UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Diverting Waste, Conserving Natural Resources: Composting Toilets for the New SUB

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DIVERTING WASTE, CONSERVING NATURAL RESOURCES: COMPOSTING TOILETS FOR THE NEW SUB

Composting Toilets in the New SUB - Executive Summary 2
Introduction 6
Context: the current system 9
Findings 13
Designing for sustainability: green building 13
Social norms: challenges and opportunities 16
Regulations: the current state of affairs 18
Conclusions and Recommendations 22
Appendices 22
Appendix A: NSF Standard 41 23
Appendix B: Nutrient, pathogen and heavy metal test results for the C.K. Choi system (2007–2008) 35
Appendix C: Maintenance manual for C.K. Choi Building at UBC 41
Appendix D: Architect – building maintenance communications re: C.K. Choi system 48

Composting Toilets in the New SUB - Executive Summary

The AMS has adopted the Lighter Footprint Strategy showing student interest in and support for the pursuit of a reduced campus environmental impact. The project of building a new SUB for UBC students presents the AMS with a significant opportunity to demonstrate this commitment on a uniquely large and high profile scale.

Our management of human excreta is an area in which we can begin to replace linear, extractive, wasteful practices with ones that more closely resemble the natural cycling of nutrients and other resources in ecosystems. Composting toilets incorporated into the design and maintenance of buildings can be a facilitating infrastructure component of such an alternative excreta management system. Incorporating a composting toilet system into the new SUB would place the AMS and UBC amongst the world's leaders in both the practice of and research on ecologically sound and beneficial excreta management and leading edge institutional sustainability practices.

There is also tremendous potential for experiential education through a composting toilet system in the SUB. There are few subjects considered more taboo than human excreta and our relationship with them; yet the issues surrounding excreta management are important to sustainability and health. A composting toilet system, including promotional materials and signage, is a way to engage UBC students, faculty, staff and visitors on many levels with the issues surrounding human excreta management and environmental sustainability in general.

Goals of Human Excreta Management A composting toilet system can be used to accomplish the fundamental goals of human excreta management:

- ❖ Ecosystem Health:
  - *Prevention of ecosystem pollution*. The end-product of the system is a concentrated, non-toxic, and environmentally stable as compared to the discharge from sewage treatment plants which are dilute, frequently toxic and environmentally active.
  - *Completion of the human nutrient cycle* by reuse of treated excreta in food production systems.
- ❖ Human Health: *elimination of the disease potential of excreta*. The composting process creates an environment foreign to pathogenic organisms which are therefore eliminated as a result of unsuitable temperatures and competition by other organism better suited to life in compost.
- ❖ Psychological: *elimination of disgust generated by excreta*. Composting and system design eliminate odors; sightline can be minimized by system design.

Serious questions remain about the fate of pharmaceuticals and personal care products (PPCPs) in the end product of composting toilet systems. These chemicals have the potential to cause problems for human and environmental health when applied to land (in admixture with the compost). However, the situation is not better with the conventional sewage system; in fact, composting may be better at metabolizing and/or stabilizing many PPCPs than conventional wastewater treatment processes. Because the PPCP issue will be present in any excreta management system, a composting toilet system creates potential for extensive research in this area.

Green Building Frameworks Composting toilet systems require no water for operation and can therefore reduce overall water consumption of a building. Green building standards such

as LEED and the Living Building Challenge recognize the ecological importance of water conservation, and therefore offer "credit" for "waste" management systems that reduce water usage.

LEED. The LEED rating system document (2009) recommends "toilets connected to composting systems" to achieve Water Efficiency prerequisites and credits. A composting toilet system would reduce the blackwater (water contaminated by feces and urine) generated in the building by 100%.

- ❖ The number of points possible by way of the composting toilet system is dependent on the proportion of *total* estimated water use that blackwater would represent for the SUB facility assuming conventional sewage connection.
  - The composting toilet system would likely satisfy the prerequisite of an overall 20% reduction in water.
  - From Credit 1, at least 2 points could be gained by the composting toilet system, since potable water use for sewage conveyance would be reduced by 100%.
  - There are a possible two to four points from Credit 2 distributed over the range of 30% to 40% reduction of total estimated water use.
  - Extra points in the "exceptional performance" category may be possible as well if the system reduces total estimated water use by more than 40%.

Actual points possible will depend on building estimations that are not yet available.

Living Building Challenge. As in the LEED rating system, a composting toilet system would likely be valued under the LBC's "Water Petal," owing to the water conservation inherent in the system. There is, however, potential for composting toilets to be valued under other of the LBC's "petals" because of the concept of "scale jumping" which allows LBC projects to accomplish some of the prescribed functionalities by means of sharing resources and/or infrastructure with neighboring and related projects.

The standard dictates that land be set aside for urban agriculture. It may be worthwhile to investigate whether there is room in the LBC to account for the agroecological benefit of the compost end product if the necessary connection to agriculture could be made.

Clivus Multrum. For commercial-scale composting toilet systems, Clivus Multrum is an experienced consultant. They also design, manufacture, and maintain their own systems. An example of their work on UBC campus is the C.K. Choi Building housing the Institute for Asian Research. Installed in 1996, the system has been relatively problem-free. In addition, they have installed a large system for the Bronx Zoo in New York, which accommodates up to ½ million uses per year. They work with the design team, engineers, and architects to design and manufacture a composting toilet system specific for a given building project.

Maintenance Considerations AMS should consider the increased maintenance that a composting toilet system will require when compared to a conventional sewage connection. Because UBC Custodial and UBC Building Operations would likely be responsible for maintenance of the toilet system,[1] this increased requirement for management would increase AMS's interaction with these "outside" groups. Clivus Multrum, if engaged, will likely offer maintenance services for the system. This option should be considered, at least initially, in order to train maintenance staff and develop recordkeeping and documentation for the system.

[1] Andreanne Doyon. 2010. Personal communication.

Regulations BC provincial legislation does not mention composting toilets explicitly. The conventional water-based sewage system is regulated under a complex of legislation administered mainly by the Ministry of Health Services, the Health Authorities, the Ministry of Environment, and municipalities. Current legislation does not recognize on-site treatment systems as an option for contexts where the conventional water-based system is available. Even in cases where on-site ("alternative") systems are considered, only water-based on-site systems are described. Therefore, there is very little precedent in current legislation on which to base the case for composting toilets.

However, the BC Building Code allows for "Alternative Solutions" to standard requirements of the Code. An Alternative Solution requires that a qualified professional submit a design and professional statement of opinion on the alternative system. Once the proposal is accepted, the alternative system can be installed. However, UBC will likely opt to seek approval from Vancouver Coast Health (VCH) Authority before moving forward on any alternative human excreta management system because VCH can act as a provincial authority under the Health Act and shut down any systems it deems unsafe.

Recommendations and Further Research

Following review of an earlier version of this paper by the new SUB coordinators in early 2011, it has been decided that composting toilets will not be included in the new building. Greywater toilets will be employed in the building. The main reasons for this decision are cost and apprehension about social acceptability of the composting toilet system. Further, the logistics and legalities surrounding the use of the end-product (finished compost) remain unresolved. While composting toilets will not be used in the new SUB, there is still ample room to pursue their inclusion in future developments on UBC's campus. The issues outlined in this report remain pressing.

The following recommendations should be considered when pursuing future composting toilet projects.

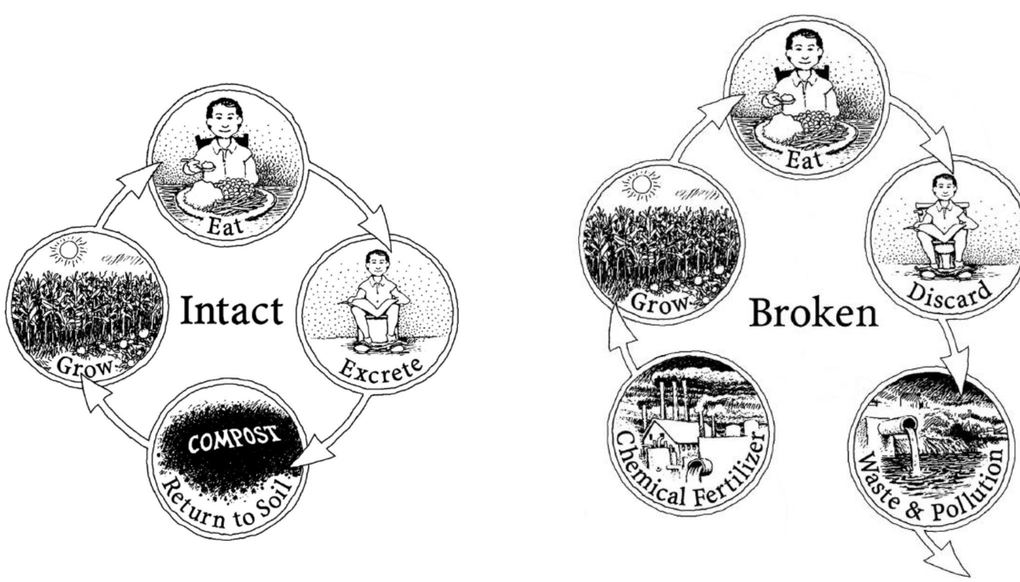
- ❖ Engage Clivus Multrum. They need to be involved from the beginning of the design process, since the system must be fitted to each building project.
  - Feasibility assessment for the planned design of the new SUB – can the entire building by accommodated by composting toilets?
  - Economic assessment for the installation of the system.
  - Feasibility assessment in terms of maintenance requirements.
  - An alternative scenario to consider depending on the outcomes of the above: install one or a few composting toilets as a "demonstration" of the system, rather than using them for the entire building
- ❖ Begin engagement with relevant regulatory authorities: UBC Building Operations, UBC Health, Safety and Environment, and Vancouver Coastal Health Authority. An "alternative solution" will need to be drafted by the engineers, working with Clivus Multrum, and submitted to UBC Inspections for approval.
- ❖ If implemented, develop a detailed life cycle plan for the system.
  - Work with Clivus Multrum to train maintenance staff and develop a detailed maintenance plan and recordkeeping for the system.
  - Research: what to do with the end products

- pursuing regulation under the Organic Matter Recycling Regulation?
- connection to UBC Farm and/or other local agriculture; use in Plant Ops compost to improve nutrient quality

Introduction

The purpose of this paper is to promote the adoption of new more ecologically sound attitudes and practices regarding human excreta management by the stakeholders of the new Student Union Building (SUB) at UBC. It also attempts to outline the challenges to be faced in the pursuit of sustainable sanitation. This paper focuses its exploration of sustainable sanitation options on composting toilet technologies.

Although there are other technologies that potentially could be implemented in the context of sustainable sanitation, such as biogas generators and wetlands bioremediation, for example, composting most closely matches natural terrestrial systems of nutrient cycling and it complements the way we produce the majority of our food. Animals excrete their bi-products onto the soil where they are digested by a diversity of micro and macro-organisms. This digestion releases plant nutrients into the soil where they promote plant growth. Plants are eaten or eventually die and contribute carbon to the soil. Soil is built in this way. Human-mediated composting is simply a concentrated form of this natural process. Composting also yields an end product that is readily useful as an agricultural soil amendment. The majority of the food we consume comes from agriculture, so it makes sense to return what we take from the land being worked to sustain us. Indeed, many agricultural soils are in desperate need of composted organic material because we have abused them over many hundreds of years. The overall sustainability of agriculture is, of course, a question. Yet we will never reach anything resembling sustainability while we continue to take food from the soil and then neglect, in turn, to feed it. And when the great circle is followed from beginning to end, it is clear that eventually the food we nourish ourselves with is the very food that the soil needs to be nourished.



a b

Images © Joseph C. Jenkins. (2005). The Humanure Handbook (3rd ed.)

Figure 1 The Human Nutrient Cycle. a) Intact. b) Broken. The current method of managing human excreta, represented by the open or “broken” diagram on the right, treats excreta as waste and discards them, causing pollution, wasting their benefit to the soil, and requiring the production and application of synthetic nutrient replacements. Intact systems, represented by the closed or “intact” diagram on the left, regard excreta as valuable agricultural and ecosystem resources and reuses them in the production of food, fiber, and biomass crops, helping to create a waste-free system of human sustenance.

It is possible to achieve the fundamental goals of conventional water-based sewage systems without high-tech, water and energy intensive solutions required by it. For the purposes of this paper, there are three fundamental goals to consider:

- From an *ecological perspective*, the fundamental goal of excreta management is two-sided:
  - prevention of ecosystem pollution and
  - completion of the human nutrient cycle by reuse of treated excreta in food production systems.
- From the *human health perspective*, the goal is the elimination of the disease potential of excreta.
- *Psychologically*, the fundamental goal of human excreta management is the elimination of disgust generated by excreta.

The conventional water-based sewage system over its history has both addressed and exacerbated all of these goals. It is making progress in all of these areas, but at increasing ecological, economic, and social costs. Adopting waterless on-site treatment of excreta, utilizing effective composting techniques and technologies, has the potential to accomplish all of the goals of human excreta management with many fewer of the ecological costs incurred by the current system. The most profound benefits of a composting toilet system are ecological: water and energy savings, prevention of pollution, and the potential to close the human nutrient cycle.

Sidebar 1 Composting – the *What* and the *How*

Composting in a process by which naturally occurring complex organic materials are broken down into simpler components and transformed into a stable soil-like substance that is a vital component of both agricultural and uncultivated soils. In essence it is the same process that happens on the forest floor or under the mantle of prairie grasses: plants die and animal defecate and die and decompose, building soil mass and bringing nutrients to the surface. Composting replicates this process in a more or less controlled environment in which relatively large amounts of organic materials are gathered and processed which increases the rate of decomposition (as well as the heat generated). Composting is a metabolic biological process run by many species of bacteria, fungi, and invertebrates. These organisms utilize the energy and nutrients available in dead complex organic materials for their own life processes and eventually convert raw materials into a finished, stable product – compost. The process of natural selection plays itself out in the compost process as well: only those organisms that are suited to life under composting conditions can persist. This means that pathogens that thrive in the human body are not favored in a compost pile and are soon out-competed or killed by excessive heat.

