APPALACHIA
SCIENCE IN THE PUBLIC INTEREST
Route 5, Box 423 Livingston, KY 40445

COMPOST TOILETS

ASPI Technical Series

DRY COMPOSTING TOILETS

Compost toilets are waste–recycling systems used to process human waste matter into a nutrient–rich fertilizer for use as an agricultural soil amendment. Risks associated with water–borne waste disposal include contamination of ground and surface waters and the spread of disease–causing bacteria and viruses through possible contact with insects, animals and human beings. These risks can be eliminated for all intents and purposes by utilizing the closed–container type of composting toilet where conditions are controlled so that proper temperatures, sufficient oxygen, and adequate carbon/nitrogen ratios can accomplish the necessary aerobic decomposition of the waste material.

HISTORY

Early models of composting toilets first appeared in Sweden in the 1930's and '40's. What prompted this research and development in alternative waste treatment systems were the extremely rocky soil conditions found in the Swedish countryside. The rocky soils prevented the installation of the typical water–borne sewage transport systems to centralized sewage treatment plants. Likewise, septic tank soil absorption systems proved impractical if not impossible in the rocky terrain. Thus, the need for a container method of waste collection, storage and processing emerged.

In early hunter–gatherer cultures and tribal societies, disposal of human waste material was done in a rather dispersed fashion. No doubt careful attention was paid to protection of drinking water sources, and taboos probably also played a significant role in preventing water contamination. Low population densities enabled dispersal of wastes without a need for waste protection or collection. However, with increasing concentrations of people, prevention of disease and pollution became paramount. Use of latrines in rural areas allowed the separation of wastes, but some threat of ground water contamination still remains. Odor problems and access to wastes by insects and rodents raise the danger of disease and limit such use. Furthermore, latrines do not allow access to material for fertilizer.

Early use of water–borne sewage systems involved the use of cesspools, which required the distasteful and no doubt messy task of emptying when full. Ground and surface water contamination accompanied the ultimate disposal of cesspool wastes which also produced health–related problems. Use of cesspools has gradually given way to use of centralized sewage collection and treatment facilities at an enormous economic and environmental cost to communities worldwide.

Septic tank soil absorption systems are also problematic in that they can contribute to ground water pollution, consume vast quantities of drinking water for toilet flushing, allow minimal access to resource recovery, and are often found in soils with too high clay content, which happens to be the majority of cases in rural America and other parts of the world.

The decade of the 1990's opens to the problems of water shortages, depletion of fresh drinking water resources, and increasing levels of pollution through improper waste disposal. Widespread adoption and use of compost toilets can contribute in an important and meaningful way towards a solution of these problems. The metaphor of composting is apt: Wastes can be turned into resources, and pollution can be eliminated.

THE COMPOSTING PROCESS

Dry composting wastes are not removed by a carrier medium (water) but remain in the container for a period of time. Wastes decompose over a bed of carbonaceous materials (peat moss, wood chips, sawdust, chopped leaves, grass clippings or other loose organic materials) in a ratio of about five parts organic material to one feces –– and the helpful bacteria are allowed to do the rest.

The compost toilet generates carbon dioxide and water vapor that can be easily vented from the decomposition chamber, and the remaining valuable composted material used as a soil amendment for shrubs, trees, grass, flowers, and berries. However, guard against the very remote possibility of long–lived viruses by refraining from application to vegetables.

Pure urine is not harmful and can be applied to edible crops as well as trees and shrubs. The removed human waste is 5–10% of the original volume. Only three to ten gallons of humus is produced per person per year.

