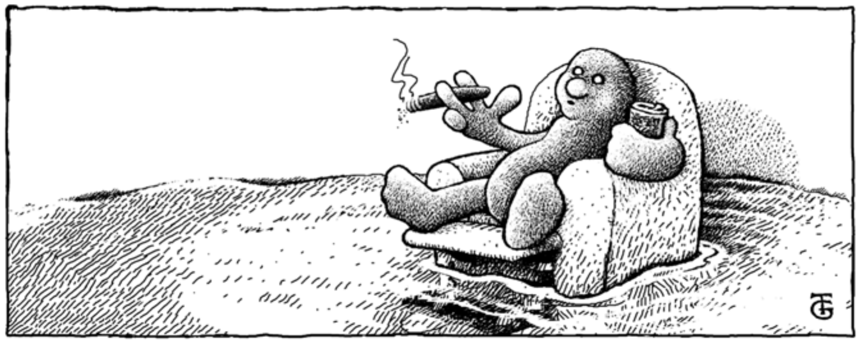


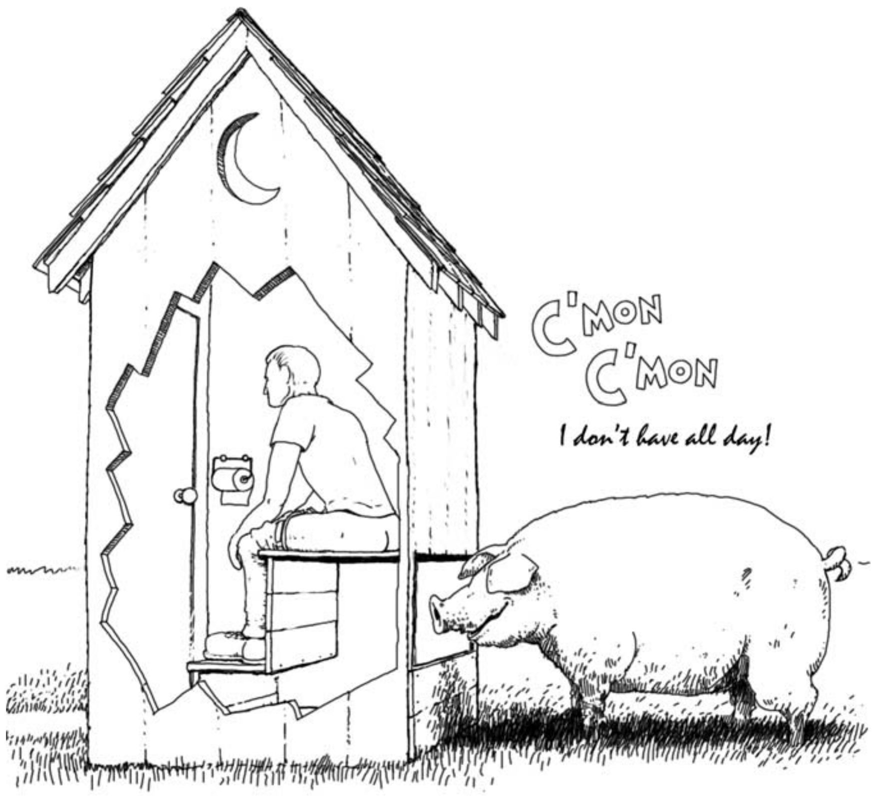
A DAY IN THE LIFE OF A TURD

When I was a kid, I listened to army veterans talking about their stints in the Korean War. Usually after a beer or two, they'd turn their conversation to the "outhouses" used by the Koreans. They were amazed, even mystified, about the fact that the Koreans tried to lure passersby into their outhouses by making the toilets especially attractive. The idea of someone wanting someone else's crap always brought out a loud laugh from the vets.

