your abilities, answer the following questions. Any and all input is greatly appreciated!

1. What is it that you love about your neighborhood?

2. What would you change?

3. What do you think is the biggest problem facing your neighborhood in the future?

4. What would you want your community to look like in...
    a. 10 years?

b. 30 years?

5. What actions do you think you and your neighbors can do to reach that vision?

6. What actions do you think municipal and/or state officials need to do to help your community reach that vision?

7. What would you like to know, or learn, about your neighborhood?

THANK YOU FOR YOUR PARTICIPATION