SOME WORDS ON WASTE

Of the 2.5 pounds (1.14 kilos) of excreta that humans produce per day 2 lbs is urine and 1/2 lb is feces. Water makes up 75% of feces and 94% of urine. The rest is :

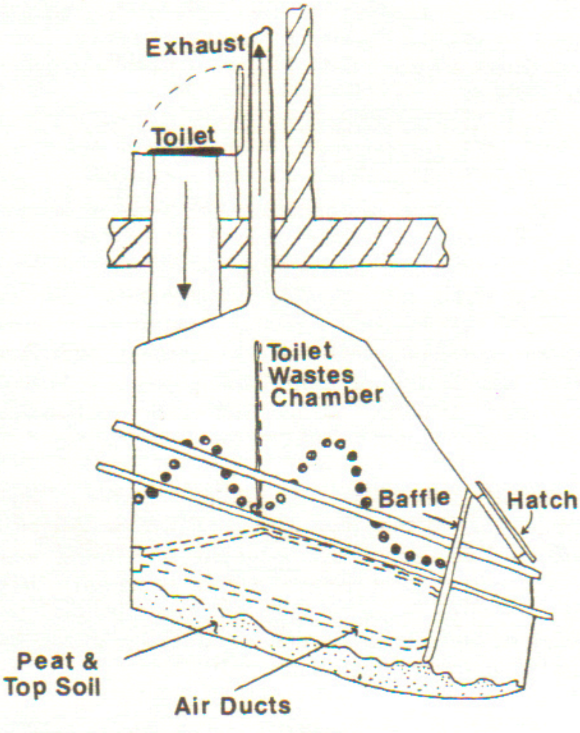
Feces		Urine	
Carbon –	40–50%	Carbon –	11–17%
Nitrogen –	5–7%	Nitrogen –	15–19%
Calcium –	4–5%	Calcium –	4.5–6%
Phosphorus –	3–5%	Phosphorus –	2.5–5%
Potassium –	2.5–5%	Potassium –	3–4.5%

Printed on Recycled Paper

VARIETIES OF COMPOSTERS

Compost toilets may be constructed from scratch for virtually nothing or purchased at costs ranging from $1,500 to above $5,000 depending on the type and capacity of the container. Remember, per capita sewer and treatment costs far outdistance compost toilet costs. Upgraded public sewer systems near Mammoth Cave, Kentucky cost over $1,000 per person.

With proper care the compost toilet is long–lasting and expense–free. Most compost toilets are made of fiber–glass, masonry, plastic, or other durable material. They could theoretically last for a lifetime. In ten years, the ASPI Clivus Multrum has required no major repair–– and none is anticipated. The technology is simple and there are no delicate mechanisms that can malfunction.