Perhaps this attitude sums up the attitudes of Americans. Humanure is a waste product that we have to get rid of, and that's all there is to it. Only fools would think otherwise. One of the effects of this sort of attitude is that Americans don't know and probably don't care where their humanure goes after it emerges from their rear ends as long as they don't have to deal with it.

MEXICAN BIOLOGICAL DIGESTER

Well, where it goes depends on the type of "waste disposal system" used. Let's start with the simplest: the Mexican biological digester, also known as the stray dog. In India, this may be known as the family pig. I spent a few months in southern Mexico in the late 1970s in Quintana Roo on the Yucatan peninsula. There, toilets were not available; people simply used the sand dunes along the coast. No problem, though. One of the small, unkempt and ubiquitous Mexican dogs would wait nearby with watering mouth until you did your



PRIMITIVE BIOLOGICAL DIGESTER

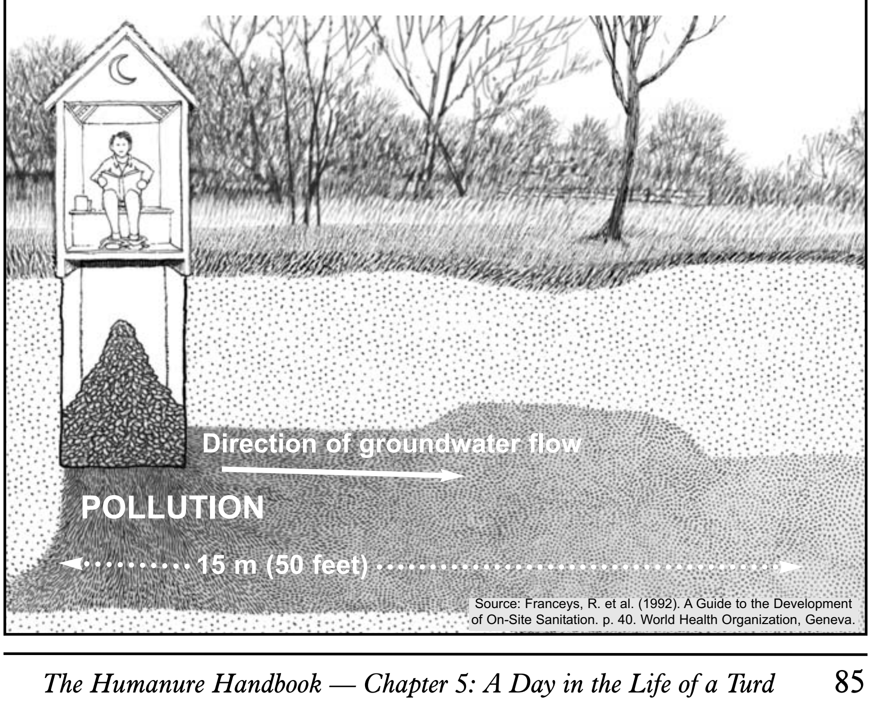
thing. Burying your excrement in that situation would have been an act of disrespect to the dog. No one wants sand in their food. A good, healthy, steaming turd at the crack of dawn on the Caribbean coast never lasted more than 60 seconds before it became a hot meal for a human's best friend. Yum.