Composting toilet systems, and decentralized systems in general, also present new challenges. Because they should only collect excreta, greater user awareness will be required to prevent contamination by non-compostable materials. Further, decentralization of processing will require an increased number of people with the ability to operate the systems safely and effectively, as compared with centralized systems that can be maintained by relatively few trained professionals in a centralized and highly controlled environment. Finally, the use of the end-product of the composting toilet system must be considered. A framework, not yet developed, for ensuring safety and facilitating and controlling agricultural re-use is required for a composting toilet system to fulfill its potential benefits.

Composting toilets are an inherently integrative technology, as they combine many of the issue areas to be addressed by sustainable sanitation: reduction of water and energy usage, nutrient recycling, and social consciousness of environmental issues. This integrative quality has benefits as well as challenges. Most often we approach excreta management in an isolated (even disciplinary) way. As long as the primary or immediate goals of excreta management are accomplished, it does not matter if the means used cause more problems somewhere else in the system. Further, social awareness of the issues surrounding excreta management is rarely if ever a goal of such approaches. Such approaches have contributed to massive overuse of water and energy, reliance on synthetic and mined sources to maintain soil fertility, and a populace that thinks it can simply flush its problems away. However, it is clear that on this planet, the principles of ecology must ultimately be respected in order to maintain dynamic equilibrium. It is possible that one of the key factors in creating a sustainable approach to excreta management is just this issue of social awareness and knowledge. Integrating knowledge into the system in an evenly disbursed way could have the beneficial effect of empowering the system's users rather than cutting them off or allowing them to "not care". We have the opportunity to "push the envelope" towards a society whose members know (and hence must take responsibility for) what their physical existences mean to the ecosystems that support them. Composting toilets can turn a large problem into a large benefit for our food system and environment.

Large scale and potentially irreversible environmental disruptions are inevitable if disequilibrium conditions are maintained too long. Our culture's conventional approach to human excreta management is only one in a vast array of ways in which we maintain disequilibrium with the environment. Rectifying it will not solve all of our problems, but there is certainly a great potential to step in the right direction. Further, industrialization and urbanization have radically altered both the spatial dynamics and the scale at which human-environmental issues take place. "Cottage" solutions that may work on the scale of small communities distributed fairly widely over landscapes are often infeasible in the context of urban concentration and population densities.

Context: the current system

Water-based sewage systems share the history of industrialization[2] and more broadly the history of urbanization. In general, humans and some other animals tend to avoid their own excrement. We can understand why: disease. In the case of humans, many (though not all) cultures have developed an attitude toward excreta such that

> […] the perceived ideal normative state of excreta disposal and handling is that of treating it as though it did not exist. Avoiding or denying the subject on a psychological level is considered preferable in most cultures.[3]

People living in densely populated cities experience both the real and perceived problems of excreta in an intensified way when compared to low-density rural living situations. Centralized, high capacity water delivery and disposal systems allow these urban people to perceive themselves as fulfilling the "normative state" regarding excreta, that is, pretending as though they do not exist, by simply flushing them away. At the advent of these systems, when flushing excreta often led directly to contamination of drinking water and the spread of disease because the systems emptied directly into nearby water sources, health outcomes did not necessarily correlate with fulfilling this "normative state". As understanding of disease and pollution evolved, however, so too did the water-based system evolve, notably by incorporating treatment of the wastewater before discharge, to offer real health benefits to urban populations.

However, the conventional water-based sewage system (CWBSS) has continued to cause multiple problems for the environment and for society. The CWBSS:

- pollutes water and disrupts receiving ecosystems with excess nutrients as well as industrial chemicals,
- overuses water resources, and
- wastes soil resources and requires the extraction, processing, and application of replacement nutrients, all of which have adverse environmental effects.

The CWBSS is generally an "all-in-one" municipal collection system – as is the case for Vancouver – collecting domestic, storm drain, and industrial wastewater streams, and it is common for pollutants from industrial production to be collected and managed by the same system. For this reason, heavy metals and persistent industrial chemicals are commonplace in sewage sludge and treated blackwater. Under current law, wastewater sludge and sludge composts are permissible soil amendments. Despite current research into nutrient and metal recovery and chemical deactivation technologies, by and large the conventional sewage system is remains an important conduit through which soil resources used to feed human populations are removed from agroecosystems and by which farmland and aquatic ecosystems are polluted and degraded. The removal of agricultural nutrients requires resource intensive synthetic fertilizers,

[2]Valiente, M. 2007. Book review of The Culture of Flushing [Benidickson, J. 2007. Vancouver: UBC Press]. Available online from: http://ohlj.ca/english/documents/OHLJ_45_3_Valiante_FINAL.pdf.
[3]Rosenquist, L. E. D. A psychosocial analysis of the human-sanitation nexus. Journal of Environmental Psychology 25:3(335-346).

which contribute to loss of soil biodiversity, decreased soil organic matter, and overall soil degradation processes,[4] to make up the loss. Improved nutrient removal technologies have been and continue to be developed, but in general, improvement of technology in one sense or aspect simultaneously means "more costly" as well as "more resource intensive" in other components of the system[5] At the same time, it has become necessary to legislate "acceptable" levels of heavy metals and other toxic industrial pollutants when applying the nutrients recovered from the conventional sewage system on agricultural land. However, from the ecosystem perspective, there is probably no acceptable level of industrial contamination of farmland or any land.

Moreover, each of these problems associated with using water to flush excreta "away" almost intrinsically assumes the large-scale availability and use of energy:

- polluted water must be conducted away from the site of its original use for treatment
- treatment processes require energy for heating, aerating, agitating and otherwise manipulating the blackwater
- treatment requires the use of resource-intensive chemicals for disinfection, nutrient removal, and other resource recovery.

In the early days of the CWBSS, with smaller populations using fewer resources, there was no reason to foresee shortages of natural resources which we are experiencing today. The CWBSS exacerbates the interconnected water, energy and natural resource crises that are coming to characterize our era of history. Heavy investment in centralized sewage systems and the perceived fulfillment of the desire to disappear the excreta problem have resulted in a general focus on improving the existing system while maintaining its basic tenets. Indeed, most of us do not even know that other options exist.

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[4]Bulluck III, L.R., M. Brosius, G.K. Evanylo, J.B. Ristaino. 2002. Organic and synthetic fertility amendments influence soil microbial, physical and chemical properties on organic and conventional farms. Applied Soil Ecology 19:147–160.
[5]Foley, J., D. D. Haas, K. Hartley, P. Lant. 2010. Comprehensive life cycle inventories of alternative wastewater treatment systems. Water Research 44(5):1654-1666.

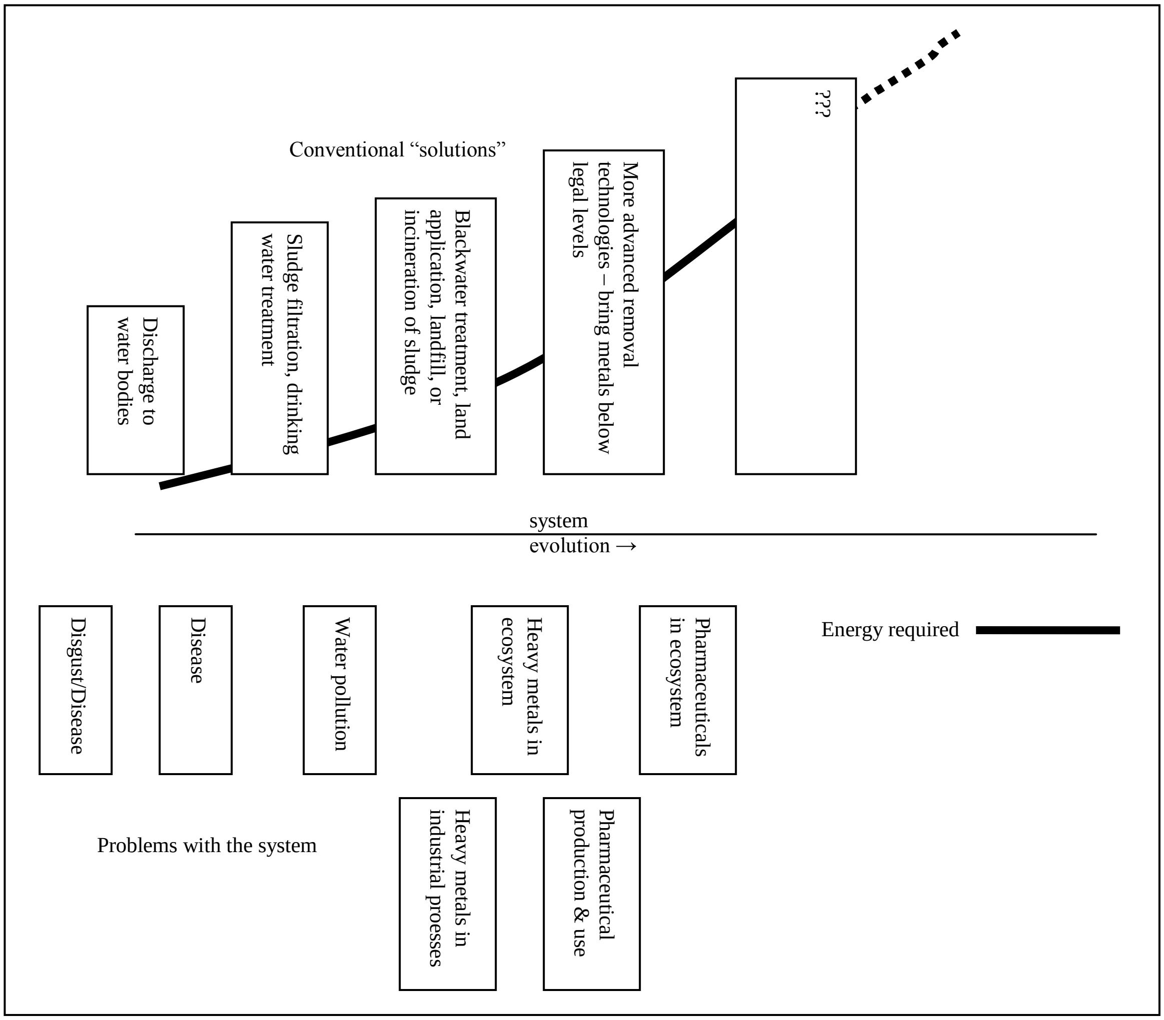

Figure 2: Evolution of the conventional water-based sewage system. This figure shows the evolution of the conventional system in response to excreta-related problems caused or left unsolved by it, as they have become apparent to society. The energy required to pursue the chosen solutions is included as well. It is not meant as a quantitative representation but as a representation of the general trend of increasing energy to achieve the required health and safety outcomes.

Perhaps it is time that as a society we ask: will water-based systems ever be sustainable? In the current discourse on "sustainability" of human systems, there is a tendency to conflate *better* practices, behaviors, and attitudes, when compared with the status quo, with ones that may contribute to true sustainability. Sustainability will require that the practice, behavior, and attitude changes we make create fewer and more approachable problems than those they address. There is certainly an argument to be made that the attempts thus far to rectify the CWBSS have created significant problems that may be more difficult to approach than the problems they have tried to address. New technologies developed to solve the emerging ecological and health problems associated with water-based sewage systems tend to be expensive and resource intensive, and growing populations multiply these increased costs and require expansion of treatment facilities and conveyance systems requiring significant resource usage. While new technologies may appear to be solving problems with our sewage system, the benefits must be weighed against increased impact elsewhere in the supply chain that allows those technologies to function. Comprehensive life cycle assessments reveal increasing resource intensity even as more agriculturally valuable nutrients are recovered and less ecosystem-damaging chemicals are discharged using new technologies.[6] Certainly, it is a *better* practice to recover nutrients and prevent discharge of dangerous chemicals than to allow waste and pollution. But if these "solutions" require pollution and resource depletion elsewhere, we enter into an ecological catch twenty-two. Perhaps it is time to rethink excreta management altogether.

[6]Stokes, J. R. and A. Horvath. 2010. Supply-chain environmental effects of wastewater utilities. Environmental Research Letters 5(1).

Findings

Designing for sustainability: green building

AMS Lighter Footprint Strategy and Sustainability Charter

The AMS has adopted the Lighter Footprint Strategy showing student interest in and support for the pursuit of reduced campus environmental impact. The project of building a new SUB for UBC students presents the AMS with the opportunity to demonstrate this commitment on a relatively large scale. Incorporating a composting toilet system in a large building such as the new SUB would place AMS amongst the world's leaders in ecologically sound human excreta ("waste") management systems.

The ecological benefits of a non-water based system for human excreta management, including water and energy conservation and pollution prevention, will be realized continuously for the life of the building. Further, implementing such a system provides a unique opportunity for new research that will only be possible once this kind of toilet system is available for study. One of the most potentially far-reaching benefits of installing a composting toilet system is that it may one day provide a positive ecological (and agroecological) service by recycling the nutrients passed through human individuals and allowing for their safe, ecologically beneficial, and agronomically effective reuse in agricultural production.

Canadian Green Building Council / LEED Canada 2009[7]

The LEED rating system document recommends "toilets connected to composting systems" to achieve Water Efficiency prerequisites and credits. A composting toilet system would reduce the blackwater (water contaminated by feces and urine) generated in the building by 100%.

The number of points possible by way of the composting toilet system is dependent on the proportion of *total* estimated water use that blackwater would represent for the SUB facility assuming conventional sewage connection.

- The composting toilet system would likely satisfy the prerequisite of an overall 20% reduction in water.
- From Credit 1, at least 2 points could be gained by the composting toilet system, since potable water use for sewage conveyance would be reduced by 100%.
- There are a possible two to four points from credit 2 distributed over the range of 30% to 40% reduction of total estimated water use.
- Extra points in the "exceptional performance" category may be possible as well if the system reduces total estimated water use by more than 40%.

