Pipeline

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Small Community Wastewater Issues Explained to the Public

ALTERNATIVE TOILETS Options for Conservation and Specific Site Conditions

How often do we think about toilets? Probably pretty rarely, and why would we? Toilets provide a convenience most Americans take for granted.

But the standard porcelain fixture we're accustomed to has been changing in these times of water quality protection and conservation. Manufacturers are designing alternative toilets that use much less water and some models that use no water at all.

Old-fashioned, water-guzzling toilets of the past consumed up to five gallons of water per flush. (*See table 1 on page 2.*) Many households still use these dinosaurs. Obsolete toilet designs contribute to the estimated 9,000 gallons of potable water that a person uses to flush away 130 gallons of human waste a year. That's an awful lot of good, clean water swirling down the commode.

Twenty years ago toilet manufacturers began to reduce their tank capacities to a maximum of 3.5 gallons per flush. This reduction in tank size helped lower water consumption somewhat. Today's standard low-flow toilets use a mere 1.6 gallons of water per flush, and the ultra-low-flow or microflush designs use even less. Studies show that this reduction in water usage has not reduced the flushing capability of these toilets in many models.

Owners of boats, recreational vehicles, and campers are already familiar with some alternative toilet systems. Ultra-low-flow, vacuum, and chemical toilets have been used for years in these limited spaces. Today some of these toilet designs have developed beyond their use in vacation and travel vehicles. They have become part of a strategy to reduce the amount of potable water used for waste disposal.

Water conservation isn't the only reason that toilet alternatives have evolved. Certain site conditions or lack of a water supply may make the traditional septic tank and soil absorption field unsuitable for a home or public restroom facility's wastewater (effluent) disposal. These problems force a landowner to explore other effluent disposal methods.

In addition to alternative effluent treatment processes, a variety of efficient, low-flow or waterless toilet systems are available that can resolve the dilemma of unsuitable site conditions. Toilet options include composting, incinerating, chemical, and oil flush toilets, and privies.

Each toilet has certain features that may make one design more appropriate than another for a family's lifestyle. Some toilets are better suited for infrequent-use situations, such as in vacation cottages or recreational vehicles. And some, like the composting toilet, require a commitment to maintain and remove composted waste material from the storage tank. Privies and portable toilets are most often used in parks, at large outdoor gatherings, or on construction sites.

This issue of *Pipeline* discusses the previously mentioned types of alternative toilets, where they may best be used, and contacts for additional information. Due to space constraints, we cannot present a comprehensive discussion of all types of alternative toilets in this newsletter.

It is not the National Small Flows Clearinghouse's (NSFC) intention to endorse one product over another, but to inform the readers of options on the market. With this information, consumers can better decide which toilet characteristics may be most appropriate in their individual circumstances.

Toilet Options: Ultra-low-flow

Figure 1. This ultra-low-flow toilet from Microphor in Willits, California, uses 0.5 gallons of water per flush.

Ultra-low-flow toilets

Water conservation awareness prompted manufacturers to begin making more efficient toilets in the early 1980s. The federal government established a national manufacturing standard in 1994 mandating that new toilets sold in the U.S. use a maximum of 1.6 gallons of water for flushing.

Studies across the country show that these low-flow toilets reduce water use by 23 to 46 percent, saving an average 10.5 gallons of water per person daily. According to the U.S. Environmental Protection Agency's Office of Water, through the use of water-efficient toilets in new construction and normal replacement, the U.S. is expected to save 7.6 billion gallons of water per day by 2020.

Some toilet manufacturers have taken water reduction further with ultra-low-flow models. (*See figure 1.*) These toilets can use as little as 0.25 gallons per flush. Products vary in that they may have narrower bowls with a smaller water surface, manually controlled water flow (via a foot pedal) into the bowl, or water pumps to assist in bowl emptying and cleaning.

One model eliminates the "S" trap of a conventional toilet design, enabling waste to be washed down using less water. Another product flushes by opening a hinged flap to let wastes and a small amount of water fall into a lower chamber. After several seconds the flap reseals, and a blast of compressed air forces the wastewater over the trap and out a discharge line from the toilet.