THE OLD-FASHIONED OUTHOUSE

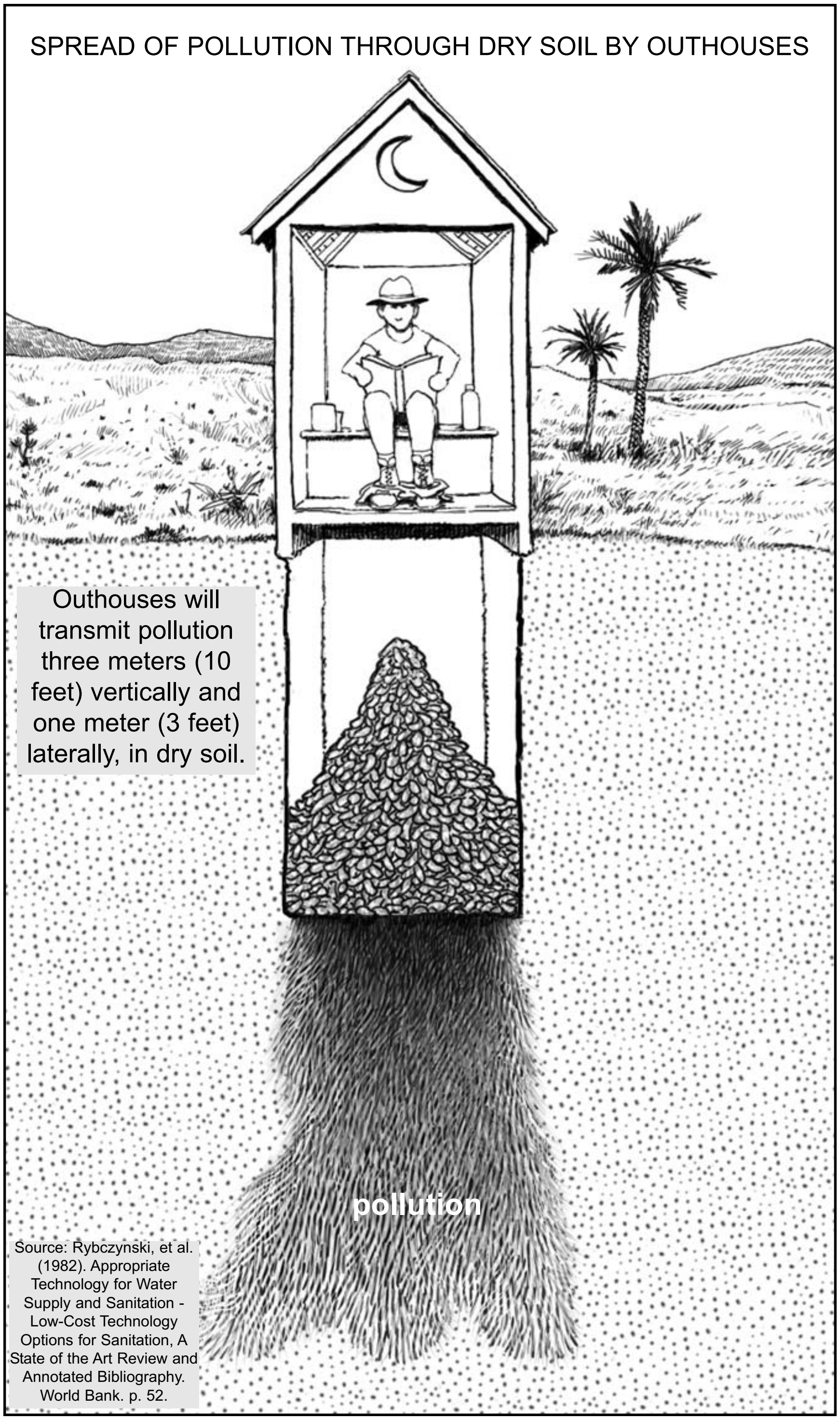
Next up the ladder of sophistication is the old-fashioned outhouse, also known as the pit latrine. Simply stated, one digs a hole and defecates in it, and then does so again and again until the hole fills up; then it's covered with dirt. It's nice to have a small building or "privy" over the hole to provide some privacy and shelter. However, the concept is simple: dig a hole and bury your excrement. Interestingly, this level of sophistication has not yet been surpassed in America. We still bury our excrement, in the form of sewage sludge, in landfill holes.

Outhouses create very real health, environmental and aesthetic problems. The hole in the ground is accessible to flies and mosquitoes which can transmit diseases over a wide area. The pits leak pollutants into the ground even in dry soil. And the smell — *hold your*

SPREAD OF POLLUTION THROUGH WET SOIL BY OUTHOUSES



Source: Franceys, R. et al. (1992). A Guide to the Development of On-Site Sanitation. p. 40. World Health Organization, Geneva.