The precise proportion of total estimated water usage that blackwater would represent is unclear at this point. However, it is important to note some water-using appliances and associated activities that the LEED rating system does not consider in Water Efficiency:

- Commercial Steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers
- Commercial (family –sized) Clothes Washers

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[7]Canada Green Building Council. 2010. LEED Canada 2009 for New Construction and Major Renovations. Available online from: http://www.cagbc.org/uploads/LEED/NC/LEED_Canada_NC_CS_2009_Rating_System-En-Jun2010.pdf. Accessed 7/26/2010.

- Residential Clothes Washers
- Standard and Compact Residential Dishwashers.[8]

Appliances that *are* counted in Water Efficiency are:

- Commercial Toilets
- Commercial Urinals
- Commercial Lavatory (Restroom) Faucets
- Commercial Showerheads
- Commercial Pre-rinse Spray Valves (for food service applications)
- Residential Toilets
- Residential Lavatory Faucets
- Residential Kitchen Faucets
- Residential Showerheads.

Without building usage estimates, it is difficult to project what percentage of total water usage blackwater would represent, and therefore how much water use reduction and consequent Water Efficiency points a composting toilet system could achieve. However, food service is likely to be a large proportion of the water demand in the building and some food service-related water-using appliances are not counted in LEED Water Efficiency estimates. It is therefore possible that blackwater will represent a proportion of the SUB's water use that would allow a composting toilet system to achieve the higher end of the points scale in the LEED Water Efficiency section.

International Living Building Institute / Living Building Challenge

As in the LEED rating system, a composting toilet system would likely be valued under the LBC's "Water Petal," owing to the water conservation inherent in the system. There is, however, potential for composting toilets to be valued under other of the LBC's "petals" because of the concept of "scale jumping" which allows LBC projects to accomplish some of the prescribed functionalities by means of sharing resources and/or infrastructure with neighboring and related projects.

Especially noteworthy in the LBC with respect to a composting toilet system at the new SUB are the urban agriculture requirements. The standard itself dictates that land be set aside for urban agriculture commensurate with the size of and inversely proportional to the density of an LBC project[9]. A composting toilet system has the potential to generate a more renewable, much less energy and resource-intensive soil amendment which could be used in urban and non-urban agricultural contexts. It may be worthwhile to investigate whether there is room in the LBC to account for this environmental benefit if the necessary connection to agriculture could be made.

When considering waste management systems in terms of the LBC, the most important factor to keep in mind is, of course, water consumption. However, energy consumption must also be considered since LBC requires that buildings consume no energy on net. With this in mind, on-site energy-from-waste systems that utilize methane capture and reuse might appear to be a good option, but there are two problems: how to treat the conveyance water used in biogas

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[8]Canada Green Building Council. 2010. LEED Canada 2009 for New Construction and Major Renovations. Available online from: http://www.cagbc.org/uploads/LEED/NC/LEED_Canada_NC_CS_2009_Rating_System-En-Jun2010.pdf. Accessed 7/26/2010.

[9]McClennan, J. F. and E. Brukman. 2010. Living Building Challenge Standard Document 2.0. International Living Building Institute and Cascadia Green Building Council. Available online from: https://ilbi.org/lbc/Standard-Documents/LBC2-0.pdf. Accessed 6/3/2011.

systems; and the fact that according to the LBC standard, combustion of any kind is not allowed when generating energy for the building[10]. With these problems in mind, the very low energy and no-water composting toilet system has distinct advantages from the perspective of the LBC. A further disadvantage to methane systems is that they remove carbon from the system: it is burnt off as methane. While methane captured and used in this way displaces some need for non-renewable natural gas, it also lowers the carbon content of any fertilizer made from the end-product. Carbon in compost stabilizes other nutrients (e.g., nitrogen) in the soil, directly preventing their loss to erosion, and provides energy to soil biota which otherwise will be taken from the soil's organic matter reserves, depleting them and leading to further erosion and soil degradation.

Clivus Multrum

As discussed, composting toilets hold the potential to benefit human relationship with the environment. Both LEED and the LBC recognize (if implicitly) the water conservation benefits of on-site composting toilet systems. This benefit goes hand in hand with the pollution prevention benefits that are inherent in no-water systems. There are the additional potential food system benefits of creating the possibility of closed-loop human nutrient cycles, reducing the costs and environmental toll associated with chemical fertilizer production and application.

The next question is: how does one turn the potential into the real? How does one install and operate a composting toilet system?

Clivus Multrum (www.clivusmultrum.com) is a firm based in Massachusetts, USA that specializes in just this area: designing, manufacturing, and maintaining composting toilet systems for a range of building project scales, from public parks to commercial buildings. When engaged in a commercial-scale project, they work from the beginning of the design phase with the engineers and architects to custom design a system for the building. They manufacture the composting units and fixtures specifically for the project at hand. Once installed, they offer maintenance, support, and educational services to clients for the lifetime of the composting toilet system.

There is an example of Clivus Multrum's work on UBC campus. The C.K. Choi Building, which houses the Institute of Asian Research, utilizes a Clivus Multrum composting toilet system to handle all of the excreta generated by building occupants. According to the facilities manager for the Choi Building, the system has been relatively hassle free and has not broken down over its 14 year history. Other case studies of Clivus Multrum's work are attached in the Appendices section of this report. Further research is needed to assess the feasibility of including composting toilets into the specific project we are approaching with the new SUB. Clivus Multrum should be consulted if composting toilets are pursued further for the building.

[10]McClennan, J. F. and E. Brukman. 2010. Living Building Challenge Standard Document 2.0. International Living Building Institute and Cascadia Green Building Council. Available online from: https://ilbi.org/lbc/Standard-Documents/LBC2-0.pdf. Accessed 6/3/2011.

Clivus Multrum is recognized by the United States Green Building Council and the United States General Services Administration[11]. Its products comply with the National Sanitation Foundation's Standard 41, "Non-Liquid Saturated Treatment Systems"[12]. NSF is accredited by the Standards Council of Canada[13].

Social norms: challenges and opportunities

A composting toilet excreta management system, by virtue of being quite distinct from conventional human excreta management systems, will likely cause a heightened awareness of everyday excreta-related activities and practices in the using population as well as the maintenance staff. Owing to the general fecophobia ("fear of feces"; may or may not include urine) that is likely to characterize most potential users and maintainers of the system[14], this heightened awareness is likely to generate negative impressions or perceptions of the system even before actual interaction with it. At the same time, a composting toilet system will require several real behavioral changes from both system users and will require new behaviors from system maintenance staff. Therefore, it will be imperative to educate both users and maintenance staff about the system and its requirements, as they differ from the conventional system being replaced, such that non-rational negative impressions are overridden *and* proper use and maintenance of the system, through adoption of changed behaviors suited to the new system, are assured.

Addressing fecophobia:

According to informal interviews with several members of the UBC community, some of the issue areas that are likely to inform negative impressions in both the user population and the maintenance staff in regards to a composting toilet system are: odors, disease-causing organisms, and final fate of the end-products. The composting toilet system is capable of treating human excreta in such a way as to achieve favorable outcomes in these issue areas.

My own personal experience and personal communication with other users has shown that the composting toilet system in active use at the C.K. Choi Building, which is the most likely the type to be used in the new SUB, is not malodorous; the washrooms have no detectable odor of any kind. The Clivus Multrum system in use at C.K. Choi accomplishes the odor-free state by the use of an always-on, low-power electric ventilation system that creates negative pressure in the toilet and collection bin, removing the air to the atmosphere.[15] This fan can be wired such that it will stay on during emergencies when normally all power would be off in the building.[16]

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[11] Clivus Multrum. 2011. Accreditations. Available online from: www.clivusmultrum.com/associations.php. Accessed 6/3/2011.

[12] NSF International. 2011. NSF/ANSI Standard 41: Non-Liquid Saturated Treatment Systems [Clivus Multrum's accreditation information]. Available online from: http://nsf.org/Certified/Wastewater/Listings.asp?TradeName=&Standard=041. Accessed 6/3/2011.

[13] NSF International. 2011. Accreditations. Available online from: http://nsf.org/regulatory/about_regulatory/accreditations.asp. Accessed 6/3/2011.

[14] Rosenquist, L. E. D. A psychosocial analysis of the human-sanitation nexus. Journal of Environmental Psychology 25:3(335-346).

[15] Samodien, Greig. 2010. Personal communication.

[16] See Appendix D: Choi communications.

Perceptions and Practice:

Some people may use conventional toilets for purposes other than their primary intended use, that is, receiving excreta and urine. For example, women may regularly dispose of certain feminine hygiene products in the toilet. Others may deposit other non-biodegradable items in the toilet. A composting toilet system should not receive such non-biodegradable items, since they may inhibit proper function. Given this situation, implementation of a composting toilet system will require a degree of user education regarding which items must not be deposited in the toilet. Alternatively or additionally, this education could be presented positively by listing which items may be deposited in the system. The likely forum for presenting this information is inside the washroom stalls themselves, through the medium of informational posters or signs. Information might also be posted in the common space of the washroom. Additionally, the AMS could decide to “advertise” the system to some degree in the non-washroom areas of the new SUB. There is an opportunity to develop sensitive, effective, and appropriate “programming” for a composting toilet system that could be incorporated into broader sustainability endeavors in the new SUB.

A composting toilet system will require a new set of practices in order to maintain its function, such as adding carbonaceous bulking materials, maintaining proper moisture levels, and emptying finished compost. (A more detailed treatment of these new practices must be developed in consultation with the system designer). At the same time, compared with a centralized system which requires only irregular repair work, a generally higher level of maintenance will be required for a composting toilet system. Lastly, when dealing with the end-product a composting toilet system will require an increased level of interaction with other campus entities such as (potentially) Plant Operations, Health, Safety and Environment, or others. All of these maintenance-related issues and activities should be considered components of a composting toilet system.

Regulations: the current state of affairs

At present, composting toilet systems are not addressed explicitly in any relevant provincial legislation. The regulatory environment relevant to human excreta management has evolved mainly in response to the dominant method of handling the issue, that is, the conventional water-based system. Even where regulations do extend into situations where using conventional system is not feasible, such as construction in remote or rural areas, the influence of the dominant system is observable: only water-based alternative systems, such as septic tanks and leach fields, are considered under current regulation[17]. The use of water for excreta management appears to be considered necessary for a viable system.

The experience of the C.K. Choi Building bears this out: while the composting toilet system was allowed to be installed, the designers and engineers of the building were also required to make the building “sewer ready”; that is, they had to install all of the plumbing needed to connect to the conventional sewage system in addition to installing the composting toilet system. Regulatory bodies appear to be operating with a somewhat skewed version of the “Precautionary Principle,” erring on the side of the “proven” conventional system. The lack of precedent for composting toilets has so far meant little pressure on the regulatory system to evolve in such a way as to recognize and promote their benefits. Creating and extending that precedent is part of the opportunity that we have with the new SUB or with other new buildings on campus.

There are distinct areas of policy in different provincial ministries and municipal departments that are relevant to excreta management in general that have coalesced to create the current regulatory system. The two broad areas of policy that are involved are human health and environmental health. Because the regulatory system for the conventional sewage system is functional, its complexity and many components are somewhat opaque and difficult to assess. However, it is important to dissect them somewhat in order to understand how a composting toilet system would “match up” with the goals prescribed by existing policies. Because composting toilets function on a significantly different scale, with a different relationship to space, and generally in a very different way, and produce end-products that are significantly different from the end product of the conventional sewage system, there is not a completely clear picture of how this system “appears” from the perspective of existing regulations. Probably the best approach is to gain an overall picture of potentially relevant legislation and then enter into negotiation with relevant authorities as issues arise during design, implementation, and system maintenance. Table 1 provides an initial overview of relevant legislation.

Installing the system and running it is only one side of the issue, however. One of the goals of composting toilet systems, and sustainable sanitation in general, is to treat excreta as a resource rather than a dangerous waste product. While from a broader system perspective there is great potential to *improve* community health by utilizing empowering technologies such as composting toilets, for example by improving the quality of agricultural soils that support the community, the current regulatory environment focuses heavily on individual biomedical “health”, or (equivalently within the conventional arena of meanings) “absence of disease.” As such much emphasis is placed on disease potential. Currently there is a belief that “bigger is better” and that highly centralized and centrally controlled systems can ensure the absence of disease better than more disbursed, community oriented solutions. These beliefs have deep

[17] According to my perusal of BC’s Sewage Systems Regulation and other relevant legislation and regulations.

connections to the many other processes of the concentration of power, knowledge, and control in our society in the hands of "experts" and powerful people. There is much to be discussed and debated in this arena, but for the purposes of this paper, it is important to recognize the extremely entrenched barriers to establishing a closed-loop food production system utilizing composting toilets or other "alternative" excreta management systems.

Alternative Solutions in the B.C. Building Code

While there are certainly potential barriers to implementing a composting toilet system from the regulatory viewpoint, there is also a simple allowance in the B.C. Building Code for "Alternative Solutions" to replace standard requirements in the Code. An Alternative Solution requires that a qualified professional submit a design and professional statement of opinion on an alternative system. Then, the authority responsible for inspecting the construction project reviews and approves or rejects the Alternative Solution with room for appeal. This process is almost certainly going to be required if the new SUB stakeholders decided to pursue composting toilets. It is also likely to be sufficient to allow the installation and use of the composting toilet system. According to Ed Lin[18] at UBC Inspections, because a composting toilet system does not generate blackwater, it may not be subject to direct regulation by the Ministry of Health and Sport.

However, according to Dr. Nick Vassos,[19] a consultant at Novatec Consultants who has been involved with the wastewater system in the new Center for Interactive Research on Sustainability at UBC, the university will seek the approval of the Vancouver Coastal Health (VCH) Authority before beginning any construction project that takes an approach to human excreta management that differs from the conventional sewage connection. They seek this approval because VCH can act as a provincial authority under the Health Act and unilaterally shut down any system they deem to be causing health concerns. Further research is needed to determine what this approval process would consist in for the case of composting toilets.

