Three Part H.375 Prerecorded Testimony on Behalf of Vermonters Against Toxic Sludge

:: Narrative Accompanying PowerPoint Slides ::

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I am pleased today to provide testimony on behalf of House Bill 375. Let me begin by forwarding a hearty "thank you" to the Chair and the individual members of the committee for the opportunity to speak on behalf of the issues raised by H.375 and also sharing my sincere appreciation for the dedicated work of Rep. Teo Zagar, the legislator for whom the existing bill owes its impetus.

First, for some general housekeeping: we've chosen to approach these hearings from two distinct angles. The first, and which I am initiating today, is to examine the opportunity available to us in the form of ecological toilets. The second will be to examine the opportunity that's available to us in the form of greywater reuse. We've managed to pull together some highly effective speakers and we hope that each of you will comes away from the upcoming presentations with a new understanding of both the issues at play and the solutions that we are proposing.

Now, a brief introduction. My name is Kai Mikkel Førlie and I am the principle founder of Vermonters Against Toxic Sludge, a grassroots community group organized to oppose the land application of toxic sewage sludge and also to advocate on behalf of sustainable alternatives to our legacy sanitation systems. Some call me a concerned community member and that would be an apt description. Professionally, I am a former airline captain and, before that, a developer and property manager at the largest community land trust in the United States (which just so happens to be located in Burlington). My interest in sanitation (and, in particular, sustainable sanitation and reuse) blossomed when I stumbled upon the fact that my local solid waste district (the CSWD) was proposing to export millions of pounds of toxic sewage sludge produced in Chittenden County to a facility located in a small farming community in upstate New York.[1] This proposal seemed at odds with Vermont's "green" image and the more I dug into the issues surrounding the proposal the more alarmed I became.

As for my presentation, allow me layout what I intend to cover. In total, I will examine three major areas. First, in an attempt to provide some important background, I will delve into the challenges that we face as a result of our reliance on existing sanitation systems. Second, I will provide an overview of some opportunities that we have available to us in the form of low-tech, low-cost and safe technologies. And, third, I will highlight some amazing work taking place at the international level that I hope will serve both as inspirations and examples of what we can accomplish here in Vermont. Commencing a few minutes into my testimony I will begin making use of a Power Point.

However, before I launch into my first segment, I want to clarify three important things right off the top:

1st) Although we're here today talking about ecological toilets we do so in the midst of some who are opposed to their widespread use. Luckily, a large portion of this opposition results from a poor understanding of the rules. For example, the current manager of the DEC's Wastewater Division, Ernie Kelley, is mistaken when he states publicly – as he did at last year's statewide sludge forum – that EPA, and specifically the rules laid out in 40CFR, Part 503 (known as the "503 rule" or the

"sludge rule) has the ultimate jurisdiction over both ecological toilets and the byproducts they produce. Well, this is simply not true. Not only does that federal regulation include zero mention of the technology or materials that I am about to cover but the existence in almost every U.S. state of widely varying eco-toilet regulations *all of which are totally at odds with 40 CFR, Part 503* corroborates this fact. Moreover, the EPA itself readily admits that individual states and not the EPA are responsible for regulating the contents of an ecological toilet.[2,3] So, please remember that the material I will discuss is not "sewage" (what flows through a sewer) nor is it "sludge" (the solids collected from wastewater treatment plants) and nor is regulated by the "503 Rule". Now, Mr. Kelley may have a point when it comes to commercial operations in which this material is specifically marketed and sold to the public as fertilizer, but even this falls into a substantial grey area. But, either way, the takeaway is that regular people looking to dispose of the treated contents of their ecological toilet are exempt under the federal regulations that govern sewage sludge.

2nd) Those of us involved in this work are generally aware of the anecdotal history of unscrupulous developers and contractors who, in the 1980's, were able to circumvent an earlier version of existing wastewater regulations by agreeing to install ecological toilets in place of flush toilets but who upon clearing that regulatory hurdle immediately replaced the eco-toilets with flush toilets and in doing so caused undue hardship for the eventual owners of the property who faced subsequent septic and leach field failures. To be clear, we in no way wish to repeat this unfortunate period and we recommend that the final version of H.375 include adequate protections to ensure that this history will not be repeated.