SPREAD OF POLLUTION THROUGH DRY SOIL BY OUTHOUSES
Outhouses will transmit pollution three meters (10 feet) vertically and one meter (3 feet) laterally, in dry soil.
pollution
Source: Rybczynski, et al. (1982). Appropriate Technology for Water Supply and Sanitation - Low-Cost Technology Options for Sanitation, A State of the Art Review and Annotated Bibliography. World Bank. p. 52.

nose.

Outhouses will transmit pollution three meters (10 feet) below the outhouse hole and one meter (3 feet) sideways in dry soil. They can be expected to leak pollution 50 feet sideways in wet soils, following the direction of groundwater flow.

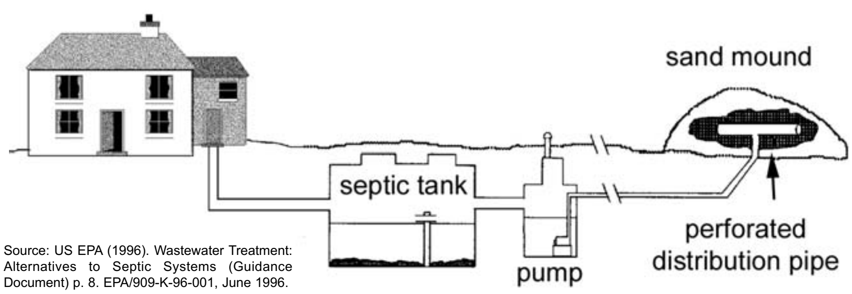
SEPTIC SYSTEMS

Another step up the ladder, one finds the septic tank, a common method of human waste disposal in rural and suburban areas of the United States. In this system the turd is deposited into a container of water, usually purified drinking water, and flushed away.

After the floating turd travels through a sewage pipe, it plops into a fairly large underground storage tank, or septic tank, usually made of concrete and sometimes of fiberglass. In Pennsylvania (U.S.), a 900 gallon tank is the minimum size allowed for a home with three or fewer bedrooms.[1] The heavier solids settle to the bottom of the tank and the liquids drain off into a leach field, which consists of an array of drain pipes situated below the ground surface allowing the liquid to seep out into the soil. The wastewater is expected to be undergoing anaerobic decomposition while in the tank. When septic tanks fill up, they are pumped out and the waste material is trucked to a sewage treatment plant, although sometimes it's illegally dumped.

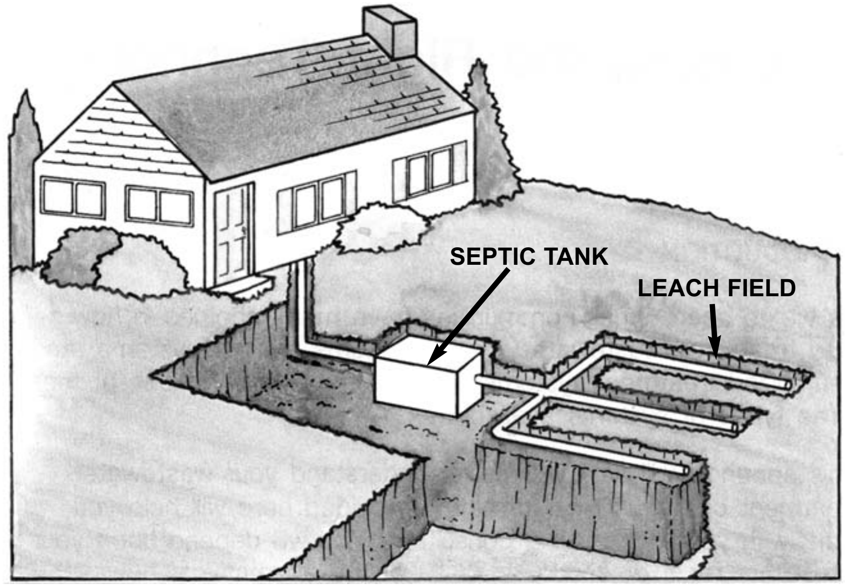
SAND MOUNDS

In the event of poorly drained soil, either low-lying or with a high clay content, a standard leach field will not work very well, especially when the ground is already saturated with rainwater or snow melt. One can't drain wastewater into soil that is already saturated with water. That's when the *sand mound* sewage disposal system is