[18]Lin, Ed. 2010 Personal communication.
[19] Vassos, Nick. 2010. Personal communication.

Table 1 The following table summarizes legislation that may be involved in regulation a composting toilet system. In the case of alternative systems, there is no explicit language in existing legislation that addresses their regulation; hence this table is not necessarily exhaustive and may contain legislation that turns out not to be pertinent.

Level of gov't	Institution	Relevant legislation	Relevance to human excreta management	Contact
Federal (Canada) **Acts**	Environment Canada	**Fisheries Act**	Regulates water quality of discharged wastewater	
Provincial (B.C.) **Acts**, *Regulations and subsections*	Ministry of Environment	**Environmental Management Act**	Forbids pollution of the environment without permits granted by the Act and authorized "directors".	
		Organic Matter Recycling Regulation	Provides guidelines for the creation and land application of biosolids (from wastewater treatment plants) and composts (including biosolids compost)	Linda Vanderhoek – Environmental Protection Officer – [redacted]
		Municipal Sewage Regulation	Regulates the design and discharge quality of municipal sewerage systems.	
	Ministry of Health and Sport	**Public Health Act**		
		Sewage Systems Regulation	Regulates onsite sewage systems (water-based) with daily flows <22,700 l. Environmental effects on human health.	
	Codes	**B.C. Building Code**	Standards used by engineers and architects for safety and efficiency in construction	
		B.C. Plumbing Code	The standard for plumbing installations; does not allow for onsite treatment when the conventional sewage system is available.	
Regional (B.C.)	Health Authorities (Vancouver Coastal Health)	**Public Health Act**	Gives approval for a sewage system in terms of human health; may act as a provincial authority – able to shut down any system deemed unsafe; UBC usually elects to seek their approval for all systems before	

			building begins[20]	
Municipal (UBC)	Plant Operations	(uses B.C. Building Code)		
	Building Inspections		Enforces the B.C. Building Code; accepts, reviews and approves submitted Alternative Solutions	Ed Lin – Chief Building Official – 604 822 0481
	In-vessel composter	Internal Regulations	Accepted the end-products of the Choi Building's system after deeming them biologically safe with reference to the 2007 analyses[21]; they were mixed with the compost windrow, not put through the in-vessel composter because the machinery is not set up to handle fine-textured inputs	Darren Duff – Municipal Services Manager 604 822-0439, darren.duff@ubc.ca Gary Wolfram – Waste Management Operations Head – 604 822 9619, gary.wolfram@ubc.ca
	Health, Safety and Environment			

[20] ____. 2010. Personal communication.
[21] See Appendix B: Choi Building composting toilet end-product analyses

Conclusions and Recommendations

Recommendations and Further Research

Following review of an earlier version of this paper by the new SUB coordinators in early 2011, it has been decided that composting toilets will not be included in the new building. Greywater toilets will be employed in the building. The main reasons for this decision are cost and apprehension about social acceptability of the composting toilet system. Further, the logistics and legalities surrounding the use of the end-product (finished compost) remain unresolved. While composting toilets will not be used in the new SUB, there is still ample room to pursue their inclusion in future developments on UBC's campus. The issues outlined in this report remain pressing. In the mean time, energy and resources should be focused on raising awareness and laying the groundwork for social acceptance, and even demand for, more sustainable food systems based on closed loop agriculture.

In future projects, the following points should be considered in pursuing composting toilets:

- Engage Clivus Multrum. They need to be involved from the beginning of the design process, since the system must be fitted to each building project.
  - Feasibility assessment for the planned design of the new SUB – can the entire building by accommodated by composting toilets?
  - Economic assessment for the installation of the system.
  - Feasibility assessment in terms of maintenance requirements.
  - An alternative scenario to consider depending on the outcomes of the above: install one or a few composting toilets as a "demonstration" of the system, rather than using them for the entire building
- Begin engagement with relevant regulatory authorities: UBC Inspections, UBC Health, Safety and Environment, Vancouver Coastal Health Authority. An "alternative solution" will need to be drafted by the engineers, working with Clivus Multrum, and submitted to UBC Inspections for approval.
- If implemented, develop a detailed life cycle plan for the system.
  - Work with Clivus Multrum to train maintenance staff and develop a detailed maintenance plan and recordkeeping for the system.
  - Research: what to do with the end products
    - pursuing regulation under the Organic Matter Recycling Regulation?
    - connection to UBC Farm (?) and/or other local agriculture; use in Plant Ops compost to improve nutrient quality, staff and procedures required for transporting organic matter.

Appendices

[Next Page.]

Appendix A: NSF Standard 41

41 - 98

STANDARD

ANSI/NSF 41–1998

2

Non-Liquid Saturated Treatment Systems

American National Standard/
NSF International Standard

NSF®

ANSI/NSF 41–1998

2010

National Sanitation Foundation

ANSI/NSF International Standard for Wastewater Technology —

Non-Liquid Saturated Treatment Systems

1 General

1.1 Purpose

The purpose of this standard is to establish minimum materials, design and construction, and performance requirements for non-liquid saturated treatment systems. It is intended to protect public health and the environment as well as minimize nuisance factors. This standard also specifies the minimum literature that manufacturers shall supply to authorized representatives and owners.

1.2 Scope

This standard contains minimum requirements for treatment systems that do not utilize a liquid saturated media as a primary means of storing or treating human excreta or human excreta mixed with other organic household materials. Management methods for the end products of these systems are not addressed by this standard.

System components covered under other NSF or ANSI/NSF standards or criteria shall also comply with the requirements contained in those other standards. This standard shall in no way restrict new system designs, provided such designs meet the minimum specifications described herein.

1.3 Systems classification

For the purpose of this standard, systems are classified according to the use environment for which they are intended to be installed. The systems classifications identified in this Standard are residential systems, day-use park systems, and cottage systems. Performance testing and evaluation requirements for each of these systems classifications are described herein.

2 Normative references

The following documents contain provisions that, through reference in this text, constitute provisions of this ANSI/NSF standard. At the time of publication, the indicated editions were valid. All standards are subject to revision, and parties are encouraged to investigate the possibility of applying the recent editions of the standards indicated below.

APHA, *Standard Methods for the Examination of Water and Wastewater,* nineteenth edition (herein after referred to as *Standard Methods*) [1)]

ANSI/NFPA 70, 1993, *National Electrical Code* [2)]

USEPA, Code of Federal Regulations, Title 40, September 20, 1987, Protection of Environment [3)]

USEPA, *National Primary Drinking Water Regulations, 40 CFR Part 141* [3)]

USEPA, *National Secondary Drinking Water Regulations, 40 CFR Part 143* [3)]

3 Definitions

3.1 authorized representative: An organization, group, individual, or other entity that is authorized by the manufacturer to distribute, sell, install, or service non-liquid saturated treatment systems.

3.2 components: All of the physical, mechanical, and electrical parts that comprise non-liquid saturated treatment systems.

3.3 design rated capacity (DRC): The product of the population rating and the population equivalent. This number is reported separately for both urine and feces.

3.4 end products: The solid and liquid outputs, which represent treated human excreta or treated food wastes or both, from a non-liquid saturated

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[1)] American Public Health Association, 1015 Fifteenth Street, NW, Washington, DC 20005

[2)] National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269

[3)] Superintendent of Documents, US Government Printing Office, Washington, DC, 20402 treatment system. Bulking agents, bedding materials, and nondegradable waste materials are not considered end products in this Standard.

3.5 manufacturer: The entity that develops, designs, and produces non-liquid saturated treatment systems.

3.6 population equivalent (p.e.): The average number of excrement events produced by an average adult person in one 24-hour period. For this Standard, 1 p.e. is defined as 1.2 fecal events and 4 urine events per person per day.

3.7 population rating: 1) For day-use park systems, it is the total number of uses or the combination of the daily total of urine and fecal events a system is designed to handle in a 24-hour period. 2) For residential and cottage systems, it is the maximum number of people the system is designed to service in a 24-hour period, without regard to the number of fecal events or the number of urine events.

3.8 specialized tools: Tools that are not readily obtained from a hardware store or general retail stores.

4 Materials

Materials shall be durable and capable of withstanding stresses and wear during shipping, assembly, installation, and operation. System materials shall not be adversely affected when subjected to the use environment. Any portion of the system that requires cleaning shall be smooth and easily cleanable.

NOTE – Because there are numerous design criteria suitable for the manufacture of non-liquid saturated treatment systems, manufacturers should acquire appropriate engineering expertise in evaluating the design of the system.

4.1 Interior surfaces

Interior surfaces shall show no visible signs of structural change following performance testing and evaluation including, but not limited to, flaking, pitting, or the formation of structurally significant cracks.

4.2 Exposed surfaces

Exposed surfaces shall show no visible signs of structural change following performance testing and evaluation including, but not limited to, flaking or pitting of exposed surfaces or the formation of structurally significant cracks.

NOTE – Small surface cracks exhibited by concrete tanks are normally expected insome circumstances and shall not be considered structural deterioration.

4.3 Maintenance tools

Systems shall be supplied with all of the specialized tools required for emptying and maintaining the normal operation of the system.

4.4 Dissimilar metals

Dissimilar metal materials, considered noncompatible at the electromotive level, shall not be in direct contact with each other. An electrically nonconductive insulating fitting shall be provided at the junction between such dissimilar metal parts or components.

4.5 Impact resistance

Containers used for treatment or storage shall not break, display structurally significant cracks, or, other than cosmetic damage, display visible signs of permanent deformation when tested in accordance with 4.5.1 and 4.5.2.

All impact resistance testing shall be conducted at 23°C ± 2°C (73°F ± 3.5°F).

4.5.1 Impact test for horizontal surfaces of containers

A 38 mm (1.5 in) diameter steel ball weighing 0.225 kg (0.5 lbs) shall be dropped from a height of 600 mm (24 in) to strike all horizontal and subhorizontal surfaces of all treatment and storage containers.[4)]

4.5.2 Impact test for vertical surfaces of containers

All vertical surfaces of treatment and storage containers shall be subjected to a blow from a pendulum having an arm 75 cm (30 in) in length, and released from an angle of 45° from the test surface. The bob shall be 11cm ± 1cm (4.3 in ± 0.4 in) in diameter, be constructed of steel, and weigh 3 kg (6.6 lbs).[5)]

4.6 Burn resistance

The burn resistance test shall be conducted on each surface or sample of each surface (including all treatment and storage containers) that can hold

[4)] This test method is a modification of section 5.11 of CSA Standard B45.5-94 *Plastic Plumbing Fixtures,* CSA, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3.

[5)] This test method is a modification of section 3.2 of the *Method for Testing Closed Toilet Systems*, The Norwegian Foundation for Environmental Labeling, Kristian Augusts gates 5, N-0164 Oslo, Norway.

a lighted cigarette. All test surfaces shall not ignite, progressively glow, smolder, or show evidence of being functionally impaired during or after testing in accordance with the following method.

For each test surface, select 3 cigarettes from a freshly opened package of cigarettes. Light all 3 cigarettes and place them on the test surface. If possible, place them 25 mm (1 in) from the edge and 50 mm (2 in) from each other. Allow the cigarettes to burn for 2 minutes ± 2 seconds. Remove the cigarettes and allow the surface to cool for 1 minute.[6)]

4.7 Additives

Non-liquid saturated treatment systems shall not necessitate the use of bulking agents or chemical additives in a manner that is considered harmful to public health or the environment. The manufacturer shall provide documentation to owners and authorized representatives explaining any hazards, proper use, and proper handling of all additives.

5 Design and construction

5.1 Exposed surfaces

All exposed surfaces shall be free from nonfunctional rough or sharp edges that may cause injury to persons using, installing, maintaining, or servicing the system.

5.2 Structural integrity

After the system is installed according to the manufacturer's instructions, all components of the system shall not break, crack or show evidence of permanent deformation during or after testing in accordance with methods described in section 5.

5.2.1 Static load test

An ordinary 2 in × 4 in wooden board (nominal size) shall be positioned across the center of the stool with 12 mm (1/2 in) of protective sponge rubber between the stool and the board. A weight of 136 ± 2 kg (300 ± 5 lbs) shall be applied equally about the centerline of the board and maintained for 15 minutes. The weight and board shall then be removed, and the system shall be inspected.[7)]

5.2.2 Buried systems

The system, when filled or empty, shall maintain its structural integrity when subjected to earth and hydrostatic pressures. An *in situ* visual evaluation shall be performed during and after the performance testing and evaluation.

5.2.3 Infiltration and exfiltration resistance

The system, including all joints, seams, and components shall preclude infiltration of ground water into the system and exfiltration of liquid out of the system. The system that will be subjected to the "controlled" performance testing and evaluation described in section 11 shall be filled to the overflow point, or top of the containment chamber, or high water alarm level with tap water and held for 24 hours. At the end of this 24-hour period, there shall be no evidence of leakage from the system.

NOTE – At the manufacturer's discretion, the system may be filled to the high water alarm level with tap water and held for up to 24 hours prior to the start of the infiltration and exfiltration resistance test.

5.3 Noise

When installed according to the manufacturer's instructions, the system shall not produce excessive continuous noise. Any continuous noise associated with mechanical components, measured at a distance of 1 meter in all directions from the system, shall not exceed 60 dbA.

5.4 Component accessibility

Components that require periodic maintenance shall be easily accessible and easily replaceable.

5.5 Agitators

Following the performance testing and evaluation described in section 11, the agitator and all components of the agitator shall show no evidence of structurally significant breaks or cracks that could impair the performance of the agitator.

NOTE – This requirement applies to both manual and mechanical agitators.

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6) This test method is a modification of section 5.9 of CSA Standard B45.5-94, *Plastic Plumbing Fixtures* (CSA, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3) and section 6.1 of ANSI Z124.5-1989, *American National Standard for Plastic Toilet (Water Closet) Seats* (ANSI, 1430 Broadway, New York, New York 10018).