3rd) Along the same lines, we are aware of the very effective manner in which existing sanitation regulations have acted ever since to very quietly limit development (essentially by limiting development on land that won't perc). This is something we view as a good thing and is also something that we don't seek to eliminate via this bill.

So, with that out of the way, I will begin.

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Part 1. <u>The Challenge in Front of Us</u>

My passion for this topic results from the manner in which we currently manage human excreta and wastewater and, in particular, how these practices run totally contrary to that which is logical, efficient or ecological.

First, some background. Passage in 1972 of the Federal Water Pollution Control Act (what we've ever since obliquely referred to as the "Clean Water Act") regulated what are known as 'point sources' of water pollution; most obviously, the commonplace practice (at the time) of directing raw wastewater directly into surface bodies of water like lakes, rivers and, in coastal communities, the ocean.[4] That legislation jumpstarted the construction of what I like to refer as our 'legacy wastewater systems'; conventional infrastructure like centralized wastewater treatment plants and decentralized septic systems.[5] Given our historical reliance on water as our conveyance method of choice for transporting

our excreta way from its source to somewhere else (where it becomes someone else's problem), these water-based system were, I guess, a natural choice. However, looking back, I feel like we really missed a great opportunity to rethink our relationship to water and our approach to the management of human excreta.

But that was 1972, together the year of my birth and an example of a time in which it could be said that we had yet to seriously address the impact that we as humans were having on the natural world or the negative effects that industrialization was having on us. But, as a result of the Clean Water Act, the United States went on a collective domestic infrastructure building spree, constructing thousands of wastewater treatment plants, connecting hundreds of thousands of miles of sewers to them and, as time went on, helping to drive the even greater adoption of septic systems.[6,7] And ever since – and helped along by our country's contributions of restricted foreign development aid which acted to export this technology to other parts of the world – we helped create the worldwide perception that our 70's era technology is the "gold standard" in sanitation.

Now, don't get me wrong - by and large these systems have worked as advertised. They've reduced the rate of raw sewage entering our waterways and, thanks to later modification that allowed them to isolate nutrients – the primary source being human excrement – also minimized the *direct release* of this potent contaminate into those same bodies of water. I'll return to the concept of "direct release" in a moment.

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> *"The toilet was created to solve eighteenth-century problems of decorum, and was spread across society to solve nineteenth century problems of sanitation. Now...we have a few twenty-first century problems: the cost of the sewage infrastructure and its environmental impact. The flush toilet can't solve the problem this time, because this time, the flush toilet is the problem." [my emphasis]*
>
> *- Dave Praeger, Author of "Poop Culture"*

But, as time went on, several things began to happen. One, our population as a country increased by almost 52% (and as a state by over 35%). Two, our society increasingly came to rely upon thousands upon thousands of industrial chemicals. And, three, we began to run out of both water, fossil fuels and – because they are petroleum based and/or the products of mining – fertilizer.[8,9,10] The problem is, though, that none of our legacy wastewater systems have been able to safely and adequately address any of these recent factors; specifically, the dramatic increase in production of sludge, the contamination of wastewater by industrial toxics and the need for inexpensive and renewable supplies of plant nutrients (a.k.a. "fertilizer"). And I would be remiss in not stating now for the record that there are those, myself included, who think they never will.

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According to the EPA[11,12] and others[13,14,15], sewage sludge (which we produce more of now that at any time in our country's and state's histories) and the effluent that's released as a matter of course by WWTPs, are laced with a plethora of industrial toxics, pharmaceutical residues and antibiotic-resistant

human pathogens, almost none of which are regulated; this even though the EPA has recently somewhat vaguely characterized a host of them as "Contaminates of Emerging Concern" and is now apparently "studying the problem".[16]

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And, increasingly, this concerning material is finding its way out of our sole landfill (it, along with the recently closed landfill in Moretown, being its historic resting place) and onto farmland. Plus, with literally nothing standing in its way, more and more sludge is now even ending up in our gardens and on our yards and school grounds.[17,18]