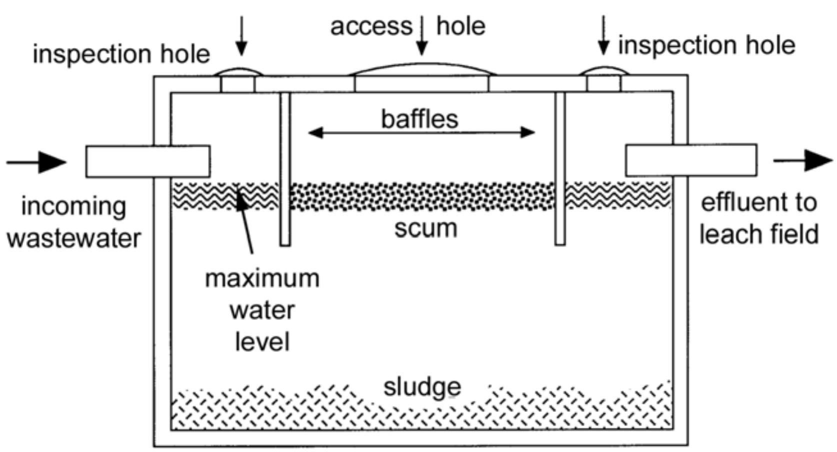
Source: US EPA (1996). Wastewater Treatment: Alternatives to Septic Systems (Guidance Document) p. 8. EPA/909-K-96-001, June 1996.

SAND MOUND SYSTEM



STANDARD SEPTIC TANK GRAVITY DISTRIBUTION SYSTEM

Source: US EPA (1987). *It's Your Choice — A Guidebook for Local Officials on Small Community Wastewater Management Options,* p. 40. EPA 430/9-87-006.



CROSS-SECTION OF A SEPTIC TANK

Source: Penn State College of Agriculture, Cooperative Extension, Agricultural Engineering Fact Sheet SW-165.

employed. When the septic tank isn't draining properly, a pump will kick in and pump the effluent into a pile of sand and gravel above ground (although sometimes a pump isn't necessary and gravity does the job). A perforated pipeline in the pile of sand allows the effluent to drain down through the mound. Sand mounds are usually covered with soil and grass. In Pennsylvania, sand mounds must be at least one hundred feet downslope from a well or spring, fifty feet from a stream, and five feet from a property line.[2] According to local excavating contractors, sand mounds cost $5,000 to $12,000 to construct in the early 21st century. They must be built to exact government specifications, and aren't usable until they pass an official inspection.

GROUND WATER POLLUTION FROM SEPTIC SYSTEMS

Humans started disposing of "human waste" by defecating into a hole in the ground or an outhouse, then discovered we could float our turds out to the hole using water and never have to leave our shelter. However, one of the unfortunate problems with septic systems is, like outhouses, they pollute our groundwater.