Public parks, restaurants, hotels, and other public facilities, such as roadside rest areas, are installing these ultra-low- flow toilets to help reduce water consumption and subsequent wastewater disposal. Ultra-low-flow toilets also enable business construction in areas where restrictions may limit sewage disposal capacity.

For example, many resort areas and municipalities place restrictions on sewage capacity flowing into publicly maintained systems. Ultra-low-flow toilets may make building in these areas possible. Similarly, facilities (like resort hotels) facing expansion difficulties due to the size of their existing onsite systems may install ultra-low-flow toilets, thus enabling their present onsite systems to adequately treat the reduced wastewater flow. (*Note: This reduction in wastewater quantity does not reduce the organic loading rate to the system.*)

Advantages:

- Ultra-low-flow toilets reduce water consumption and costs to the consumer.
- They contribute to preserving the environment by protecting ground water from depletion and possible contamination.

Disadvantages:

- Some ultra-low-flow models may require flushing more than once to adequately clean the toilet bowl.

Important!

Toilet systems in buildings without access to public sewage that discharge human waste must have some treatment system in place, whether a holding tank for subsequent pumping and disposal or an onsite sewage treatment system. Homes and facilities using toilets that do not discharge wastewater, still need to have a treatment system in place to treat and dispose of all other household wastewater.

TABLE 1 Annual Total Water Usage by Toilets*

Water Consumption by Toilets gal/flush	Water Consumption by Number of People in Household gal/year				
	1	2	3	4	5
1.5	2,190	4,380	6,570	8,760	10,950
3.5	5,110	10,220	15,330	20,440	25,550
5.0	9,125	18,250	27,375	36,500	45,625
7.0	10,220	20,440	30,660	40,880	51,100

* Assumes four flushes per day per person for 365 days.

Toilet Options: Composting

Composting toilets

A number of designs for composting toilets exist, but the process for waste treatment is basically the same in each of them. (*See figure 2 for an example of a composting toilet system.*) Human waste is biologically decomposed in a relatively moist environment by naturally occurring microorganisms. A typical system consists of a composting reactor tank or bin (sized according to frequency of use and number of users) connected to one or more waterless toilets in the house or other structure.

The reactor bin contains and controls the decomposition of excrement, toilet paper, and any organic (carbon-based) bulking agents. Bulking agents may include wood chips (other than cedar or redwood), straw, hay, or grain hulls. No liquid is added to the collected material inside the bin except for urine. This condition promotes the growth of aerobic (air-requiring) organisms that decompose the waste.

Temperature within the reactor also plays a role in composting. The process itself creates heat in the material being composted. High temperatures may inhibit growth of beneficial organisms, thereby slowing decomposition. Low temperatures (less than 41° F) may stop the composting process until temperatures increase enough for biological decomposition to resume. Composting activity is best between 78° F and 113° F.

An exhaust system (which is usually driven by a fan) vents odors, carbon dioxide, and moisture from the reactor bin to the outdoors. Air must also be drawn into the system so oxygen is available for growth of the aerobic organisms. Screening should tightly cover the exterior vent pipe opening to prevent flies and/or other insects from entering the composting system.

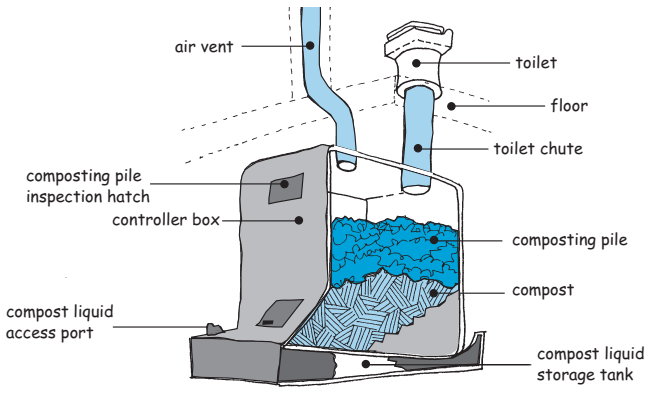
During the composting process, naturally occurring aerobic bacteria and fungi break down organic materials. Bulking agents need to consist of materials that break down quickly to avoid filling the bin with these substances.