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In fact, according to the latest iteration of Vermont's Materials Management Plan ("MMP") which, it's worth noting, was written in lockstep with Act 148 (the "Universal Recycling Law"), ANR's goal is to significantly increase the rate of land application, thereby exacerbating a peculiar and mostly unwritten facet of the story. I said a short time ago that I'd return to the concept of "direct release". Well, while it's true that many adequately equipped WWTPs *have* reduced the frequency of *direct* nutrient-laden releases into their receiving bodies of water (due to what's referred to as "tertiary treatment"), the secret is that these nutrients end up isolated in sludge which is increasingly trucked back upstream and dumped on land where, in many cases, those nutrients end up right back in those same receiving waters, thanks to the twin phenomena of agricultural runoff and runoff associated with development. Thus, those nutrients which we spend a small fortune removing from our wastewater so that they will not directly enter our waterways many times end up indirectly doing just that; running off our farms, yards and public lands and polluting our water anyways.

And because it bears highlighting, the MMP also has this rather woeful (and inaccurate) thing to say about the options that Vermonters have available to them to effect change in our sanitation system:

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> *"Unlike household trash and other closely related streams of municipal solid waste, there is very little that individual Vermont residents can do to reduce the volume of residual wastes [a.k.a. "sludge"] that are being disposed versus used. Other than septage removed from on-site septic systems, an activity which itself is not conducted by individual homeowners, residual wastes are almost exclusively produced and managed by municipal facilities or by private sector businesses."*[19]

I checked, and in the face of everything we now know about the problems and what the alternatives are that are available, all the MMP does – and it makes great strides in doing so – is *maintain* the status quo when it comes to how we manage human excreta. And the following is how that incredibly shortsighted goal will be achieved:

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> *ANR will:*

1. Continue to look for opportunities to educate and inform the commercial sector and the general public about the sources and potential effects related to contaminants of emerging concern in wastewater biosolids,

2. Work with interested parties to examine and evaluate innovative and alternative uses for wastewater biosolids,

3. Encourage WWTFs and other governmental programs and non-governmental associations to offer tours and educational opportunities to local schools and universities, and

4. Continue to look for opportunities to educate and inform the commercial sector and the general public about the beneficial uses and the opportunities for residual materials.

ANR will continue to look for opportunities to educate and inform the commercial sector and the general public about the beneficial uses of residual wastes. In concert with the ANR's efforts, it is expected that all solid waste management entities (SWMEs) will have implemented locally specific education and outreach programs for residual wastes.[20]

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As for the industrial toxics and pharmaceuticals that are present in sludge, their origins should come as no surprise given that not only is industry lawfully permitted to dump a vast array of toxics into public sewers[21] but, in practice – even if local ordinances exist restricting certain materials – so too are private individuals. And the fact that most of these toxics persist, even after treatment, should also come as no surprise. Our WWTPs cannot neutralize the majority of these substances (which is why they end up contaminating sludge) because that's not what they were originally designed to do and, as far as I and others are concerned, it is naïve to think that will ever change. And my opinion is corroborated by the fact that we're struggling to afford the systems we currently have and so it is highly unlikely that we'll be able to afford the kind of new centralized technology that at least in theory might be able neutralize all of the toxic substances present in wastewater. And I say 'might be able' because a) there's really nothing in widespread use other than the old-standby of "carbon absorption" and b) carbon absorption doesn't neutralize anything and it doesn't make anything disappear or "go away", it only acts as a filter to isolate dangerous contaminates which means that the toxic materials that remain still need to be managed.

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Plus, what are we talking about *really* in dollars and cents? Well, according to a local coalition comprised of clean water advocates, businesses and others that fairly recently threw a number at the scale of the problem, the "Blue Coalition" as it's known, estimates that the costs involved with simply maintaining our existing systems may reach into the billions of dollars over the next two decades.[22]

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And I hope I'm stating the obvious when I remind each of you that every year that passes finds individual states less and less able, yet more and more obligated, to fund sanitation projects that were once (at least in the heyday of the Clean Water Act's passage) paid for in large part by federal grants. Therefore, I think it's a very worthwhile exercise for us to let go of any notion that big and expensive centralized solutions to our problems, particularly those paid for at the federal level, are on the horizon.[23]

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Moreover, given that it is your duty to look out for Vermonter's long-term interests, I would also like to address the long-term unsustainability of our current wastewater systems. Ask any municipality that owns and operates a wastewater treatment plant and you will find that that infrastructure alone is one of, if not the largest single consumer of electricity in the municipal portfolio (owing in large part to the huge energy demands of pumping).[24] And though some small inroads are being made into increasing the efficiency of centralized systems, the gains are minimal, particularly in the large scheme of things. The crucial point that I'm trying to make here is that given the looming low-energy/low-carbon future that we are facing (which is something that few people are willing to acknowledge), its pure folly to continue assuming that we will be able to outfit, power and maintain the kind of energy and capital intensive systems we currently rely upon.