1. CLIVUS MULTRUM, USA 21 Canal Street, Lawrence, MA 01840 (508) 794–1700

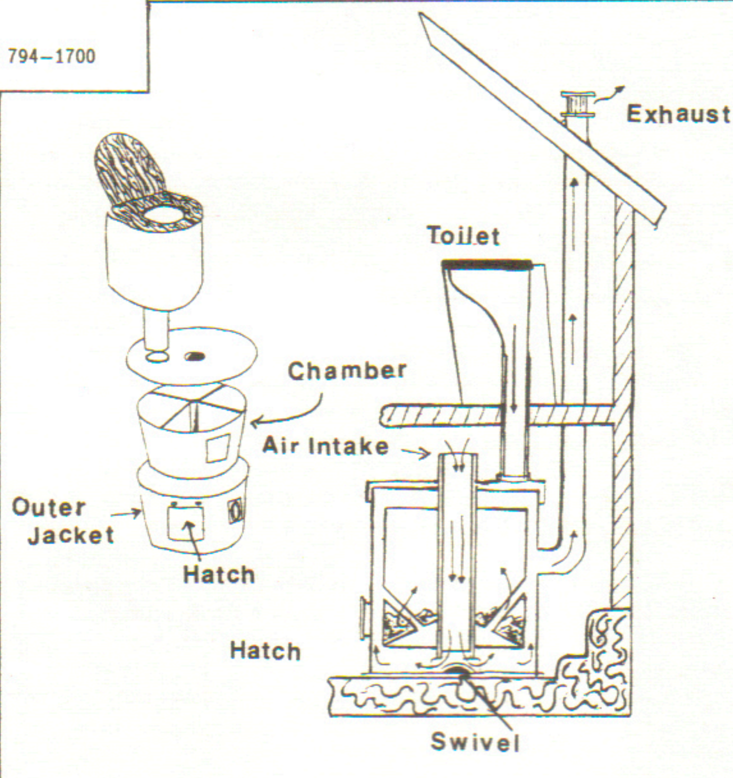
Table 1. FOUR VARIETIE

	COST	SPACE	EFFECTIVENE
Clivus Multrum (Scandinavian)	$4,000– 5,000	medium room	excellent
Carousel (Scandinavian)	$1,700	small room	good
Big Batch (American)	$500– 1,200	small room	fair to good
Solar Composter (American)	$300– 1,200	large room	good

(Other small commercial units are available, some a furnace method, which are not really composters

Extremely low–cost, low–tech composting toilets can be installed in developing countries as well as in remote areas of the First World. Recycled 5–gallon buckets (either metal or plastic) that were used for paint, cooking oil, juices, sheet rock finishing, or other non–toxic materials, can be used as human waste containers. Organic matter starter beds are placed in the container bottom to a depth of 4 to 6 inches. After each use about three or four cups of organic material must be added to maintain the proper carbon/nitrogen ratio and to keep odors from developing. (See "Maintenance of Compost Toilets")

The filled bucket must be emptied into a secondary compost pile that is protected from rain, surface–water run–off, animals, insects and other human contact. The pile is a minimum of one cubic meter in order to retain sufficient heat to ensure destruction of pathogens, disease–carrying organisms and long–lived viruses. The pile should be turned every 3–4 weeks to provide proper aeration. The carbon/nitrogen ratio should be a minimum of 30:1, but can even be 70:1 or higher and still ensure adequate decomposition. The finished compost can be removed from the protected area after one year and spread on proper areas.



2. WATER CONSERVATION SYSTEMS, INC., Damonmill Square, Nine Pond Lane Concord, MA 01742 (508) 369–3951

Compost toilets do require space. The larger ones have containers of two or more cubic meters and, when insulated, require a chamber or extra portion of a room. However, they can be built as outside facilities, provided they meet the following conditions: excreta do not come in contact with surface or ground water or soil; wastes do not come in contact with insects, human beings or animals; and the building is properly insulated.

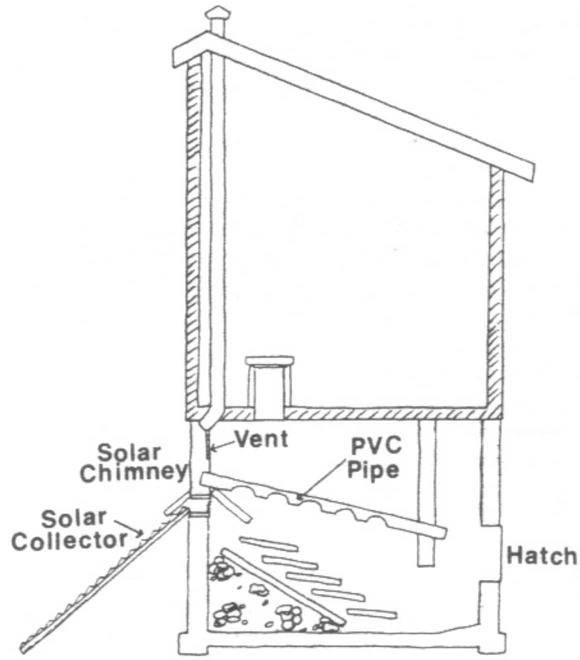
Compost toilets are most easily installed at the time of building construction. Ideally, a large insulated containment room is available directly below the bathroom. Size adds to cost. Larger fragile fiber glass containers require more care in transport and higher packing costs. However, smaller containers require more attention.