Urine usually keeps the composting waste material moist enough—50 to 70 percent moisture is fine for thorough decomposition. But, decomposition nearly stops if the moisture level drops below 40 percent. To remedy an over-dry condition, some designs have a sprayer built in that draws liquid collected in the bottom of the reactor to rewet the pile.

As in any composting action, the decomposing material needs to be turned periodically to break up the mass. This action helps the pile to remain porous and aerated so that the aerobic organisms can accomplish their work.

A correctly sized and maintained composting toilet system produces a final material that is 10 to 30 percent of its original volume. The product that remains, called "humus," resembles soil, but legally must be either buried or removed by a licensed septage hauler, depending on state and local regulations.

Figure 2. A typical single-chambered composting toilet system. *Illustration based on the Clivus Multrum system.*



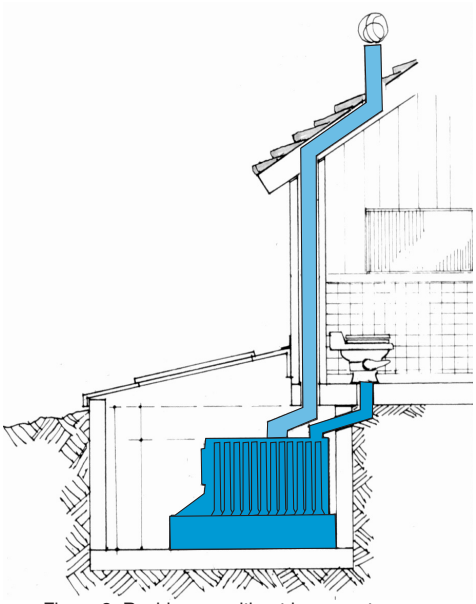


Figure 3. Residences without basements can have a composting reactor bin built in a water tight structure adjacent to the house beneath the ground's surface. *Clivus Multrum illustration.*

The composting bin and the toilet stool or seat can be constructed as a self-contained unit. (*See figure 4.*) Self-contained systems, because of their small size, are most suitable for vacation cottages or very small families. Daily residential use may overload these smaller toilet systems, so the consumer should consider purchasing a system with extra capacity.

Alternatively, composting toilets can be connected to a centralized tank reactor located in a basement of a home or built beneath the toilets, as in a public restroom. (*See figure 3 for an example.*) These larger composting reactors can be built with rotating drums, as mentioned earlier, to encourage waste decomposition. Or, they may be built with a sloped bottom where fresh wastes remain at the top of the slope as the bottom of the pile ages. Heat and a fan-powered exhaust system help remove excess moisture and speed the composting process in some models.

The composted end-product can be produced in either a single-chambered, continuous process or in multi-chamber batch units. A continuous composting system has a single chamber for containing the waste material, which is added to the top of the unit, and the finished

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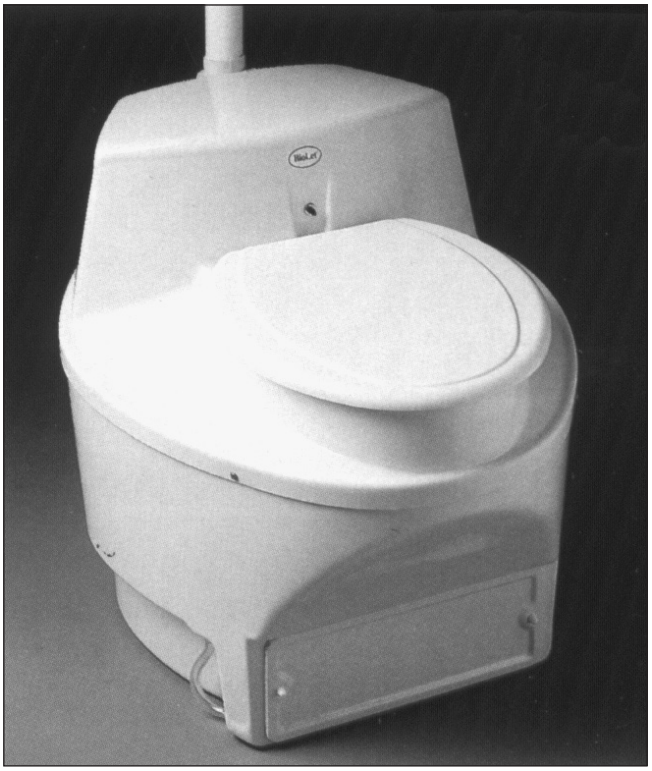


Figure 4. A self-contained composting toilet unit. The composting bin is located under and behind the toilet seat. Photo courtesy of BioLet U.S.A.

continued from page 3

compost is removed from the bottom.