Any truly holistic analysis bears this out. And your own analysis, don't forget to factor in the large embodied energy inherent in these systems, embodied energy being:

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> *"Embodied energy (...) is defined as the available energy that was used in the work of making a product. Embodied energy is an accounting methodology which aims to find the sum total of the energy necessary for an entire product lifecycle. This lifecycle includes raw material extraction, transport, manufacture, assembly, installation, disassembly, deconstruction and/or decomposition."*[25]

…which for municipal wastewater treatment infrastructure includes all of the energy required to provide the water inputs in the first place, the networks of sewers (and, when applicable, pumping stations) and the energy-use associated with the production of the electricity that powers the plants, the energy used in the management of the sludge produced and the energy expenditure associated with the materials that went into the construction and outfitting of the plant originally, the latter vital when contemplating anything new along the lines and scale of our current systems.[26]

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Moreover, our existing wastewater systems are massive consumers of water.[27] And although we've been lulled into thinking of Vermont as being a water-rich part of the world (and therefore able to afford our current demand both now and into the future), I would caution this perception for three reasons:

One, recent climate modeling has Vermont increasingly experiencing decreasing low-intensity precipitation events but at the same time experiencing an increase in higher intensity precipitation events. This frequency change coupled with higher average temperatures (which increase rates of evaporation) will result in, "…earlier snowmelt, and more runoff from heavier summer rainfall, coupled with increased evaporation, [the combination of which] are expected to increase the frequency of summer droughts - if high emissions continue."[28] And, as we already know, nothing is slowing down humankind's high emissions. So, there's a very real chance that when we need water most, it won't be available as we might expect.

Two, our drinking water sources (drinking water being the standard input in both private and municipal water systems) are increasingly subject to contamination by a plethora of industrial toxics, the vast majority of which our water systems are not required to test and control for and typically do not test and control for. And even if some water treatment plants, like Burlington's, do go beyond the minimum testing requirements[29], there is concern that testing alone without adequate controls does little to protect consumers. And this concern is based upon the dearth of reliable studies into the effects of various industrial chemicals on our bodies – only a small handful of the thousand or so new ones that are released into the environment each year are ever independently tested – and almost none of the 85,000 industrial chemicals currently in circulation have ever been tested for their synergistic effects (meaning what happens when they are combined with each other).[30] Think of that the next time you reach for your favorite glass of water.

And, three, Vermont doesn't exist in a vacuum. Within less than a day's drive from our fair state exists several major metropolises; Boston, New York City, Philadelphia and Montreal being the most obvious examples. These are very thirsty and very powerful neighbors. And regarding *how* thirsty, you should know that we here in the Northeast are already the site of at least one water pipeline[31] (in Connecticut and planned originally to extend 20 miles, pump 2 million gallons per day and cost US$50M)[32,33] and several desalination plants as well with more planned.[34] Yes, you didn't mishear me. The kind of technology that's normally reserved for arid places like Arizona and California and for even farther flung desert regions of the world – namely pipelines and desalination plants – are already in use in the greater New-England-area.

My point here is that with so many millions of thirsty neighbors in close proximity to Vermont it is naïve to think that what water supply we do have won't come under increasing pressure. So, for all of these reasons, the direction we should be headed in is *towards* increased conservation; something, mind you, that is basically anathema to our existing reliance on flush toilets and conventional wastewater treatment systems.

Much of the wastewater infrastructure we rely on today has been with us for decades and in some cases as long as a century.[35] The treatment systems themselves mostly date from the era of the Clean Water Act (the early 1970s) and most are in need of upgrades, replacement or both. As I've already outlined, these technologies represent massive public investments with long pay-off periods and so what I am wary of and what I think you should be wary of as well is paying only into and relying solely upon these same ineffective systems for the next thirty or forty years. I don't think we can afford it and I don't think the planet can either.