A comparison of four compost toilets in use either at ASPI or by regional associated groups are considered here.

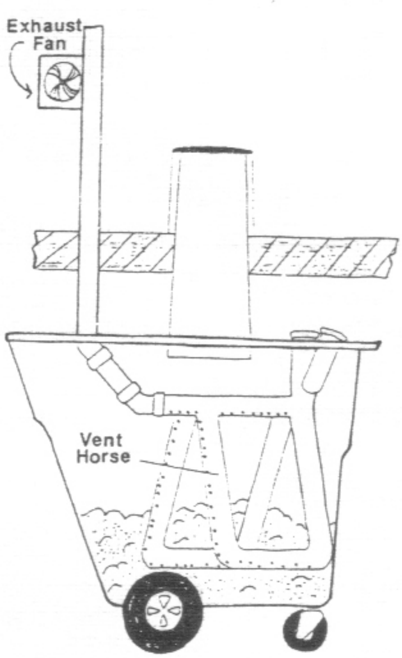
F COMPOST TOILETS

ACCESSIBILITY	SERVICE	ELECTRICITY
purchase from agent	yearly	yes, (for fan)
agent hard to locate	seasonally	yes (for fan)
do–it–yourself urchase container)	seasonally	yes (for fan)
do–it–yourself (contractor)	seasonally–annually (depends on use and size)	no

which use enormous amounts of electricity in t all.



4. "DO–IT–YOURSELF SOLAR COMPOST TOILET", Long Branch Environmental Education Center Route 2 Box 132, Leicester, NC 28748 (704) 683–3662



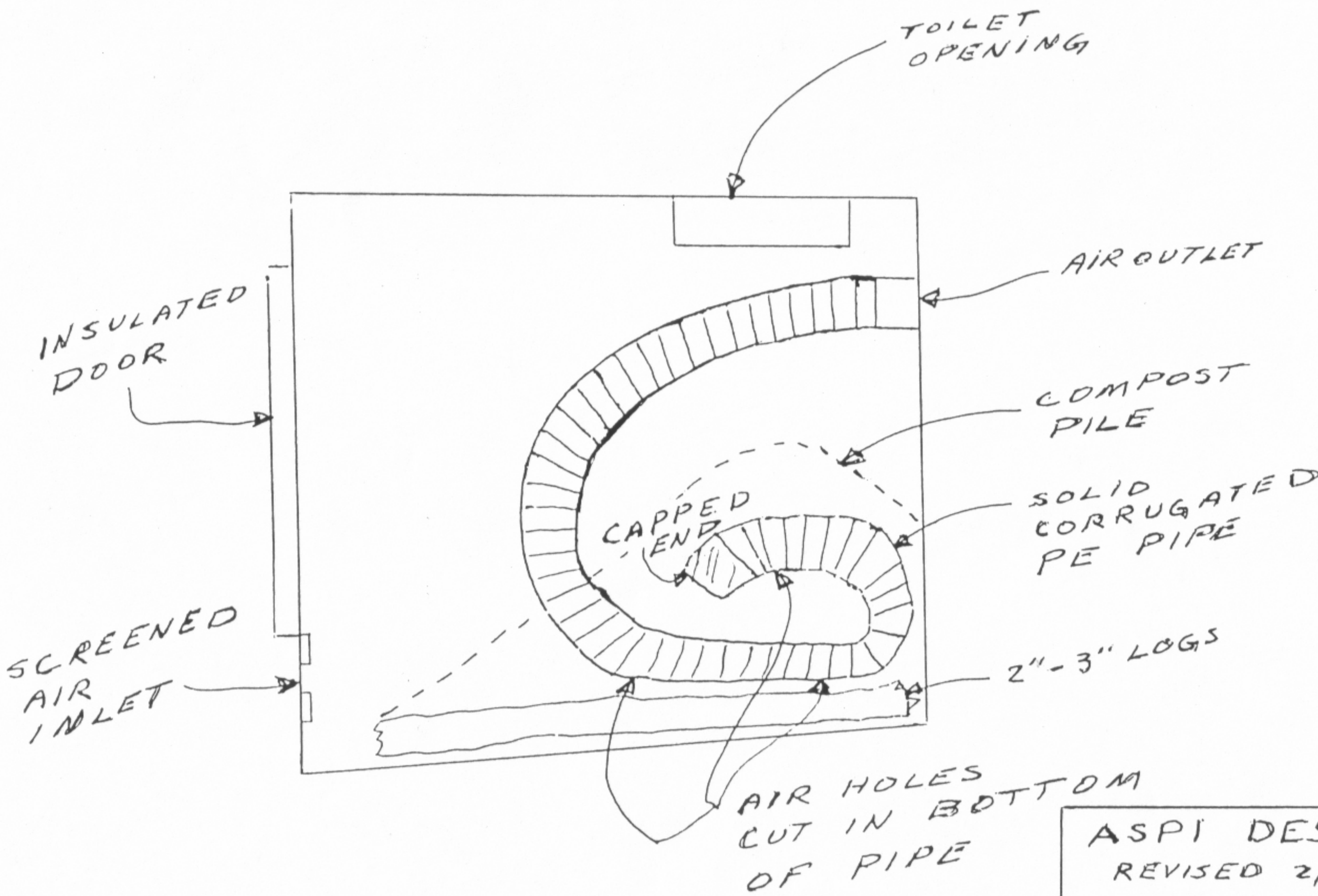
3. "Big Batch Composting Toilet Plans", Robert J. Fairchild, Executive Director EKAT/TOP,414 South Wenzel St., Louisville, KY 40204 (502) 589–0975