A batch composter has at least two chambers. When one chamber is filled, the waste stored inside is left to break down, and the system is switched to use the other chamber. These systems segregate the older waste material from fresh material, thus reducing the risk of finding living disease organisms (pathogens) in the finished compost.

Composting systems may also have active or passive reactor bins. Passive systems use a simple, moldering or crumbling process, whereby the waste material accumulates and decomposes without added heat, electric fans, or mechanical mixing. Active systems may have any or all of the following features: automatic mixers, pile-leveling devices, tumbling drums, thermostatically controlled heaters, and fans.

Advantages:

- Composting toilets do not require water for flushing, thereby reducing household water consumption.
- They reduce the amount and strength of wastewater to be disposed of onsite.
- They are well suited for remote sites where conventional onsite systems are not feasible.
- They have low power consumption.
- Composting toilets productively recycle human waste back into the environment.
- They can compost selected kitchen waste, reducing household garbage.
- They may allow a property owner to install a reduced-size soil absorption system for graywater disposal, minimizing costs and disruption to the landscape. (*Check local and state regulations.*)

Disadvantages:

- Maintenance of composting toilets requires a high level of responsibility and commitment by owners.
- Removing the end-product is an unpleasant job if the system is not properly installed or maintained.
- Composting toilet systems must be used in conjunction with a graywater system where other plumbing fixtures are in place.
- Smaller units may have limited capacity for accepting peak loads.
- Improper maintenance makes cleaning difficult and may lead to health hazards and odor problems.
- Using an inadequately treated end-product as a soil amendment may have possible health and environmental consequences.
- Composting excrement may be visible in some systems.
- Too much liquid in the composter can disrupt the process if it is not drained and properly managed.
- Most composting toilet systems require a power source.

Incinerating toilets

Composting Toilet Do's and Don'ts

Do:

* Keep the toilet seat cover down and the waste valve closed when not in use to prevent odors from escaping.
* Put toilet paper into the toilet.
* Add organic bulking material to the toilet occasionally.
* Clean the seat area with mild soap.
* Determine the proper disposal means according to state and local regulations.

Don't:

* Throw any trash (sanitary products, diapers, paper-towels, etc.), cigarettes, matches, or burning material into the toilet.
* Use harsh chemicals, chlorine bleach or toxic chemicals on or in the toilet.
* Pour quantities of water into the toilet.
* Empty compost from bin until it is decomposed.
* Remove compost from a filled external composter unless it has been composting for six to 12 months or longer.

From The CompostingToilet Book.

County Park Solves Restroom Problem

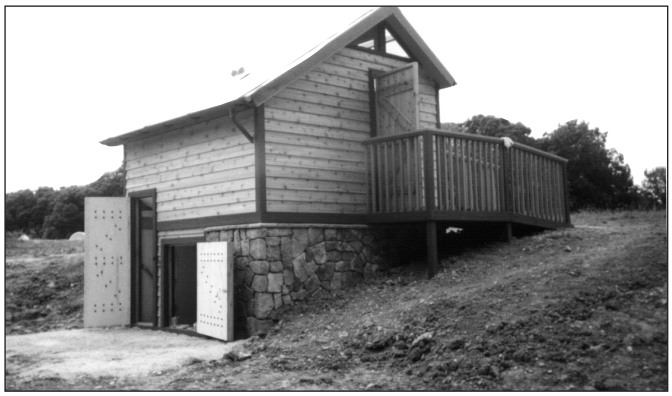
Two restrooms recently built at the new Quail Ridge Park in St. Charles County, Missouri, are considered both ecologically and user friendly. These restrooms require no public water or sewage connections.