So, if it appears that the first part of my presentation has been an indictment of our legacy wastewater systems, than that's because that's the stance I take. However, that's not the only reason I'm talking to you today. I am also keen to acknowledge the fact that we now know of much better and much less expensive ways of tackling many of the problems that these systems have either helped to create and/or have come to neglect.

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Part 2: <u>The Opportunity in Front of US</u>

First, some definitions: ecological sanitation, sustainable sanitation, ecological toilet, human excreta (funny anecdote)

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So, the opportunity in front of us is sustainable sanitation and reuse, and in particular, ecological toilets. So, what is an eco-toilet? For the purposes of this bill we have chosen to borrow the general phrase 'ecological toilet' to describe waterless (or almost waterless) toilets that are designed primarily to recycle human excreta, thereby closing the natural cycle that we've neglected for so long. We first came across this term when reading about an innovative pilot project underway in nearby Cape Cod (which you will hear a firsthand account of later in another presentation). Ecological toilets differ from the toilets that most of us are likely most familiar with (commonly known as "flush toilets") that rely on water and are designed around the concept of human feces and urine being waste materials that need to be disposed of. And, while not always utilized in conjunction with a reuse scheme, ecological toilets do by design permit and facilitate in a very safe and efficient manner the reuse of human excreta. I will come back to this in a moment.

The specific ecological toilets that this bill seeks to promote are the following: composting toilets and urine diverting dehydration toilets (UDDT).

But before I continue, please allow me two brief caveats. First, please keep in mind that the end goal of a composting toilet is compost (a.k.a. hummus) while the end *goals* of a UDDT are liquid urine and desiccated (a.k.a. dried) feces. In the case of the former, the composting process is what, at least in theory (but not always in practice) eliminates human pathogens. And, in the case of the latter, time is what sterilizes urine (although urine is usually sterile anyways) while the prolonged and profound absence of moisture is what, at least in theory (but not always in practice) eliminates human pathogens from feces.

Second, and on a related note, we should never forget that just like sanitation systems based on eco-toilets, our legacy sanitation systems are not 100% effective at eliminating human pathogens. In each instance we rely on separate and distinct "multiple barrier" approaches to minimize the risk to the public. I won't go into them here, but suffice it to say that as long as certain universally accepted precautions are taken, both systems are equally effective at preventing human exposure to harmful pathogens.

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Composting Toilets

I want to point out that the term 'composting toilet' is in some ways a misnomer given that the finish composting process may or may not occur in the toilet itself but may, depending on design and frequency of use, require a separate treatment step (generally longer term and/or higher temperature composting in an outdoor compost pile). However, this hasn't stopped the term 'composting toilet' from enjoying widespread use and so it's the term that we'll make use of as well.

So, generally speaking, what is a composting toilet?

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The definition that I'll use is a slightly self-modified version of that which appears in the associated Wikipedia article (the validity of which I can trust since I happen to know the identities of the authors involved and can vouch for their expert credentials):

> *"A composting toilet is a type of dry [or almost dry] toilet that uses a predominantly aerobic processing system for the onsite treatment of human excreta, by composting or managed aerobic decomposition."*

Some features common to all composting toilet are a toilet seat (at least in Western-style designs), a chamber or removable container where excreta is deposited and a structure of some kind that conceals the chamber or container from view. Other features may include a passive (chimney-effect) or active (electrically powered fan) ventilation system, an electric element (to heat the contents of the chamber/container and assist with evaporating liquids), the addition in the chamber/container of red wriggler worms (for vermicomposting) and some allowance for stirring or turning the contents of the chamber/container (to promote aeration).

Looking back in time, this kind of toilet and/or the sanitation principles it relies upon have been in use for hundreds (if not thousands) of years. There's ample evidence that early Amazonian peoples blossomed in the harsh rainforest environment by mixing their excrement with ash and other organic materials to create what's referred to in Portuguese as "terra preta" or "black earth" (a.k.a. incredibly rich and fertile soil). Although it runs somewhat contrary to the perception of rainforests as lands of plenty, they are in actuality a very difficult place to live if you are a non-nomadic human; in other words, a human that relies on agriculture for survival. This ingenious method thereby allowed fairly substantial populations to exist where they wouldn't have been able to otherwise.