Another low–cost container is a 55–gallon metal or plastic drum the top of which has been cut off to make a collection chamber. If the unit is to be installed beneath an existing floor, an approximately 14 inch diameter hole is cut into the floor. Beneath the floor a recycled rubber tire that is cut radially is nailed to form an insect barrier and seal for the top of the drum. A scissors jack is placed beneath the drum to force it tightly up against the tire–gasket when the system is in use.

A four–inch diameter PVC pipe (bamboo could also be used) is run from the barrel up above the peak of the roof in order to vent carbon dioxide and moisture from the drum. This vent stack should be covered with wire screen and a rain cap to avoid the problems with either unwanted insects or rainwater. Use starter organic materials including some finished compost or animal manures in order to inoculate the system with decomposing agents. Regular use of these "dry flush" materials with every use must be stressed for all users.

COMPOST CHAMBER - SIDE VIEW

ALTERNATE DESIGN



ASPI DESIGN
REVISED 2/2/2000
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THE ASPI COMPOSTING TOILET

Since the time that ASPI Technical Paper #2 was composed in 1990 we have developed and built our own low-cost dry composting toilet design. The basic principle is to construct at the least expense, a long-lasting permanent set of composting bins. The size and type of composting container differ with the various types of toilet designs: the Clivus Multrum has a long chute; the Carousel a rotating drum divided in four quadrants; the Fairchild "Big Batch" design incorporates two mechanical carts. Included in the cost of materials for all of these designs is the added cost of shipment of these items to the user. Part of the purpose of the ASPI design was to build a system that will do a satisfactory job of turning raw waste into useable compost in a container that can be self constructed at minimum expense.

A major difficulty with most compost toilet designs is finding the space to install the large composting bins. This was our major obstacle. For this reason we decided to return to the out-house two seat method. Our variation consists of two parallel and contiguous bins with a seat above each. One seat (and bin) is currently in use. This allows the compost process in a full (inactive) bin to come to completion as the alternate bin fills. The 1 cubic meter bins are constructed using 4-inch concrete block and the walls stuccoed with masonry plaster. The floors of the bins are slanted 2 to 3 inches to the front for ease in removing the compost.