The park uses a composting toilet system design, wherein human waste decomposes through the work of the natural elements of air, sunshine, and pine chips. A fan powered by solar-energized batteries sucks air downward from the toilet, virtually eliminating the odors that plague most outhouses.

Curt Loupe, director of the St. Charles County Parks and Recreation Department, said he and his staff researched composting toilets because the Quail Ridge Park site does not yet have access to public sewer lines.

Loupe heard from other park directors and employees from around the country that they had encountered "the cleanest, neatest restrooms they had ever been in" at the Grand Canyon National Park. This information prompted Loupe to contact the National Park Service for a list of companies that install restrooms in isolated parts of public parks. Loupe checked out the alternatives and decided on the composting system.

Two plastic tanks, roughly eight feet tall, sit in a basement area under each of the restrooms. Kevin Mills, who provided the composting toilet system at Quail Ridge Park, explained that waste material is deposited onto pine chips in the bin. Solar-heated air from roof-mounted collectors is forced downward through pipes into the system to increase the decomposition rate. Moreover, the basement is insulated to maintain a constant temperature conducive to composting.



This restroom facility is located at Quail Ridge Park in St. Charles, Missouri. The basement holds two composting reactor tanks. Solar radiation provides both heat and electricity to the building. *Photo courtesy of Kevin Mills.*

The composting wastes are stirred periodically by tines that rotate by turning a crank from outside the container. An automatic sprayer, using fluids collected in the bottom of the reactor bin, maintains the proper degree of moisture in the composting material.

Mills explained that a 200-gallon tank holds collected rainwater for the sinks and to clean the building. The solar collector panels in the roof charge batteries that operate all of the electrical equipment including the pump that provides the pressure for the wash-down hose and the sprinkler system.

"This is a pretty complex little building," Mills said. "It's got solar heating, solar electricity, rainwater catchment for clean-up water, self-closing toilet seats, a clear roof, on and on. It's very nice."

The end product of the composting process is collected in a plastic tray containing about two cubic feet of material that is "kind of like topsoil" that can be used in an ornamental garden or spread in a nearby field (depending on state and local regulations).

Portions of this material were taken from an article in the May 22, 1999, St. Louis Post-Dispatch.

Historic Town Leaps into 21st Century

Virtually everyone who visits Old Town Spring in the extreme northern part of Harris County, Texas, comes to take a step back in time and to have a great experience. This village features many antique stores, specialty shops, and a variety of restaurants. The atmosphere is pleasant and easy going.

Until recently, the village lacked one vitally important feature—a public restroom. Because centralized sewers don't extend to Old Town Spring, an onsite system was the appropriate choice for wastewater treatment.

The onsite system that was designed for the village uses waterless urinals and ultra-low-flow 0.5-gallon toilets. The wastewater runs through a series of several septic tanks followed by an aerobic treatment system. Effluent is disinfected and pumped to a high pressure sand filter. This wastewater is then recycled to flush the toilets. The water is colored with a blue-green tint so people will know it is not potable water.

At the end of the recycling process, the effluent is distributed to a small 5,000-square-foot drainfield that provides landscaping around the public restroom building and an adjacent small museum. The system is designed so that, on average, a gallon of wastewater is recycled and reused five times before it is sent to the disposal field.

"This system is a real blessing for the area because more than 1,000 people come to visit and shop here on a typical weekend," John Blount, manager of the Harris County Engineering Office onsite wastewater program, said. "Obviously they needed a public restroom because so many of the shops are small and lack such facilities. In fact, people were so excited when this [facility] was built two years ago that community leaders hosted and participated in a 'potty parade' to celebrate the opening of the system."

Information courtesy of Texas Onsite Insights *(August 1997), on the Web at* http://twri.tamu.edu/twripubs/Insights.

Toilet Options: Incinerating

Incinerating toilets are self-contained, waterless systems that don't discharge any effluent. They rely on electric power, oil, natural gas, or propane to burn human waste to a sterile ash. When properly installed, an incinerating toilet is safe and relatively easy to maintain.