At the end of the 20th century, there were 22 million septic system sites in the United States, serving one fourth to one third of the U.S. population. They were notorious for leaching contaminants such as bacteria, viruses, nitrates, phosphates, chlorides and organic compounds such as trichloroethylene into the environment. An EPA study of chemicals in septic tanks found toluene, methylene chloride, benzene, chloroform and other volatile synthetic organic compounds related to home chemical use, many of them cancer-causing.[3] Between 820 and 1,460 *billion* gallons of this contaminated water were discharged per year into our shallowest aquifers.[4] In the U.S., septic tanks are reported as a source of ground water contamination more than any other source. Forty-six states cite septic systems as sources of groundwater pollution; nine of these reported them to be the primary source of groundwater contamination in their state.[5]

The word "septic" comes from the Greek "septikos" which means "to make putrid." Today it still means "causing putrefaction," putrefaction being "the decomposition of organic matter resulting in the formation of foul-smelling products." Septic systems are not designed to destroy human pathogens that may be in the human waste that enters the septic tank. Instead, septic systems are designed to collect human wastewater, settle out the solids, and anaerobically digest them to some extent, leaching the effluent into the ground. Therefore, septic systems can be highly pathogenic, allowing the transmission of disease-causing bacteria, viruses, protozoa and intestinal parasites through the system.

One of the main concerns associated with septic systems is the problem of human population density. Too many septic systems in any given area will overload the soil's natural purification systems and allow large amounts of wastewater to contaminate the underlying watertable. A density of more than forty household septic systems per square mile will cause an area to become a likely target for subsurface contamination, according to the EPA.[6]

Toxic chemicals are commonly released into the environment from septic systems because people dump them down their drains. The chemicals are found in pesticides, paint, toilet cleaners, drain cleaners, disinfectants, laundry solvents, antifreeze, rust proofers, septic tank and cesspool cleaners and many other cleaning solutions. In fact, over 400,000 gallons of septic tank cleaner liquids containing synthetic organic chemicals were used in one year by the residents of Long Island alone. Furthermore, some toxic chemicals can corrode pipes, thereby causing heavy metals to enter septic systems.[7]

In many cases, people who have septic tanks are forced to connect to sewage lines when the lines become available. A U.S. Supreme Court case in 1992 reviewed a situation whereby town members in New Hampshire had been forced to connect to a sewage line that simply discharged untreated, raw sewage into the Connecticut River, and had done so for 57 years. Despite the crude method of sewage disposal, state law required properties within 100 feet of the town sewer system to connect to it from the time it was built in 1932. This barbaric sewage disposal system apparently continued to operate until 1989, when state and federal sewage treatment laws forced a stop to the dumping of raw sewage into the river.[8]

WASTEWATER TREATMENT PLANTS

There's still another step up the ladder of wastewater treatment sophistication: the wastewater treatment plant, or sewage plant. The wastewater treatment plant is like a huge, very sophisticated septic tank because it collects the waterborne excrement of large numbers of humans. Inevitably, when one defecates or urinates into water, one pollutes the water. In order to avoid environmental pollution, that "wastewater" must somehow be rendered fit to return to the environment. The wastewater entering the treatment plant is 99% liquid because all sink water, bath water and everything else that goes down one's drain ends up at the plant too, which is why it's called a *water* treatment plant. In some cases, storm water runoff also enters wastewater treatment plants via *combined sewers.* Industries, hospitals, gas stations and any place with a drain add to the contaminant blend in the wastewater stream.

Many modern wastewater plants use a process of activated sludge treatment whereby oxygen is vigorously bubbled through the wastewater in order to activate microbial digestion of the solids. This aeration stage is combined with a settling stage that allows the solids to be removed. The removed solids, known as *sludge*, are either used to reinoculate the incoming wastewater, or they're dewatered to the consistency of a dry mud and buried in landfills. Sometimes the sludge is applied to agricultural land, and now, sometimes, it's composted.

The microbes that digest the sludge consist of bacteria, fungi, protozoa, rotifers and nematodes.[9] U.S. sewage treatment plants generated about 7.6 million dry tons of sludge in 1989.[10] New York City alone produces 143,810 dry tons of sludge every year.[11] In 1993, the amount of sewage sludge produced annually in the U.S. was 110-150 million wet metric tons. The water left behind is treated, usually with chlorine, and discharged into a stream, river or other body of water. Sewage treatment water releases to surface water in the United States in 1985 amounted to nearly *31 billion gallons per day*.[12] Incidentally, the amount of toilet paper used in 1991 to send all this waste to the sewers was 2.3 million tons.[13] With each passing year, as the human population increases, these figures go up.