7) This test method is a modification of section 14.6 of CSA Standard B45.5-94, *Plastic Plumbing Fixtures* (CSA, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3) and section 5.1 of ANSI Z124.5-1989, *American National Standard for Plastic Toilet (Water Closet) Seats* (ANSI, 1430 Broadway, New York, New York 10018).

5.6 Electrical components

Electrical components shall be protected by safety devices, such as circuit breakers and fuses. ANSI/NFPA 70, 1993, *National Electrical Code* shall be followed for all electrical components, electrical connections, system installation, and system operation.

5.7 Access ports

5.7.1 The system shall be demonstrated to have easily accessible ports that are sized and located to facilitate the installation, removal, sampling, examination, maintenance, and servicing of components and compartments that require routine maintenance and inspection. Maintenance of the system shall not require the user to completely enter the treatment or storage containers. The access ports shall be of sufficient size and located so as to allow for the following:

a) Periodic cleaning or replacement of components as required by the manufacturer in the operation and maintenance manual;

> NOTE – Periodic cleaning or replacement of components refers to those procedures which are specified by the manufacturer as necessary within 2 years of system installation.

b) Visual inspection and sampling as required by the manufacturer in the operation and maintenance manual; and

c) Removal (manually or by pumping) of collected residuals and end products as required by the manufacturer in the operation and maintenance manual.

5.7.2 Access ports, not including the toilet seat and toilet seat lid, shall have child resistant locking mechanisms and pose no threat of injury to any person.

5.8 Failure sensing and signaling equipment

5.8.1 Systems rated for day-use and residential systems rated to continuously serve 10 or more people shall possess a mechanism or process capable of detecting failures of electrical and mechanical components critical to the treatment processes and delivering a discernable visible and audible signal to notify the owner of the failure. These same systems shall also possess a mechanism or process capable of detecting a high water condition and delivering a visible and audible signal to notify the owner that the water level is above normal operating specifications.

5.8.2 The visual and auditory signals shall continue to be functional in the event of an electrical, mechanical, or hydraulic malfunction of the system.

5.9 Flow design

Systems shall have a designated flow-path that is reflective of the entire treatment process. During periods of normal system operation, as well as periods of system and component malfunction, the design and construction of the system shall preclude alternative flow-paths and prevent the discharge of liquids and solids from an opening external to the designated flow-path.

5.10 Dataplate and service label

5.10.1 A permanent and legible dataplate shall be placed on all systems at a location accessed during maintenance cycles and inspections. A second dataplate shall be affixed to the front of the electrical control box, if applicable. The dataplates shall include:

a) manufacturer's name or authorized representative, address, and telephone number;

b) model number;

c) serial number (required on 1 dataplate only);

d) rated capacity of the system;

e) the system classification(s) as determined with the performance testing and evaluation requirements described herein;

f) a detailed description of the type, volume, and frequency that bulking agents and other additives are to be added to the system;

g) if the system is designed to handle food wastes, the data plate shall contain a detailed description of type of food (in terms of vegetable matter, oil and grease, and meat/animal material) the system is capable of handling; and

h) a brief description of common items that should not be added to the system.

5.10.2 A clearly visible label or plate that provides instructions for obtaining service shall be permanently located near the failure signal, if applicable (see 5.8.1). The label or plate shall contain at a minimum the manufacturer's, or authorized representative's name, address and telephone number.

5.11 Pest control

Devices shall be fabricated to prevent entry of insects into any component in which biological activity is intended to occur, when installed and operated according to the manufacturer's instructions. Entry points where wastes are intended to be deposited under normal usage shall be exempt from this requirement.

6 Product literature

6.1 Owner's manual

Each system shall be accompanied by a manufacturer-prepared owner's manual. The manufacturer or authorized representative shall provide the manual to the owner at the time of system installation. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

a) the system's model designation;

b) a statement designating the classifications of the system as well as a confirming statement that the system meets the requirements of ANSI/NSF 41–1998 corresponding to the designated classification(s);

c) a functional description of system operation, including diagrams illustrating basic system design;

d) a clear statement of examples of the types of materials that can be effectively placed in the system;

e) a list of household substances that, if placed in the system, may adversely affect the system, the process, or the environment;

f) comprehensive, site-specific operating instructions that clearly describe proper function of the system, periodic removal of end products, and the operating and maintenance responsibilities of the owner and authorized service personnel;

g) site-specific requirements for compliance with local, state and federal regulations for the handling and disposal of end products from the system;

h) a course of action to be taken if the system is to be used intermittently or if extended periods of nonuse are anticipated;

i) detailed methods and criteria to be used to identify system malfunction or problems;

j) a statement instructing the owner to reference the system data plate in the event that a problem arises or service is required;

k) the name and telephone number of an appropriate service representative to be contacted in the event that a problem with the system occurs; and

l) electrical schematics for the system if not appearing on the system itself.

6.2 Additional product literature

Manufacturers shall provide authorized representatives with additional product literature intended to accommodate all persons who may be involved in the installation, maintenance, servicing, or repair of systems. Each system shall be accompanied by manufacturer-prepared literature including specific instruction for system installation, operation and maintenance, and troubleshooting and repair. This information may be provided in the form of discrete manuals or may be combined into a comprehensive manual(s) as the manufacturer deems appropriate.

6.2.1 Installation manual

Manufacturers shall provide comprehensive and detailed installation instructions to authorized representatives. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

a) a numbered list of system components and an accompanying illustration, photograph, or print in which the components are respectively identified;

b) design, construction, and material specifications, for the system's components;

c) wiring schematics for the system's electrical components;

d) off-loading and unpacking instructions including safety considerations, identification of fragile components, and measures to be taken to avoid damage to the system;

e) a process overview of the function of each component and the expected function of the entire system when all components are properly assembled and connected;

f) a clear definition of system installation requirements including any applicable plumbing and electrical power requirements, ventilation, air intake protection, bedding, hydrostatic displacement protection, water tightness, slope, and miscellaneous fittings and appurtenances;

g) a sequential installation procedure;

h) repair or replacement instructions in the event that a system possesses flaws that would inhibit proper functioning and a list of sources where replacement components can be obtained; and

i) a detailed start-up procedure.

6.2.2 Operation and maintenance manual

Manufacturers shall provide comprehensive and detailed operation and maintenance instructions to authorized representatives. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

a) a maintenance schedule for all components;

b) a detailed procedure for visual evaluation of system component functions;

c) a description of olfactory and visual techniques for the evaluation of end product quality; and

d) the expected end product characteristics of the system as established through analytical methods described or referenced in this standard.

6.2.3 Trouble shooting and repair manual

Manufacturers shall provide comprehensive and detailed trouble shooting and repair instructions to authorized representatives. The manual shall be written so as to be easily understood by the intended reader and shall include, at a minimum:

a) a guide for visually evaluating the system and narrowing the scope of the problem based on product characteristics, system operation, and history;

b) a sequential method for isolating specific component failure; and

c) a step by step guide for repairing or replacing all system components.

7 Other documentation

The manufacturer shall prepare and maintain documentation for each system including, at a minimum:

a) a basic description of the system;

b) drawings of the system;

c) design basis data; and

d) a comprehensive and detailed discussion of process fundamentals.

8 Replacement parts

8.1 Parts availability

The manufacturer and authorized representative shall make available to owners and operators replacement parts for all components of the system.

8.2 Stand-by parts

In the event that a mechanical or electrical component must undergo off-site repairs, the manufacturer and authorized representative shall maintain a stock of mechanical and electrical components that may be temporarily installed until repairs are completed.

9 General performance testing and evaluation requirements

Systems shall be subjected to the performance testing and evaluation described in this section as well as sections 10 and 11.

NOTE – The results obtained from performance testing and evaluation of one model may be indicative of other models provided the other models are comparable in terms of design and function.

9.1 Assembly and installation of systems shall be conducted according to the manufacturer's instructions.

9.2 Systems shall be loaded with actual human excreta.

9.3 All performance testing and evaluation shall be conducted at a location that excludes the manufacturer or the authorized representative from controlling access to the system.

9.4 Systems shall be operated in accordance with the manufacturer's instructions, including the discharge or removal of materials from the system.

9.5 A report of general performance testing and evaluation for each system found to conform with this standard shall be prepared. The report shall include numbered sections and subsections carrying a title identifying this standard. The report shall include:

a) identification of the type and model designation of the system tested;

b) rated capacity of the system tested, including average, minimum, and maximum loadings (usage) specified by the manufacturer;

c) schematic or design drawing to indicate integral components of the system tested;

d) log of actual use during testing with documentation of all supplemental loading of bulking materials and liquids — quantity and type — supplied during the test. (This requirement applies only to the testing described in section 11);

e) chronological list of pertinent equipment/component failures and actions required for correction. (This requirement applies only to the testing described in section 11);

f) incidents related to testing agency equipment or personnel performance affecting test conditions, or data acquired during incidents. (This requirement applies only to the testing described in section 11);

g) histograms or other appropriate graphical or tabular displays of all data collected as part of the testing and performance evaluation. (This requirement applies only to the testing described in section 11); and

h) a summary of the ambient temperature and humidity conditions during the testing. (This requirement applies only to the testing described in section 11).

10 Mature systems ("field") performance testing and evaluation

Systems having end products characteristic of routine operation shall be subjected to a field test and performance evaluation. A minimum of 3 systems currently in operation and representing the same model type shall be selected for testing.

10.1 System selection criteria

Systems selected for field testing and evaluation shall meet the following criteria:

a) the loadings shall correspond to the loading capacity for which the non-liquid saturated treatment system is designed;

b) installation and operational history of the systems shall comply with the manufacturer's instructions; and

c) systems shall have been in operation for a period claimed by the manufacturer to be sufficient to produce end product(s) suitable for removal.

NOTE – It is suggested that the selection of mature systems include those from varying climatic conditions. The systems should be selected from areas with differing geographical conditions of temperature and humidity, where available.

10.2 Sample collection and analysis

Samples of end products shall be collected from the systems and analyzed in accordance with sections 12 and 13, respectively.

10.3 Performance criteria

Systems shall meet the performance criteria contained in section 14.

11 New system ("controlled") performance testing and evaluation

In addition to the performance testing and evaluation described in section 10, one system shall be subjected to a controlled test for a total of at least 6 months from the conclusion of start-up to collection of the end product(s). The test shall be conducted under the operating conditions that are characteristic of the intended installation conditions. The number of uses during a test shall be tallied on a cumulative counter and recorded. A complete profile of usage versus time shall be reported.

NOTE – Some systems require longer than 6 months to attain equilibrium or to accumulate a sufficient volume of end product to sample. Such systems shall be sampled and evaluated at the time specified by the manufacturer as the recommended time when the user should remove end product(s) for the first time. In these instances when testing is to be longer than 6 months, the system shall continue to be loaded in accordance with the applicable loading patterns specified in section 11.1. These extended periods of loading shall be accomplished by repeating the applicable loading pattern.

In addition to loading the system according to the applicable loading patterns described in this section, systems designed to receive food wastes shall be loaded daily with a total of 200 grams of food per person per day. The system shall be loaded with an equal proportion (by weight) of the types of foods (in terms of vegetable matter, oil and grease, and meat/animal material) that the system is designed to receive. Figure 1 (this section) provides an example of how systems shall be loaded with food.

If the system is designed to service a household of 4 people, then

$$4\ persons \times \frac{200\ g\ food}{(person)\ (day)} = \frac{800\ g\ food}{day}$$

Figure 1 – Food loading

11.1 Loading patterns

11.1.1 Residential systems

Residential systems are those systems that are intended for use in home settings, apartment complexes and other settings that receive daily residential use.

A residential system shall be subjected to the loading that is representative of the 24-hour excrement cycles of humans. A population equivalent (p.e.) shall be defined as 1.2 fecal events and 4 urine events per person per day. The system shall be loaded according to each of the 8 loading patterns described in this section. These loading patterns shall be conducted sequentially in the order described. Figure C.1 (see Annex C) illustrates graphically how these loading patterns shall be conducted.

NOTE 1 – For those loading patterns that are conducted for 7 or more days, the actual loading for both feces and urine may vary by ± 10% on a weekly basis. For loading patterns that are conducted for less than 7 days, the actual loading for both feces and urine may vary by ± 10% over the course of each loading pattern.

NOTE 2 – Design rated capacity (DRC) is calculated by multiplying the manufacturer's population rating (the maximum number of people the system is designed to service in one 24-hour period) by the p.e. for both urine and feces.

a) Start-up: The system shall be installed, started, loaded, and operated according to the manufacturer's instructions. The duration of the start-up period shall be specified by the manufacturer.

b) Preliminary routine operation: Following start-up, the system shall be loaded daily for 30 days at 100% of the design rated capacity (DRC). See example calculations in figure 2 (this section).

The total number of fecal events and urine events that are to be loaded weekly during the 30-day preliminary routine operation pattern is demonstrated below.

Manufacturer's population rating = 10 people

$$10\ persons \times \frac{1.2\ f.e.}{(person)\ (day)} \times \frac{7\ days}{week} = \frac{84\ f.e.}{week}$$

f.e.= fecal event

With the ± 10% allowable deviation, the total loading shall be between 76 and 92 fecal events per week.

$$10\ persons \times \frac{4\ u.e.}{(person)\ (day)} \times \frac{7\ days}{week} = \frac{280\ u.e}{week}$$

u.e. = urine event

With the ± 10% allowable deviation, the total loading shall be between 252 and 308 urine events per week.