For aeration a rack made of locally grown bamboo was placed on a very slight slope. The front of the bin has a screened opening of 2 feet by 3 inches through which a stream of air is pulled by a fan located at the upper portion of the bin. A layer of chips (wood) were placed to cover the bamboo rack. The waste chute from the seat is large with PVC piping 1 foot in diameter. This keeps waste from touching the walls on the way to the bin container (an unsightly flaw of the Carousel Model). If there is a danger that young infants may crawl into the chute, we suggest constricting the size of the seat or locking the lid closed.

Another novel idea in this ASPI design is that the toilet boxing consists of containers to hold the sawdust on three sides. When filled these also serve as ideal insulating materials for the upper portion of the containers.

Part of the premise is that the composting toilet needs to conserve building materials and commercial components for the sake of human labor. Obviously, building the two-seater takes more time (though no more than the Solar design). We strongly suggest a workshop to develop siting, placement of the seats, air ducting, and the other details. An actual workshop to build the toilet with others present may be somewhat tedious, as two or more days are required due to the drying demands of the block. We suggest partially constructing the toilet with the finishing operations being undertaken in a workshop. Participants could put the final blocks in, plaster the walls and assemble the seat and toilet boxing.

As shown in the following table the cost of the construction materials (not labor) came to a little more than $500/toilet, lower than any of the other designs shown in TP 2. This total cost also includes the sawdust bins which were omitted from cost estimates for the other compost toilets.

TABLE 1: ASPI Compost Toilet Materials Cost

MASONRY:		PIPING:	
cement, sand, gravel, block	$148.83	tubing for chute	$40.00
		vent and other pipes	$150.53
LUMBER:			
2X4's, common boards, plywood, insulation, screen, seat nais, door latches and handles	$178.44	FUEL:	$9.00
		TOTAL:	**$527.80**