WASTE STABILIZATION PONDS

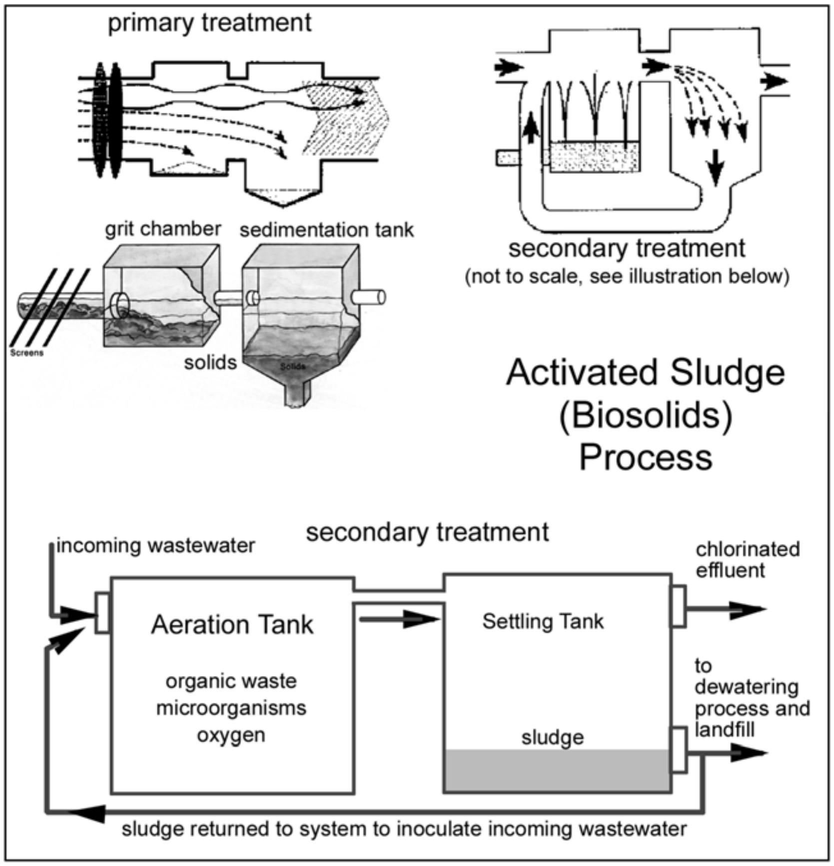
Perhaps one of the most ancient wastewater treatment methods known to humans are waste stabilization ponds, also known as oxidation ponds or lagoons. They're often found in small rural areas where land is available and cheap. Such ponds tend to be only a meter to a meter and a half deep, but vary in size and depth and can be three or more meters deep.[14] They utilize natural processes to "treat" waste materials, relying on algae, bacteria and zooplankton to reduce the organic content of the wastewater. A "healthy" lagoon will appear green in color because of the dense algae population. These lagoons require about one acre for every 200 people served. Mechanically aerated lagoons only need 1/3 to 1/10 the land that unaerated stabilization ponds require. It's a good idea to have several smaller lagoons in series rather than one big one; normally, a minimum of three "cells" are used. Sludge collects in the bottom of the lagoons, and may have to be removed every five or ten years and disposed of in an approved manner.[15]