Leading up to the advent of the flush toilet and even following its creation, people in various parts of the world relied on "earth closets" (the predecessor term to "water closets") which were nothing more than simple storage boxes designed for the temporary storage of excreta, wiping materials and what's presently termed "bulking agents" or "cover materials"; typically brown carbon-rich materials like sawdust, dried leaves, coconut coir or even soil itself which was sprinkled over each deposit to reduce odors and improve the experience for the next toilet user. These toilets were either emptied by their owners into outdoor refuse piles (where, along with other organic refuse, was presumably allowed to

decompose naturally) or collected by the "night soil" entrepreneurs of the day who marketed this material to area farmers as nutrient rich fertilizer or transported it away from settlements where it was simply dumped. In fact, this sanitation method was still in use in Japan up until a few decades ago and is still practiced in parts of rural China, India and elsewhere. Plus, there's an entire development model that's been operating in the Majority World (what most pejoratively call the "developing world) for the last few decades that has made tremendous inroads into reviving this technology for use by the world's economically, politically and geographically disenfranchised. I'll give some international examples a bit later.

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Fast forwarding to the here and now and modern composting toilets tend to fall into one of two major categories; those that are 'remote' and those that are 'self-contained'.

Remote

Remote composting toilets in a way lightly resemble flush toilets in that they consist of three distinct and separate parts – a toilet, some sort of conveyance and a remote treatment facility. However, in the case of a remote composting toilet these three parts are typically housed in the same structure rather being set some distance away from each other (as in systems that utilize a septic tank or centralized wastewater treatment facility). The toilet typically (in the West at least) resembles a conventional flush toilet (in appearance only) and can be constructed from plastic, fiberglass, porcelain, wood, masonry, cement or the equivalent. And, in place of wastewater pipes, most composting toilets make use a chute, a conveyor belt or, in some cases, a vacuum system, all of which lead to a nearby composting chamber. These systems are generally designed so that the entire composting process takes place within the unit although a secondary treatment step (generally an outdoor compost pile) may be warranted depending on the process utilized.

Self-contained

In contrast, self-contained units combine these three parts into one compact unit. Whereas 'remote' toilets are typically intended for installation in homes and business (and are somewhat more complicated, particularly as a result of the need for – in the case of existing buildings – extensive retrofitting, and – in both existing and new construction – a basement or adequate crawlspace located immediately underneath (or, in the case of vacuum systems, adjacent to) the location of the toilet, 'self-contained' composting toilets can be installed almost anywhere, needing at most connection to some sort of ventilation ductwork and a drain for excess liquids (normally directed to a sub-grade soak-way) and, in some cases, an electrical power source. And, at their simplest – like those self-contained versions which rely solely on an outdoor compost pile(s) – none of these more complex systems are required and so the toilet itself can be placed literally anywhere a toilet is needed or desired. Which brings me to an important point: although it's impossible to know the numbers involved, given their particular ease of installation there's plenty of anecdotal evidence available that people are making use of self-contained composting toilets and are doing so under the radar of local code enforcement authorities, health departments, etc., and so one of the goals of this legislation is to create a user-friendly framework that will produce an environment conducive to allowing these users to emerge from the shadows. We want

to support these folks and the commitment they've made toward improving the world around them while also ensuring that not only will others feel comfortable following their lead but that best practices are followed in order that these systems are operated in a safe and non-environmentally-destructive manner.

And, if I may editorialize for a moment: something we hope is covered in the final version of this bill is some sort of protection for consumers in relation to certain designs of self-contained composting toilets. A quick web search will produce ample negative consumer reviews of certain self-contained composting toilets, some of which can be purchased right now at a nearby building supply store. The problem, it seems, is that certain designs that were never meant for full-time use (but instead for seasonal or only very occasional use like at backcountry camps or summer cottages, etc.) have been placed in service with the intent of full time use, something that in practice causes a host of problems, not the least of which are very negative consumer attitudes towards these toilets. The cause, at least as far as we've been able to determine, can be isolated to vague and unrealistic marketing claims made by manufacturers and the lack of real-world standards. So, to head off any downstream problems, we'd like to see the final version of this bill include a performance standard that would work to pair expectant users together with systems that are adequate and appropriate for their needs.