An electric-powered incinerating toilet (*see figure 5*) is designed with a paper-lined upper bowl to hold newly deposited waste. This paper liner is replaced after each use. "Flushing" is accomplished by pressing a foot pedal, causing an insulated chamber cover to lift and swing to the side while the bowl halves separate. The paper liner and its contents drop into the incinerating chamber. When the foot pedal is released, the chamber cover reseals, and the bowl halves return to the closed position.

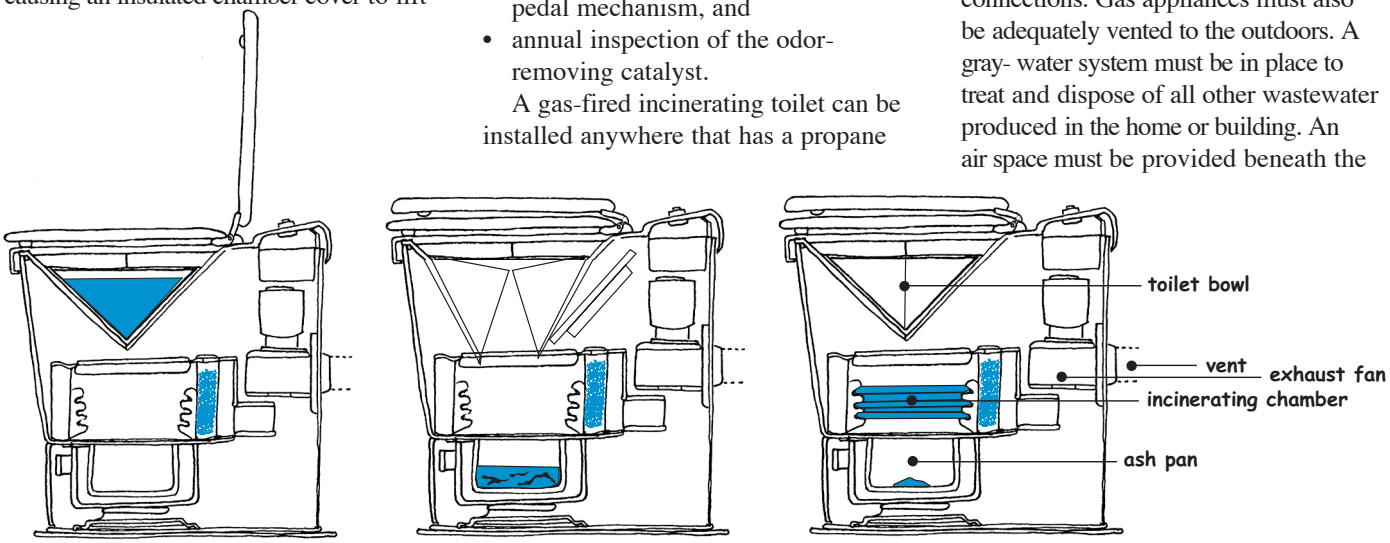


Figure 5. An electric incinerating toilet system. *Illustration based on the Incinolet toilet from Research Products, Dallas, Texas.*

The system is designed to burn individual deposits, while outside surfaces remain cool to the touch. Burning begins with a press of the "start" button located on the frame of the toilet. An electric heating unit cycles on and off for 60 minutes while a blower motor draws air from the incineration chamber over a heat-activated catalyst to remove odors. The air then flows (with help from a fan) to the outdoors through a vent pipe. The fan continues to run after the heating cycle finishes to cool the incinerating unit. The entire cycle of burning waste to a small amount of ash takes from 1.5 to 1.75 hours.

Maintenance of the electric incinerating toilet includes:

- regular emptying of the ash collection pan,
- cleaning the outer surfaces including the upper bowl halves,
- periodic (every 90 days) cleaning of the blower motor and occasional replacement of the blower wheel,
- cleaning and lubricating the foot pedal mechanism, and
- annual inspection of the odor-removing catalyst.

A gas-fired incinerating toilet can be installed anywhere that has a propane or natural gas source. The toilet unit has an integral storage tank that can accommodate 40 to 60 uses before beginning the incinerating cycle. According to the only manufacturer of gas-fired incinerating toilets, Storburn International Inc., these systems can accommodate eight to 10 workers in an average work day or six to eight people in a cottage or residence in a normal-use day.