Figure 2 – Preliminary routine operation

c) Vacation stress: A vacation stress shall be simulated by 17 consecutive days of nonuse.

d) Routine operation: The system shall be returned to routine operation by loading the system daily for 7 days at 100% of the DRC.

e) Overload stress: An overload stress shall be simulated by loading at 200% of DRC, applied over an 8-hour period during each 24-hour day for 5 days.

f) Routine operation: The system shall be returned to routine operation by loading the system daily for 7 days at 100% of the DRC.

g) Party stress: The party stress is a hydraulic overload stress in excess of the routine operation. This stress shall be simulated by loading urine at the rate of 500% of the DRC for one 8-hour period. It is not necessary to load the system with feces during this stress. However, if feces loading does occur, it shall not exceed 100% of the DRC. Figure 3 (this section) demonstrates how the urine loading shall be conducted.

Manufacturer's population rating = 10 people

$$\frac{10\ persons}{8\ hr\ party} \times \frac{4\ u.e.}{(person)(day)} \times 500\% \times \frac{1}{3}\ day = \frac{67\ u.e.}{8\ hr\ party}$$

u.e. = urine event

These 67 urine events are added to the 40 urine events that the system would receive during normal daily usage (100% of the DRC) to yield a total loading of 107 urine events. With the ± 10% allowable deviation, the total loading shall be between 96 and 118 urine events.

Figure 3 – Party stress

h) Routine operation: The system shall be returned to routine operation by loading the system daily at 100% of the DRC. This loading pattern shall continue for the duration of the 6-month test period and shall not be less than 3 months in duration.

11.1.2 Day-use park systems

Day-use park systems are those systems that are intended for use in day parks, roadside stops, and other similar settings.

A day-use park system shall be subjected to th e loadings representative of day-use installations. The system shall be loaded according to each o f the 4 loading patterns described in this section . These loading patterns shall be conducted sequentially in the order described. Figure C.2 (see Annex C) illustrates graphically how thes e loading patterns shall be conducted.

NOTE 1 – Day-use park systems typically receive a greater proportion of urine to feces than residential and cottage systems. Efforts should be made during testing to assure that the relative proportion of 6 urine events to 1 fecal event is maintained or exceeded during each of the loading patterns described in this section.

NOTE 2 – The manufacturer's designated population rating does not take into consideration p.e. Instead, it is defined as the total number of uses or the combination of the total number of urine events and fecal events the system is designed to handle in a 24-hour period.

For those loading patterns that are conducted for 7 or more days, the actual loading for both feces and urine may vary by ± 10% on a weekly basis. For loading patterns that are conducted for less than 7 days, the actual loading for both feces and urine may vary by ± 10% over the course of each loading pattern.

a) Start-up: The system shall be installed, started, loaded, and operated according to the manufacturer's instructions. The duration of the start-up period shall be specified by the manufacturer.

b) Preliminary routine operation: Following start-up, the system shall be loaded daily for 30 days at 100% of the manufacturer's designated population rating (the total number of uses, combined urine and fecal events, the system is designed to handle in a 24-hour period) for 5 consecutive days each week for a period of 1 month. Two days of overload stress shall be conducted on the 2 remaining days of each week. Overload shall be conducted by loading the system at 200% of the manufacturer's designated population rating.

c) Peak season stress: Peak season stress shall be simulated by loading the system at 200% of the manufacturer's designed population rating. This loading shall be conducted daily for 14 consecutive days.

d) Routine operation: The system shall be returned to routine operation by loading the system daily at 100% of the manufacturer's designated population rating for 5 consecutive days per week. Two days of overload stress shall be conducted on the 2 remaining days of each week. Overload shall be conducted by loading the system at 200% of the manufacturer's designated population rating. This loading pattern shall continue for the duration of the 6-month test period and shall not be less than 3 months in duration.

11.1.3 Cottage systems

Cottage systems are those systems that are intended for occasional use. Cottage settings can include vacation homes, weekend cottages, and cabins.

A cottage system shall be subjected to the loading pattern representative of the 24-hour excrement cycles of humans. One population equivalent (p.e.) shall be defined as approximately 1.2 fecal events and 4 urine events per person per day. The system shall be loaded according to each of the 6 loading patterns described in this section. These loading patterns shall be conducted sequentially in the order described. Figure C.3 (see Annex C) illustrates graphically how these loading patterns shall be conducted.

NOTE 1 – For those loading patterns that are conducted for 7 or more days, the actual loading for both feces and urine may vary by ± 10% on a weekly basis. For loading patterns that are conducted for less than 7 days, the actual loading for both feces and urine may vary by ± 10% over the course of each loading pattern.

a) Start-up: The system shall be installed, loaded, and operated according to the manufacturer's instructions. The duration of the start-up period shall be specified by the manufacturer.

b) Preliminary routine operation: Following start-up, the system shall be loaded at 100% of the DRC for 2 consecutive days each week for a period of 2 months. Five days of no loading shall be conducted on the 5 remaining days of each week.

NOTE 2 – For an example of how to calculate daily loadings based on DRC and p.e., refer to note 2 and figure 2 in section 11.1.1.

c) Peak season stress: Peak season stress shall be simulated by 14 consecutive days of use. For the first week of peak season stress, the system shall be loaded at 100% of the DRC for 5 consecutive days followed by 2 consecutive days of loading at 200% of the DRC. During the second week of peak season stress, this pattern of loading at 100% of the DRC for 5 consecutive days and 200% of the DRC for 2 consecutive days shall be repeated.

d) Routine operation: The system shall be returned to routine operation by loading at 100% of the DRC for 2 consecutive days each week. The system shall receive no loading on the 5 remaining days of each week. This loading pattern shall continue for a total of 2 weeks.

e) Seasonal stress: The seasonal use stress shall be simulated by 42 consecutive days of use at 100% of the DRC.

f) Routine operation: The system shall be returned to routine operation by loading at 100% of the DRC for 2 consecutive days each week. The system shall receive no loading on the 5 remaining days of each week. This loading pattern shall continue for the duration of the 6-month test period and shall not be less than 30 days in duration.

11.2 Schedule for performance testing and evaluation

Liquid containment and odor shall be evaluated weekly. Solid and liquid end products shall be collected when the user is first required to remove each of these end products from the system.

11.3 Sample collection and analysis

Samples of end products shall be collected from the system and analyzed in accordance with sections 12 and 13, respectively.

11.4 Performance criteria

The system shall meet the performance criteria contained in section 14.

12 Sample collection

12.1 All sample collection methods shall be in accordance with *Standard Methods*, unless otherwise specified.

12.2 End product samples shall be collected when the user is first required, according to the manufacturer's instructions, to remove end products from the system.

12.3 End products shall be sampled at the location specified by the manufacturer as the point for product removal and collected in sufficient volume to measure all of the parameters necessary for evaluation. The solid end product sampling shall consist of a minimum of 5 core samples of approximately equal weight or volume. The collection of core samples shall be evenly distributed and representative of the entire clean-out port. The 5 solid samples shall be thoroughly mixed together and placed in 1 container. If applicable, 5 samples of liquid product shall also be collected, mixed together, and placed in 1 sample container. Both the solid and liquid product samples shall be analyzed for the applicable parameters contained in section 13.

NOTE – Samples shall be representative of end product material. Sampling of non-end product material such as bulking agents or bedding materials shall be avoided.

13 Analyses of end products

The fecal coliform of the collected solid and liquid end product sample shall be determined utilizing the appropriate methods in *Standard Methods*.

14 Performance criteria

The following requirements shall apply as indicated:

14.1 Liquid containment

All devices shall provide for containment of liquid.

14.2 Odors

Gas emitted from the vent system shall be nonoffensive at ground level, and there shall be no offensive odors at the toilet seat at all times.

14.3 Solid end products

- Solid end products shall not produce an objectionable odor immediately following removal from the system.
- Moisture content of the solid end product shall not exceed 65% by weight.
- Solid end product shall not contain fecal coliform in excess of 200 MPN per gram.

14.4 Liquid end products

Liquid end products shall meet the following criteria:

- Liquid end products shall not produce an objectionable odor immediately following removal from the system.
- Liquid end products shall not contain fecal coliform in excess of 200 CFU per 100 ml.
- The volume of the liquid end product that accumulates during the test shall not exceed the designed liquid storage capacity of the system. If the system is designed for liquid product discharge, the discharged volume shall not exceed the manufacturer's designed discharge rate.

Appendix B: Nutrient, pathogen and heavy metal test results for the C.K. Choi system (2007–2008)

B1: PSAI nutrient testing for C.K. Choi end products

PSAI

Jan 24, 2008

U.B.C. Plant Operations for George McLaughlin

SAMPLE	pH	Buffered pH			Carbon/Nitrogen Ratio C/N	Salts (mmhos/cm) E.C.	Organic Matter (%) O.M.	Total Nitrogen (%) N	Phosphorus P	Potassium K	Calcium Ca	Magnesium Mg	Copper Cu	Zinc Zn	Iron Fe	Manganese Mn	Boron B	Sodium Na
									AVAILABLE NUTRIENTS (ppm)									
U.B.C. Dry Sewage ①	4.8				9.4	31.0	12.1	0.75	2550	3200	1800	450	2.0	102	240	76	3.6	2300
②	5.7				19.1	4.6	24.1	0.73	2000	1130	5200	680	4.4	146	230	109	1.4	530
③	4.9				17.2	8.6	10.4	0.35	1600	1250	2200	390	14.0	95	400	70	1.1	860
④	4.3				13.2	36.0	18.9	0.83	2500	4300	2600	530	3.6	84	160	108	4.6	4300
⑤	4.6				14.7	10.0	15.0	0.59	3400	1510	3100	530	5.8	180	290	121	1.5	820

COMMENTS:

George It is always an easier job to recommend fertilizers and/or liming agents for soils showing deficiency as compared to situations of major excess levels. I would suggest extreme caution in using the dry sewage to amend soils. In particular, please note that the five samples offer an excess level of soluble salts resulting from excessive fertility levels. Sodium is not considered to be a nutrient but in each sample is present in excess. I also do not recommend application of lime to adjust the pH. The lime if applied further increases soluble salts.

Bill Herman
Dr. W.A. Herman, P.Ag.

#5 – 11720 Voyageur Way, Richmond, B.C. V6X 3G9 [redacted]

Notes on Appendix B1:

- The organic matter composition reported by these results is interesting and somewhat problematic. They range from about 10% to 25%; but in a product composed of entirely organic solids (fecal matter and sawdust for bulking and carbon:nitrogen balancing) this percentage should be much higher. (The liquid urine component would not be counted in a dry-weight analysis). Possibly the analysis screened out un-decomposed organic materials, i.e., sawdust. When I observed the composting reactors, the product in the finishing area did appear to have a high level of un-decomposed sawdust. However, 75% to 90% un-decomposed bulking material seems quite high. While pathogen destruction may still be accomplished under these conditions owing to extended retention times, in terms of agricultural reuse of the end product such a product would not be ideal as nitrogen and other soil nutrients would be bound up with the carbon and would require extended periods of decomposition on the soil surface before being released. This situation seems to be and outcome of the design of the Clive's Meldrum system, which allows the high-nutrient liquid urine component of the excreta input to filter through the composting mass. This process sanitizes it through the microbiological processes occurring in the compost. It is collected in a separate storage tank and can be used as a potent fertilizer. In situations where a well-rotted compost (i.e., completely mummified carbon, little remaining un-decomposed biomass, and well stocked with soil nutrients) is desired, it may make sense to reapply this strong liquid over the composting mass. The system already requires periodic additions of liquid to maintain proper composting conditions. Reapplying the strong liquid could accomplish this goal as well as improving the quality of the finished compost product in terms of physical properties (i.e., mummified versus un-decomposed carbon) and chemical properties (i.e., higher levels of plant/soil nutrients).

- Dr. Herman warms about the high levels of sodium in the end product.

Dec 7, 12:46 PST by: Amandeep Nagra (12:48) Pg 3 of 6

REPORTED TO: University of British Columbia

REPORT DATE: December 7, 2007

GROUP NUMBER: 81121160

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		No 1	No 2	No 3	No 4	
DATE SAMPLED:		Nov 16/07	Nov 16/07	Nov 16/07	Nov 16/07	DETECTION LIMIT
CANTEST ID:		711210889	711210890	711210891	711210892	
Selenium	Se	<	<	<	<	2
Antimony	Sb	<	<	<	<	10
Arsenic	As	<	<	<	<	10
Barium	Ba	66	86	58	69	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	<	0.6	<	<	0.5
Chromium	Cr	13	11	11	12	2
Cobalt	Co	5	4	4	5	1
Copper	Cu	28	46	29	27	1
Lead	Pb	67	56	61	69	5
Mercury	Hg	0.08	0.09	0.09	0.07	0.01
Molybdenum	Mo	<	<	<	<	4
Nickel	Ni	10	9	9	9	2
Silver	Ag	<	<	<	<	2
Tin	Sn	10	<	<	<	5
Vanadium	V	29	23	25	29	1
Zinc	Zn	97	206	120	78	1
Aluminum	Al	10200	8220	9160	10100	10
Boron	B	7	5	3	7	1
Calcium	Ca	8890	11200	4520	3570	1
Iron	Fe	12200	9710	10400	12400	2
Magnesium	Mg	4160	3140	2990	2930	0.1
Manganese	Mn	243	343	201	148	1
Phosphorus	P	4010	4320	2700	5420	20
Potassium	K	3500	1510	1040	3690	10
Sodium	Na	1960	470	305	2050	5
Strontium	Sr	38	60	34	24	1
Titanium	Ti	265	220	269	248	1
Zirconium	Zr	3	2	2	2	1

Results expressed as micrograms per gram, on a dry weight basis. ($\mu g/g$)
< = Less than detection limit

Page 3

McLaughlin, George

From: Levit, Noga
Sent: Wednesday, December 12, 2007 3:59 PM
To: McLaughlin, George
Cc: Smith, Craig
Subject: Cantest Compost Samples Test Results

Hello George,

Please see below assessment of compost sampling results
Let me know if you have any question or if you need more information

Test results were compared to the **Canadian Council of Ministers of the Environment-Guidelines for Compost Quality**