Urine Diverting Dehydration Toilets

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A more recent development in the ecological toilet arena is what most is commonly referred to as the "urine diverting dehydration toilet' (a.k.a. 'urine diverting desiccation toilet' or 'urine diverting dry toilet'). With users in Vietnam back in the 1980's now credited with the basic design, the concept is brilliantly simple. By utilizing a special toilet bowl that is designed to separate urine and feces at the source and store each in a segregated fashion most of the operational challenges inherent with composting toilets are eliminated. One of the biggest of these challenges is odor. If odor is ever associated with a composting toilet (and this can quickly become an issue if certain basic and universal practices are not adhered to) it is the joint result of what happens when urine and feces are allowed to mix and a factor of the amount of oxygen (or lack thereof) present in the combined storage chamber. Anyone who's ever used a Port-a-Potty or what many think of as an "outhouse" knows what I am referring to; the noxious smell that's produced by hydrogen sulfide and ammonia. Well (assuming the UDDT is used properly), odor is not a problem with a UDDT.

And neither is another problem that is common particularly with the aforementioned scenario of people using toilets designed for part time use as their full time toilet. And that is the unpleasant (to put in mildly) slurry that can result from a poorly designed or misused composting toilet. Although the urine storage container in a UDDT can (and does) smell if a) there's no integral odor trap built into the urine drain and/or b) if the container is not emptied on schedule, the feces chamber only imparts the smell of damp soil and even this is difficult to experience given the partial vacuum that exists in the feces chamber (which ensures that any smells are exhausted to the out of doors.

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Some features common to all urine diverting toilets are a toilet seat (at least in Western-style designs), a partitioned bowl (or some allowance for the separation of urine from feces), a removable container for the storage of urine (or a drain that leads to a soak-way), a chamber or a removable container for the storage of feces, a passive or active ventilation system connecting the feces chamber/container to the outside world (designed to create a partial vacuum in order to prevent odors in the bathroom and to contribute constant airflow to assist in drying or *dehydrating* the feces - which, by the way, is 80 percent water) and a structure of some kind that conceals the internals of the toilet from view.

Other features may include a mechanically operated trap door for covering the feces chamber/container in between uses and some allowance for stirring or turning the contents of the feces chamber/container (to promote drying).

And although, just like their composting toilet relatives, UDDTs tend to fall into one of two major categories - those that are 'remote' and those that are 'self-contained' – there's no need to detail the specific differences as these should, by now, be self-evident.

With both composting toilets and UDDTs current state law permits the byproducts of these toilets to be buried, however, the only land this can be accomplished on in land known to meet the requirements for a leach field. We'd like to see this requirement eased in the final version of H.375.

With any luck, in future hearings, you will hear more about specific projects underway in Vermont and Massachusetts related to these technologies, and specifically:

- Brattleboro's Rich Earth Institute and its first of its kind in the U.S. urine recycling study;
- The multiple decade's long history of the Green Mountain Club utilizing site-built composting toilets in the backcountry of Vermont;
- The Vermont Law School's experience with its installation of remote composting toilets;
- From Hartland, the Cobb-Hill Co-Housing group's experience with its installations of remote composting toilets; and
- The Cape Cod community of Falmouth's experience with its innovative eco-toilet pilot project

Moreover, following my presentation, you will also learn about what is taking place in the rest of the country to legislate sustainable sanitation.

But now, let me transition into a brief overview of international sustainable sanitation efforts.

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Part 3: <u>International Sustainable Sanitation Efforts</u>

We all know that Vermont is no longer isolated from the rest of the world and that it's the globalized nature of information that allows us to learn from the best of the best. Well, as I alluded to earlier and promised to return, there are numerous sustainable sanitation endeavors underway in other parts of the world that I hope will be able to serve as inspirations for what we can accomplish here in Vermont and also the potential that exists for Vermont to become a leader in the West in these kinds of

innovative approaches to sanitation that are already serving other peoples not only well, but better than those systems that we take for granted here at home.