Gas-fired incinerating toilets do not have a toilet bowl. The waste drops into a holding chamber directly beneath the seat of the unit. An aerosol masking foam can be used to reduce odors and cover wastes between incineration cycles.

Before the burning process begins, an anti-foaming agent must be added to the heating chamber to reduce the likelihood of liquid wastes boiling over during incineration. The toilet seat is lifted and a cover plug is inserted over the chamber opening to act as a fire wall. A timer is set according to the recommended duration for the load size. A gas valve is turned to the pilot position and ignited by pressing a button. The pilot light ignites the burner, which automatically locks down the unit (similar to a self-cleaning oven), so the toilet cannot be used during the burning cycle. The complete incinerating cycle takes from 1.5 to 4.5 hours, depending on the waste load.

Several factors must be considered when installing a gas-fired incinerating toilet. The toilet, being a gas fixture, must be routinely inspected for integrity of connections. Gas appliances must also be adequately vented to the outdoors. A gray- water system must be in place to treat and dispose of all other wastewater produced in the home or building. An air space must be provided beneath the unit to ensure proper drafting/airflow during the incineration cycle. Rugs and carpets should not be installed under the unit. And, intake air vents may need to be installed if the incinerating toilet is installed in an enclosed, air-tight room.

Advantages:

- Units are self-contained and use no water.
- No effluent is discharged.

Disadvantages:

- A power source must be available.
- Ash must be removed and the incinerating unit must be cleaned.
- Units cannot be used during the incinerating cycle.
- Incinerating toilets are not practical for public use.

Other toilet alternatives

Several additional alternative toilet

Toilet Options: Other Alternatives

designs can be purchased and installed for home use or public restrooms, depending on needs and individual preferences. One, the oil-flush toilet, uses a closed-loop system that employs mineral oil to flush wastes from the toilet bowl. The waste flows to a gravity separation tank where the oil floats to the top and the heavier wastes sink. The oil is then drawn off the top, filtered, and recirculated to the toilet.

Figure 6. Portable toilets, like these at Four Corners, where Colorado, Arizona, New Mexico, and Utah meet, must be pumped out frequently by a sanitation service tank truck.

The oil remains clear and odorless. Wastes are drained from the bottom of the collection tank and are then incinerated, composted, or removed by a licensed septage hauler.

Chemical toilets are similar to other models that store wastes in a holding tank. Water mixed with chemical preservatives is the medium for holding wastes. These substances stop biological activity and prevent decomposition. The volume of waste and organic strength are not reduced. A valve opens to drain the holding tank in some models, or the entire holding tank lifts out in other models. Chemical toilets, like the portable toilets shown in figure 6, require

- onsite storage of chemicals and waste,
- regular waste removal by a licensed hauler, and
- the waste must be treated at a sewage treatment facility. (*Note: Chemical toilets may upset or inhibit the biological processes used in conventional treatment plants, so the facility must be designed to accept these wastes.*)

Vacuum toilets are used most often in boats. They consume about 0.25 gallons of water per flush. A vacuum is maintained in the system at all times. Water is drawn into the bowl by lifting a lever in one model, then flushing is accomplished by pressing the lever. The change in pressure in the vacuum tank activates the vacuum pump, which pulls the wastewater down through the system and deposits it in the holding tank.

Privies or outhouses still have a place in today's world. Some public parks, homes, and cottages in remote areas still use pit privies to contain human wastes. These facilities may seem primitive, but when properly constructed and maintained, they can adequately resolve the problem of sanitary human waste disposal. State and local guidelines must be followed in constructing privies.

An open pit privy consists of a small building situated above a hole in the ground. Privies should not be located on soils with a high water table, on a flood plain, or in an area where bedrock is close to the ground's surface. Solid wastes decompose into humus in the pit, and liquids seep into the soil.

A sealed vault privy, which is more likely to be seen in state and national parks, has a holding tank set into the ground below the privy building.

The tank, which should be capable of holding up to 1,000 gallons of waste, must be pumped out periodically, depending on frequency of use. The tank must be air and water tight, except for the waste entry hole and a vent stack that extends above the roof of the privy. Some regulations require a self-closing door. As with open pit privies, vault privies should not be installed on a flood plain or where a high seasonal water table occurs.