Figure 1

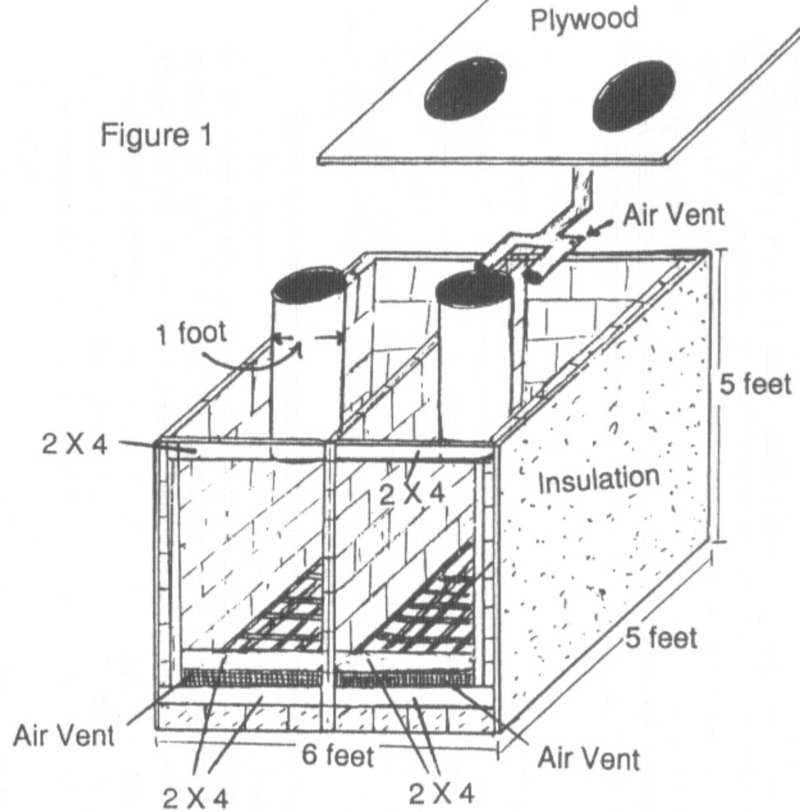


Figure 3

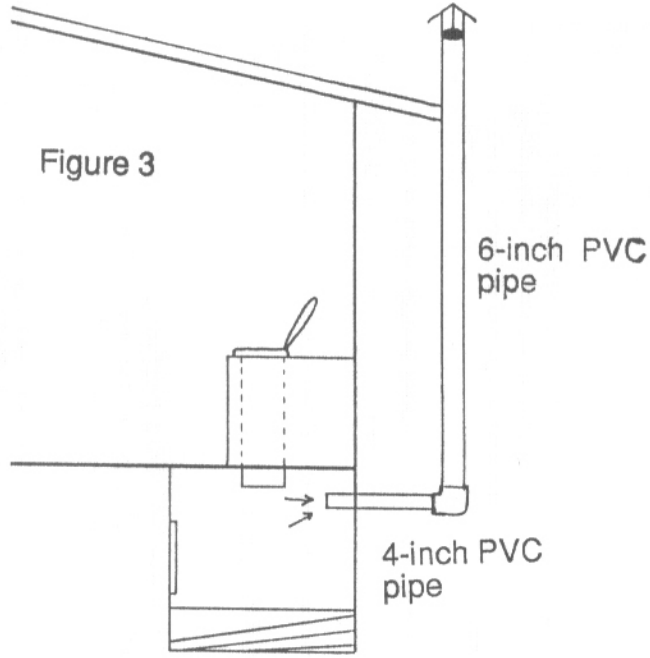
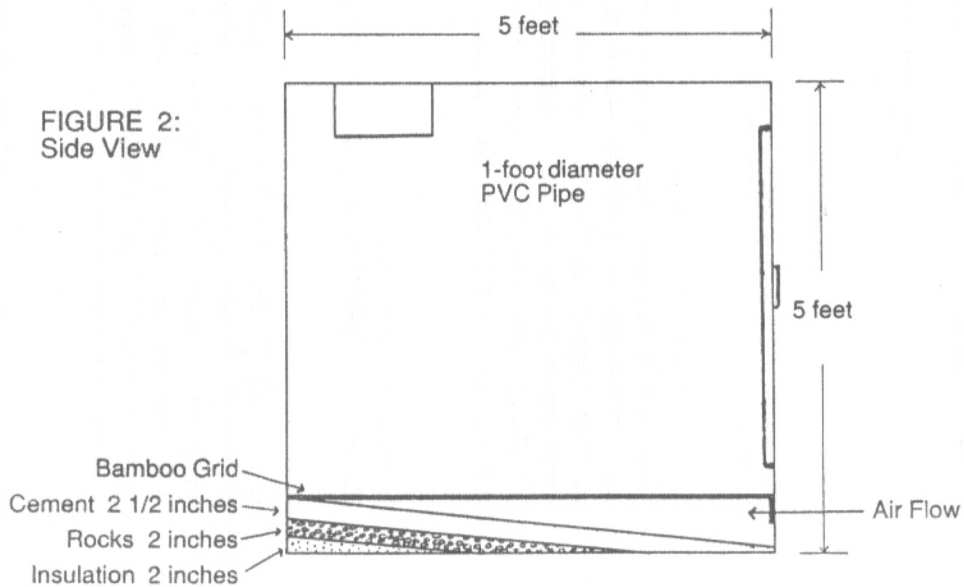


FIGURE 2:
Side View



PUBLIC INTEREST CONSIDERATIONS

Public health approval of compost toilets has been given in only seven U.S. states —— Maine, New Hampshire, Vermont, Kentucky, Nebraska, Oregon, and Iowa. Approval for experimental use has been given in some states for certain types and brands. The Passive Solar Composting Toilet has been utilized in North Carolina, Georgia, Kentucky, Tennessee, South Carolina, Massachusetts, Maine, and New York. The first three states approve that method and the state of New York is currently reviewing the plans for approval.