Insert Slide 25

I will begin this section by playing a brief snippet from a video recorded by IDUBE Media in which Neil Macleod provides a summary of his organization's approach to sanitation. Mr. Macleod is the person who prior to his recent retirement as Head of Water and Sanitation at eThekwini Water and Sanitation, was responsible for the provision of water and sanitation services to 3.5 million people in Durban, South Africa. As you watch, I urge you to keep in mind that during his tenure, Mr. MacLeod oversaw the single largest roll-out of UDDTs in one municipality that the world has ever seen, some 82,000 (and growing!) that serve over half a million people.[36] For comparison, Vermont's population currently sits at just under 627,000. Also, please note that "eThekwini" is the original Zulu name given to the place that white South Africa re-named "Durban".

Insert Slide 26

Insert Slide 27

In eThekwini it's the local water and sanitation department where you go to sign up for a free UDDT and, if you'd like, a waterless urinal too. It should be of great interest to note that not only do participating customers of the eThekwini municipality benefit from annual complimentary emptying of the desiccated contents of their UDDT's feces vaults but more and more are actually being paid for the urine they produce (and which is also picked up for free!). You heard me right. Based upon the exchange rate at the time of writing, participating customers are paid the equivalent of about US$1.64 for each 20 liters (5.2 gallons) of urine they produce. For the average household which consists of six or more people and which produces two 20 liter jerrycans of urine a week this equates to additional annual revenue for that household of ~US$170; which is substantial in a part of the world where the unemployment rate is at 30% and 42% of the population earns less thanUS$3150 a year.[37,38]

Feces culled from the dual-vault style toilets is at present being buried on site, which is more than appropriate given the material's adequate retention time (two years) that, as I discussed above, works to dramatically reduce the risk to humans. Also, since the vast majority of the nutrients that we expel from our bodies is excreted in our urine and not our feces, there's very little risk that this material will pollute groundwater.

Insert Slide 28

Also valid to this discussion, is the fact that the eThekwini municipality in conjunction with the Swiss Federal Institute of Aquatic Science and Technology (EAWAG) has recently completed a study that examined the feasibility of three methods all aimed at isolating the nutrients present in urine (with an eye toward reuse).

Insert Slide 29

The first was the production of struvite (perhaps most familiar to us in this room as kidney stones) in which upwards of 90% of the phosphorous and a portion of the nitrogen (but none of the potassium)

was precipitated out of urine using some form of magnesium, like bittern (the salty brine produced during sea salt production) or, in eThekwini's case, magnesium salt. The granulated crystals which result from this process are, according to the open-source Sustainable Sanitation and Water Management website, an odorless and easy to store, "…bioavailable, slow-release fertilizer."

Insert Slide 30

The second was the more complex dual processes of nitrification and distillation. Remarkably, this combined process yielded, "…practically all the nutrients [present in urine] in one concentrated solution."[39] The third involved several different forms of electrolysis which were found, respectively, to, "…prevent environmental pollution and malodour," aid in the nitrification process and better facilitate the extraction of nutrients when undertaking a struvite precipitation process.[40]

Insert Slide 31

Moving across the Atlantic to Sweden…

Insert Slide 32

Moving now to the Americas, a program that's been underway for a few years in El Alto, Bolivia (an outgrowth of the capital city of La Paz), has recently garnered international recognition for its ability to provide low cost and highly effective sanitation services to a growing list of customers while also creating a local source of nutrient rich fertilizer for area farmers. Mirroring some aspects of the eThekwini program, albeit on a much smaller scale, the 4,500 participants can take additional pride in the knowledge that their urine and feces (following a storage period for the former and a managed composting process for the latter) are both provided to area farmers for use as nutrient rich fertilizer (urine) and soil amender (composted feces).

Insert Slide 33-34

Moving north to Haiti…

Insert Slide 35

Moving back across the Atlantic to Finland…

Insert Slide 36

Moving back to South America…

Insert Slide 37

Moving to China…

Insert Slide 38

As I've described, a revolution in sanitation is already underway in other parts of the world and it's our hope that Vermont will soon follow and, eventually, become a leader.

Thank you for your patience and for your willingness to learn from others!

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