1. **Metals concentration** in all 5 samples did not exceed the guidelines for concentration of trace elements
2. **E. Coli results**- the values of 40-360 MNP/100g E. Coli in the 5 samples are estimated to be below the guidelines of <1000 MNP/g for fecal coli form. The guidelines are referring to Fecal Coli form not to E. Coli. E. Coli bacteria are subset of Fecal Coli form (in sewer the ratio of 1:2 is expected)
3. **pH**- while there is no pH reference in the above guidelines, the common acceptable pH range in compost for gardening application is 5.5-8.5. Sample No 4 has a lower pH , mixing that compost with compost with higher pH value is recommended

Noga

Noga Levit, M.Sc.
HSE Advisor (Environment)
University of British Columbia
Department of Health Safety and Environment
50-2075 Wesbrook Mall
Vancouver, BC Canada V6T1Z1
Tel: 604-822-9280
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REPORTED TO: University of British Columbia

REPORT DATE: December 7, 2007

GROUP NUMBER: 81121160

CANTEST

Microbiological Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	E. Coli
No 1	Nov 16/07	711210889	80
No 2	Nov 16/07	711210890	40
No 3	Nov 16/07	711210891	<
No 4	Nov 16/07	711210892	40
No 5	Nov 16/07	711210893	360
DETECTION LIMIT			20
UNITS			MPN/100g

MPN/100g = Most Probable Number/100 grams
< = Less than detection limit

REPORTED TO: University of British Columbia

REPORT DATE: December 7, 2007

GROUP NUMBER: 81121160

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		No 5	
DATE SAMPLED:		Nov 16/07	DETECTION LIMIT
CANTEST ID:		711210893	
Selenium	Se	<	2
Antimony	Sb	<	10
Arsenic	As	<	10
Barium	Ba	66	1
Beryllium	Be	<	1
Cadmium	Cd	<	0.5
Chromium	Cr	11	2
Cobalt	Co	5	1
Copper	Cu	20	1
Lead	Pb	55	5
Mercury	Hg	0.06	0.01
Molybdenum	Mo	<	4
Nickel	Ni	9	2
Silver	Ag	<	2
Tin	Sn	<	5
Vanadium	V	27	1
Zinc	Zn	80	1
Aluminum	Al	9190	10
Boron	B	4	1
Calcium	Ca	8870	1
Iron	Fe	12000	2
Magnesium	Mg	3960	0.1
Manganese	Mn	230	1
Phosphorus	P	2560	20
Potassium	K	1220	10
Sodium	Na	371	5
Strontium	Sr	36	1
Titanium	Ti	263	1
Zirconium	Zr	2	1

Results expressed as micrograms per gram, on a dry weight basis. ($\mu g/g$)
< = Less than detection limit

Appendix C: Maintenance manual for C.K. Choi Building at UBC

11/08/1995 20:11 [redacted] CLIVUS MULTRUM INC. PAGE 02

clivus® Recycling Through Composting Toilet Technology

Clivus Multrum Maintenance Manual for C. K. Choi Building at University of British Columbia

Clivus Multrum, Inc.
104 Mt. Auburn St.
Cambridge, MA 02138
[redacted]

Rev 11/8/95

11/08/1995 20:11 [redacted] CLIVUS MULTRUM INC. PAGE 05

3

1. TABLE OF CONTENTS

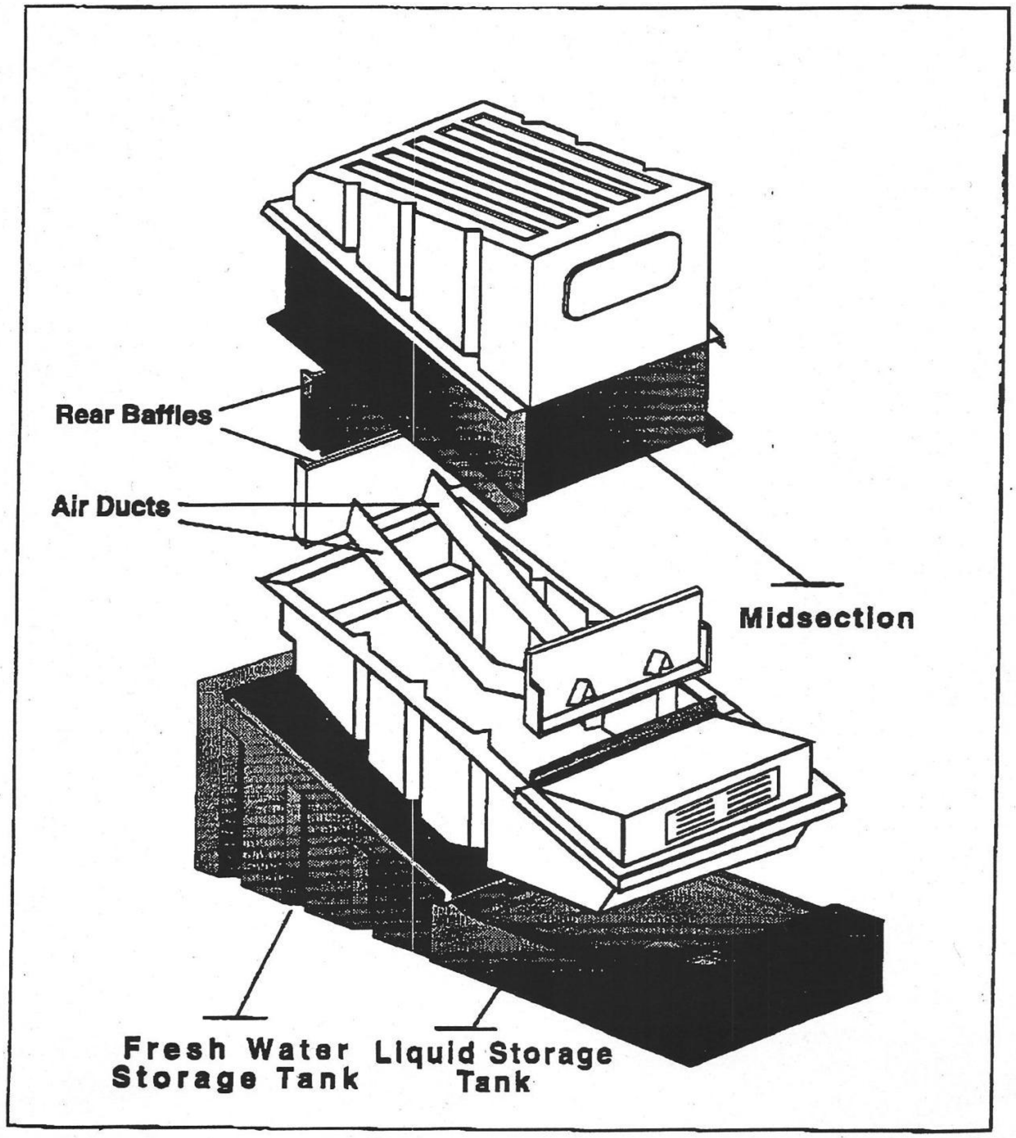
page

Maintenance Schedule 1
How It Works 1
Maintenance Notes 2
1. Table of Contents 3
2. Internal Components 4
3. Tools and Supplies 5
4. Maintenance 5
   Adding Bulking Agent 5
   Level and Mix the Compost Mass 5
   Moisten the Compost Mass 5
   Vermiculture....5
   Keep the Compost Mass Drained 6
   Ventilation System 6
   Cleaning Bathroom Fixtures 6
   Odors 6
   Bacteria 6
   Compost Removal 6
   Only Organic Matter in Clivus Composter 7
   Avoid Lit Cigarettes 7
   Assure User Cooperation 7
   Maintain Adequate Temperature and Proper Usage 7
   Maintenance Schedule Summary 7
5. Winter Usage 7
6. Safety Guidelines 7
7. Neglected Composter-Critical Care 8
   If Bulking Agent Has Been Omitted 8
   Excessive Drying of Compost Mass 8
   Compost Mass is Too Wet 8
   Excessive Cone Build Up 8
8. Accessories Available 8
9. Maintenance Services Available 8
10. Trouble Shooting Guide 8

Installation Manuals are available from your local authorized Clivus Multrum Representative.

4

2. Clivus Model M28 Composter and Internal Components



11/08/1995 20:11 [redacted] CLIVUS MULTRUM INC. PAGE 07

5

3. TOOLS AND SUPPLIES

Read Instructions
Read the entire maintenance manual before beginning. If there are any questions, contact Clivus Multrum or your local authorized representative.

Tools Required
rubber or latex gloves
rake (supplied with order)
mop
5 gal. bucket

Supplies Required
MC100 Multrum Cleaner or other bio-compatible cleaner
BULKING AGENT-planer shavings or pine bark mulch
DO NOT USE REDWOOD, CEDAR, OTHER AROMATIC WOODS OR TREATED LUMBER.

4. MAINTENANCE

The Clivus composter is similar to a garden compost pile in that it requires an adequate supply of air, sufficient moisture and moderate temperature to support the wide variety of beneficial organisms which transforms excrement into a safe and stable end-product.

The Clivus composter is designed to require minimal maintenance, but this maintenance is absolutely essential if long-term proper functioning is to be assured. Please study the following maintenance recommendations thoroughly.

ADDING BULKING AGENT

A bulking agent is needed to give the waste mass a crumbly and porous texture, to allow liquid to be absorbed, air and compost organisms to penetrate the mass, and to provide carbon for the decomposition process.

Type of Bulking Agent
Clivus strongly recommends planer shavings as a bulking agent because they trap air, do not pack down and are easily biodegradable. **DO NOT use redwood, cedar, other aromatic woods or treated lumber.** Do not use large wood chips, matting materials such as newspaper, or long fibrous materials such as tall grass and corn stalks. The purpose the bulking agent is to aerate the composting mass, allowing it to biodegrade easily and to prevent matting or compacting.

How Often to Add
Add bulking agent every time you add toilet paper or clean the restrooms or as needed, after working through the waste mass.

How Much Bulking Agent
The amount of bulking agent depends on usage. Each toilet should receive approximately a 1 lb. coffee can of bulking agent for every 50 uses, or per roll of toilet paper.

LEVEL AND MIX THE COMPOST MASS

At least once a week, open the waste access door and knock over the the cone which will have built up beneath the toilet chutes. Mix the top 24" of the waste mass with bulking agent using the long handled tool supplied with the composter and spread it evenly within the tank. Now is also a good time to add bulking agent down the toilet chutes to provide a new layer to receive new excrement. Afterwards, dip the rake in a pail of water containing MC100 Multrum Cleaner or other bio-compatible. Do not use harsh chemical cleaners which may kill composting organisms.

Adjust the Amount of Bulking Agent
Over time, the amount of bulking agent can be adjusted to actual usage. There should be enough bulking agent added so that after mixing, there are no large clumps of feces without bulking agent intermixed.

MOISTEN THE COMPOST MASS

Bio cycles which take place in the world's forests are also present in the Clivus composter. Rainfall moistens the forest floor biomass, assists with aerobic decomposition, carries oxygen and nutrients to different levels of the soil and restabilizes them. We replicate that natural process by automatically spraying fresh water on the mass.

Initiall, set the automatic spraying control for 1 minute of spray-time twice a week. The eventaul consistency of the compost pile should be moist and crumbly. Puddles indicate too much moisture; a hard crust indicated too little moisture. Check the consistency of the pile every month and adjust the spray time as needed. Short cycles over a long period are recommended over a fewer long cycles.

VERMICULTURE

Compost worms greatly enhance the efficiency of the Clivus. By burroughing throughout the compost pile, they allow air and moisture to penetrate. Also, their digestive system greatly hurries the stabilization of the compost end products.

Adding Compost Worms

After several months of operation, add about 1 lb. of red worms (Eisenia foetida) into each tank through the upper hatch. All the worms require to thrive in an active tank are moisture and warmth. Eventually, they will greatly proliferate and help reduce the level of the compost pile, thereby making maintenance quicker and easier.

KEEP THE COMPOST MASS DRAINED

During maintenance, open the compost access lid for inspection. If liquid has accumulated in the compost removal chamber, clean the drain line.

VENTILATION SYSTEM

Fan/Blower must operate 24 hours per day for odor free operation.

The vent system should be checked/cleaned annually or when odors are present.

Checking For Proper Ventilation:

1. To determine if there is a down draft through the toilet chutes, hold a strip of toilet paper across the seat and see if the air flow causes it to bow downward. If it does not, check the fan and/or clean the vent.

2. Make sure the air inlet on the compost access door is clear.

3. Check the basement air intake which allows air to enter the area of the compost tanks.

4. Check to see that a competing device such as a gas furnace, gas hot water heater, or exhaust fan is not creating a vacuum anywhere in the building that will reduce or hinder air flow to the composter.

Periodic Maintenance:

Clean the ***vent*** yearly.

Clean the ***fan*** as needed.

Clean the ***screened air inlets*** on the front of the composter and the roof top ***vent screen*** if one is present.

Maintain free ***air flow above the roof.*** Trim trees if necessary.

CLEANING BATHROOM FIXTURES

Toilets

Clean the toilet seat and plastic liner as you would a conventional toilet, except use a bio-compatible cleaner, such as Multrum Cleaner 100.

Urinals

Clean urinals with MC 100 or other bio-compatible cleaner. Once every month, take a gallon of the hottest water available and pour it down the ruinal to prevent the build-up of salt crystals along the urinal piping.

Stainless Steel Toilet Chutes

Because of the large diameter of the stlanless steel toilet chutes, there will be little, if any, soiling of the chute. Such soiling as there may be will have no affect on the composting nor will it create odor in the toilet room. Therefore, there is no need to clean the toilets below the level of the plastic liner.

ODORS

If the ventilation system is working properly and odors are still present, make sure the floor and walls are properly cleaned, and that caulking for the toilet and urinal fixtures is in place.

BACTERIA

Use extra **MB100** Multrum Bacteria if you have experienced extremely high usage, you are starting a high usage cycle, or beginning or closing a facility for a season to enhance the decomposition process. **MB100** is available from Clivus Multrum.