If compost toilets are to become popular, they will need governmental incentives and sponsorship. Extension agencies could assist with hand–out technical information. The public needs to know more about these examples of appropriate technology, how to build them, and have access to low–cost loans and grants. Currently, only large waste systems have access to governmental money. If the same amount were available in the form of loans or grants to independent builders, the compost toilet could flourish in this country —— and reduce the need for extended municipal water and treatment systems.

Some local ordinances require accompanying sewer or septic tank hook–up for gray water, thus defeating the rationale for compost toilets. Other agencies permit French drain systems provided the system does not become overloaded and provided dirty diaper washings are excluded. Flexibility in such requirements is needed, for alternative gray water disposal can be satisfactorily taken care of in most places at very low cost. However, this is a matter of public interest concern and local advocacy.

MAINTENANCE OF COMPOST TOILETS

* An inoculating material must be placed in the bed of the new and unused composter in order to furnish "friendly" bacteria for the starting decomposition process;

* Add at least one cup of "dry flush" organic materials such as sawdust, wood chips, crushed leaves, dry chopped grass, shredded newsprint, or even dirt after each use. Don't use lime or ashes which reduce acidity required for proper decomposition. Straw, rice hulls or hay may be used but are not as absorbent as the materials already mentioned;

* Keep the container free of foreign objects, meat scraps, and materials which do not easily decompose;

* Avoid excess liquids. Never put kitchen liquids in the composter (instead, put in graywater system). Harmless human urine is rich in nitrogen and can be safely recycled in the garden. Containers of sawdust and urine make excellent lettuce bedding. Avoid liquid overload of the system. One Swiss composting idea is to install a manual lever below the composter seat that shunts urine through a duct to a second sawdust filled container for direct garden application. Another method is to run sterile urine directly into a container and to dilute this to 5:1 and the tea added to the garden without impunity.

* Use composted materials on flowers, lawn, shrubs, berries, and fruit trees but not on vegetables due to the very remote possibility that long–lived pathogens might reside there, even though 99+% of all harmful bacteria are killed by the heat of the composter environment.

ADVANTAGES OF COMPOSTING TOILETS

* Easy to build and maintain;

* Environmentally safe and not unsightly. There is no odor emitted, especially when a vent fan is installed;

* No high cost sewage treatment is required. Compost toilets are relatively low–cost compared to complete septic or municipal waste systems. There is no mess, leach field, sewer or water bills or hookups, expensive plumbing, septic tanks, spills, or costly treatment plant breakdowns;

* Do not contaminate soil like water–borne waste systems, thus greatly decreasing the possibility of disease;

* Enormous water savings where flushing can account for up to half the domestic water use;

* Distribution of the nutrient–rich fertilizer may occur at the place of waste generation and thus eliminate transportation and distribution costs.

REFERENCES AND RESOURCES

GOODBYE TO FLUSH TOILETS: WATER–SAVING ALTERNATIVES TO CESSPOOLS, SEPTIC TANKS, AND SEWERS, edited by Carol Hupping Stoner, 1977, Rodale Press, Emmaus, PA

STOP THE FIVE GALLON FLUSH, Center for Minimum Cost Housing, School of Architecture, McGill University, 3480 University Street, Montreal, H3A 2A7, CANADA

COMPOST TOILETS: A Guide for Owner– builders, National Center for Appropriate Technology P.O. Box 3838, Butte, MT 59701 (406) 494–4572

WE ALL LIVE DOWNSTREAM, National Water Center, P.O. Box 548, Eureka Springs, AR 72632

REAL GOODS Trading Company, 966 Mazzoni Street, Ukiah, CA 95482

National Small Flow Clearing House West Virginia University Morgantown, WV 26506 (800) 628–8301

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