COMPOST REMOVAL

A Clivus composter is never completely emptied. The presence of older compost in the tank enhances the overall composting process. When the top of the compost mass is 2 feet or less from the bottom of the toilet chute, remove about ***3-10 cubic feet*** of compost from the compost removal chamber. No compost should be removed within the first two years of operation.

Make sure the compost mass settles immediately to the compost removal chamber. If necessary, push down through the waste access door and/or the toilet chute, using a board, rake (supplied) or other blunt instrument.

Use the removed compost as a soil amendment in ornamental gardens, on shrubs, trees, etc.

ONLY ORGANIC MATTER GOES INTO A CLIVUS COMPOSTER

Do not put in:

non-bio-compatible chemical cleaning solutions
disinfectants
paints
cans
bottles
plastic
cigarettes
ashes
portable toilet or RV toilet wastes

Remove cans, bottles, plastic, non-biodegradable objects that restrict air flow, that take up a significant portion of the composting space or other large foreign materials which may cause matting or slow the composting process.

Harsh chemical cleaners will damage the composting process. Use MC100, available from Clivus Multrum, for cleaning Clivus restroom floors, walls, toilets, chutes, etc. MC100 is designed especially for us in composting toilets.

AVOID LIT CIGARETTES

Make sure the caution label is attached to the inside of the toilet seat cover and compost access lid.

"No Smoking" signs should be provided outside the stall or restroom.

ASSURE USER COOPERATION

Maintain clean, well lit and pleasant restrooms.

For all toilets and urinals, affix the "1-2-3" user plaques within easy view of user on inside of toilet stall door facing toilet, on the wall near the urinal, etc. Provide signs explaining the system to users.

Provide receptacles for disposable diapers and plastic-lined sanitary pads. Provide receptacles for cans, bottles and other trash.

Provide ashtray outside restroom building.

Allow no loose objects in the restroom such as extra toilet paper rolls which might be dropped down the chute.

Provide user training, interpretation signage or other means of instructing users of what they are using and the reasons for the proper use of the composting system. Information signage and ideas are available from Clivus Multrum.

MAINTAIN ADEQUATE TEMPERATURE AND PROPER USAGE

Decomposition is partially dependent on the temperature of the composter and in-going air. The M28 is rated for 45,000 uses per year at an average termperature of ≥ 65°F.

MAINTENANCE SCHEDULE SUMMARY

Daily or Weekly	-add bulking agent -knock down and mix top 12" of mass
Monthly	-check waste mass moisture -check drainage
Yearly	-clean vent system -clean drain lines -service fan -remove finished compost (after 2 years operating)

5. WINTER USAGE

Compost processes quickly slow down as temperatures fall below 65°F. Keep the ambient air temperature throughout the building at or above 65° for best results.

NOTE: WARRANTY VOID if any type of heating tape or other heating devices are hooked to the composter or placed inside the composter.

6. SAFETY GUIDELINES

Normal precautions should always be taken when dealing with all untreated human wastes. We therefore recommend that maintenance workers always use industrial rubber gloves when handling waste or working inside the composter. It is especially important when work is performed that could result in scratches, cuts or puncturing of the skin. Wash with soap and water after exposure. Never expose an open wound to an unsanitary environment.

7. NEGLECTED COMPOSTER-CRITICAL CARE

IF BULKING AGENT HAS BEEN OMITTED
Knock cones down, mix the waste mass, adding moisture if necessary, then add a large amount of bulking agent (5 gal bucket) all at once, and mix it into the waste mass until the mass is well mixed and aerated. Add **MB100** Multrum Bacteria.

EXCESSIVE DRYING OF COMPOST MASS
Occasionally inorganic foreign objects such as diapers, clothes, etc., or excessive drying of the compost mass will cause a "bridging" effect between the air ducts. This can be remedied by excavating the foreign material and breaking up the bridge. The mixing and moistening of this material will allow for easy removal at a later date and reduce the level of the waste mass.

If the waste mass is too dry, it is not decomposing. It must be broken up, moistened, mixed, and bulking agent must be added to aerate the waste mass and reintroduce carbon to the process. **MB100** should be added to reintroduce the composting organisms to the system. Once the waste mass is moistened sufficiently, it is advisable to add **MW100** Multrum Composting Worms.

COMPOST MASS IS TOO WET
If there is standing liquid in the compost removal chamber, clean the drain lines. Add bulking agent to the waste mass to absorb the excess moisture and aerate it. Mix well. Add **MB100.**

EXCESSIVE CONE BUILD UP
If there is excessive coning of waste under the toilet chutes, begin by knocking the cones over. Break the waste up, moisten if necessary and mix thoroughly. Add bulking agent if necessary and mix again. Add **MB100.**

8. ACCESSORIES AVAILABLE

These items may be ordered from Clivus Multrum®, Inc. to enhance the composting process and help with ease of maintenance.

MB100 Multrum Bacteria, compost enhancer
MC100 Multrum Cleaner, bacteria based cleaner
MW100 Multrum Composting Worms, vermiculture

9. MAINTENANCE SERVICES AVAILABLE

Maintenance services are available from Clivus Multrum®, Inc.

10. TROUBLE SHOOTING GUIDE

COMPOST MASS TOO DRY-
Not Enough Moisture
-Adjust moistening timer to manual and mix compost with rake until the compost mass is moist, but with enough texture to allow air to penetrate.

COMPOST MASS TOO WET-
Too Much Moisture
-Make sure drain lines are clear.
-Ensure that the air channels have not been blocked.
-Add bulking agent and mix with rake.
-Be sure the ENTIRE waste mass is moist all the way through.

COMPOST MASS HAS DRIED OUT
-If the composter is neglected, drying of the waste mass may occur.
-To break up the waste mass it may be necessary to prod with a sharp tool or a piece of pipe to break off chunks.
-The waste mass should be soaked with water and broken up until it can be returned to a moist, crumbly consistency.

ODORS IN THE RESTROOM-
Improper Air Flow Direction
-Make sure fan is operating properly.
-Make sure vent is clear.
-Check for competing draft device.
-Make sure bathroom floor and walls are properly cleaned.
-Check caulking around toilet and urinal fixtures.

Leaking Air Vent
-Starting at the composter and working up, check every seam and joint.
-Caulk and tape with duct tape where leak is found.

Leak at Connections
-Check all openings and connections from composter. Repair or recaulk as necessary.

ODORS FROM THE ROOF VENT-
Possible Down Drafts
-Some odor from the roof top vent is normal, but will rarely be detected at ground level.
- Make sure that no trees are blocking the free air flow from the roof vent. Trim trees if necessary.

INSECTS EXITING THE TOILET CHUTE
-Check that fan is operating properly
-Spray the exposed surfaces of the waste mass with the organic insecticide **PYRETHRUM.**

Appendix D: Architect – building maintenance communications re: C.K. Choi system

D.1: re: emergency power supply to system fans

02/09/98 09:55 ☎604 822 6119 CP&D - UBC ☑001
FEB-06-98 FRI 14:43 ROBERT FREUNDLICH VA FAX NO. [redacted] P.01/01

RFA Robert Freundlich & Associates Ltd.
CONSULTING ELECTRICAL ENGINEERS

☐ 60 Bastion Square
Victoria, B.C. V8W 1J2

☑ 808-1550 Alberni Street
Vancouver, B.C. V6G 1A5

[redacted]

FAX MEMORANDUM

To:	**UBC Campus Planning** 2210 West Mall VANCOUVER, BC V6T 125	File:	433-301
Attn:	Joanne Perdue	Date:	06 February 1998
Re:	C.K.Choi Building COMPOSTING TOILETS	Fax No.:	822-2843
From:	Andy Arink	Number of Pages: (Including this cover sheet)	1
Email:	[redacted]		

Re: Dan Leslie / Joanne Perdue Memo Dated February 2, 1998

As requested, we confirm the following:

1. Both composting toilet exhaust fans are connected to emergency power.
2. Both fans are stopped when the fire alarm system reports an alarm condition.

Preventing shutdown of these fans during fire conditions can be easily achieved by removing the shut down contacts in each of two the fan starters in MCC#3.

We suggest that you discuss this proposed modification with the Fire Department before you proceed this work.

822-6969

Regards. Andy

To: · DAN LESLIE
· GRAY BRADWELL
· PETER NAULT
· GEORGE MCLAUGHLIN

"FOR YOUR INFO
Joanne
only.

D.2: Meeting of Matsuzaki-Wright Architects with C.K. Choi building managers re: composting toilet system maintenance.

10/15/97 10:44 [redacted] M.W.A. 006/011

MATSUZAKI WRIGHT ARCHITECTS INC.

Project: C.K. Choi Building **MEETING MINUTES**

Location: UBC

Recorded By: Joanne Perdue

Present: Name	Firm	**Date:** October 10/97
Dan Leslie (DL)	UBC Superint. Bldgs O&M	
Peter Nault (PN)	UBC Facility Managmt. Services	
George McGloughlan (GM)	UBC Facilities Operat. Mgr. for Choi	
Jeanette Frost (KN)	Keen	
Joanne Perdue (MWA)	MWA	

By Hand By Courier By Mail By Fax No. of Pages Incl. This Page 6

This meeting was held to discuss ongoing operation and maintenance of the composting toilets. The system is operational and generally problem free, however, recent field reviews indicate that adjustments to the maintenance process need to be made in order to avert future problems. **ACTION**

1. Leak at drain from one of the lower liquid bins (in basement). One drain was leaking and was repaired by solvent weld and silicone by Clivus Multrum.
   -DL requested that drain connection be modified by Clivus Multrum to provide tapped in connection as per other bins. Silicone sealant on a nonthreaded connection is inadequate in the long term. **CLIVUS**

2. Absence of worms in tank. Worms were delivered to UBC by Clivus Multrum, however, are not present in the tanks.
   -PN confirmed that the worms arrived, however, they were used for a composting project elsewhere on campus.
   -Clivus Multrum to be requested to supply and install new worms. (see item 7)
   CLIVUS

3. Hair interceptor
   -GM will coordinate to have regular cleaning of hair interceptor done. **UBC**

4. Crusting material floating on compost tea in bins.
   -Clivus is reviewing what this material is and if it poses a problem. No response as yet. **CLIVUS**
   -PN reported that a fair amount of food service activity has been happening in the building and wonders if this could be contributing to the crusting material.

747 - 650 West 41st Avenue, Vancouver, B.C., V5Z 2M9 [redacted]

-Post meeting request: UBC to confirm what type of cleaner is being used for the toilets and urinals. *UBC*

10. Maintenance Contract.
-The maintenance contract proposed and submitted to UBC by Clivus Multrum was never implemented. Clivus Multrum propose two options at this time:
a) Clivus takes on maintenance on an ongoing basis.
b) Clivus provides a one year quarterly maintenance service with an educational component for UBC maintenance personal.

-UBC are interested in option "b" but would like the option to extend the contract if they are not yet ready to take on full maintenance procedures at the end of the first year. It was also suggested that after UBC takes on the maintenance that Clivus provide yearly reviews to review the overall system.
-Clivus to prepare maintenance contract proposal **CLIVUS**

11. KN relayed results from the Vancouver Department of Health testing of the grey water system last spring. Tests samples were taken at the sump in the basement (mixed greywater and compost tea), mid way in the outside trench, and the tail end of the outside trench. The sump samples was 40 parts per 100 ml. of Fecal Coliform. The trench area was less than 10 parts per 100 ml. Swimming at local beaches is permissible up tp 200 counts per 100 ml., (See attached).

12. KN reported that the Vancouver Department of Health has heard of some odour problems and would like to review the composting toilet and grey water systems. KN has suggested to the Department of Health that they visit the site after Clivus Multrum makes adjustments in early November. The Department of Health has requested a copy of the minutes of this meeting.

Per: ______________________
Matsuzaki Wright Architects Inc.
Joanne Perdue, MAIBC

cc: All Above, Don Mills - Clivus Multrum, Rick Bernard - Vancouver Department of Health., PAUL BECKER UBC-CP+D

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5. Floor cleaning (hosing and sweeping) needs to be done.
-GM will coordinate to have regular maintenance done. **UBC**

6. Bugs in compost bins and mechanical room.
-Clivus Multrum reports that bugs in the compost bins are a sign of healthy compost. Bugs in the mechanical room may be a sign that the compost is not healthy thus the bugs come out of the compost.
-Clivus Multrum to review this issue. **CLIVUS**

7. Raking of waste in the composting bin and the addition of organic material.
-Raking has not been done and no organic material (bark mulch) has been added. This has resulted in a low level of compost medium inside the bins. The low level exposes air baffles inside the bins, which would otherwise be covered resulting in a change in the air flow pattern. The roof top fan(s) now draw air more easily from the open baffles and the front of the compost bin rather than down from the toilets and urinals. The down draft has been maintained from the toilet fixtures by running both roof top fans at the same time (system designed to run one at a time). Correction of the quantity of compost in the bins should significantly improve the down draft at the toilets and urinals and allow the fan operation to be returned to single unit operation.

-UBC will engage Clivus Multrum to correct the compost levels in the bins. Clivus is available in early November to do this work. Clivus Multrum to provide a cost to do this work together with providing new worms. **CLIVUS**

8. Sealing of bins.
-The PVC bins in the basement have deformed slightly creating gaps at the edges of the operable lids. These were installed as sealed lids. The gaps allow additional air to be drawn in from the basement area contributing to further loss of down draft air from the toilets and urinals above. Clivus Multrum will provide bracing and gaskets inside bins to reseal the bins. **CLIVUS**

9. Odours at urinals.
-The users have reported a light odour off and on at the urinal at the second floor. Since both roof top fans were turned on there does not appear to have been any further reports of odour. It is believed that correction of the compost level and resealing of the bins will allow the system to operate odour free on a single fan as designed. The system will be rechecked after these adjustments have been made. UBC discussed to possibility of having a spare motor available in the event of fan failure. **UBC/KEEN**

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