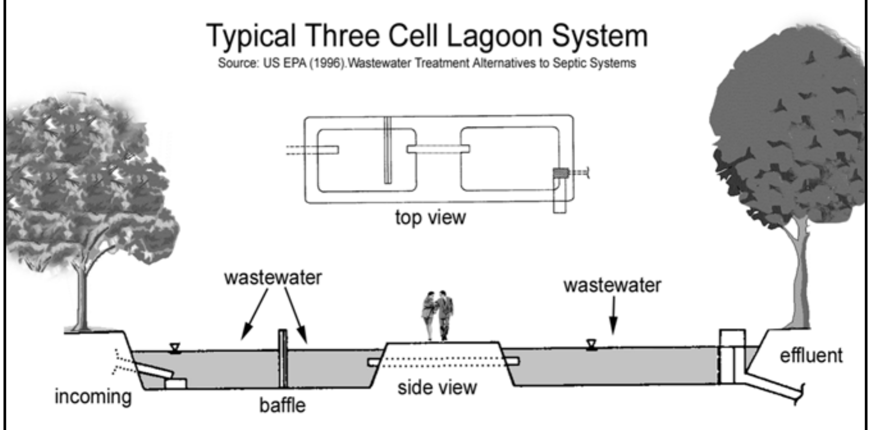
CHLORINE

Wastewater leaving treatment plants is often treated with chlorine before being released into the environment. Therefore, besides contaminating water resources with feces, the act of defecating into water often ultimately contributes to the contamination of water resources with *chlorine*.

Used since the early 1900s, chlorine is one of the most widely produced industrial chemicals. More than 10 million metric tons are manufactured in the U.S. each year — $72 billion worth.[16] Annually, approximately 5%, or 1.2 billion pounds of the chlorine manufactured is used for wastewater treatment and drinking water "purification." The lethal liquid or green gas is mixed with the wastewater from sewage treatment plants in order to kill disease-causing microorganisms before the water is discharged into streams, lakes, rivers and seas. It is also added to household drinking water via household and municipal water treatment systems. Chlorine kills microorganisms by damaging their cell membranes, which leads to a leakage of their proteins, RNA, and DNA.[17]

Chlorine (Cl_2) doesn't exist in nature. It's a potent poison which reacts with water to produce a strongly oxidizing solution that can damage the moist tissue lining of the human respiratory tract.


primary treatment
grit chamber
sedimentation tank
Screens
solids
Solids
secondary treatment
(not to scale, see illustration below)
Activated Sludge
(Biosolids)
Process
secondary treatment
incoming wastewater
Aeration Tank
organic waste
microorganisms
oxygen
Settling Tank
sludge
chlorinated
effluent
to
dewatering
process and
landfill
sludge returned to system to inoculate incoming wastewater


Typical Three Cell Lagoon System
Source: US EPA (1996).Wastewater Treatment Alternatives to Septic Systems
top view
wastewater
wastewater
incoming
baffle
side view
effluent

Ten to twenty parts per million (ppm) of chlorine gas in air rapidly irritates the respiratory tract; even brief exposure at levels of 1,000 ppm (one part in a thousand) can be fatal.[18] Chlorine also kills fish, and reports of fish kills caused chlorine to come under the scrutiny of scientists in the 1970s.

The fact that harmful compounds are formed as *by-products* of chlorine use also raises concern. In 1976, the U.S. Environmental Protection Agency reported that chlorine use not only poisoned fish, but could also cause the formation of cancer-causing compounds such as chloroform. Some known effects of chlorine-based pollutants on animal life include memory problems, stunted growth and cancer in humans; reproductive problems in minks and otters; reproductive problems, hatching problems and death in lake trout; and embryo abnormalities and death in snapping turtles.[19]

In a national study of 6,400 municipal wastewater treatment plants, the EPA estimated that two thirds of them used too much chlorine, exerting lethal effects at all levels of the aquatic food chain. Chlorine damages the gills of fish, inhibiting their ability to absorb oxygen. It also can cause behavioral changes in fish, thereby affecting migration and reproduction. Chlorine in streams can create chemical "dams" which prevent the free movement of some migratory fish. Fortunately, since 1984, there has been a 98% reduction in the use of chlorine by sewage treatment plants, although chlorine use continues to be a widespread problem because a lot of wastewater plants are still discharging it into small receiving waters.[20]

Another controversy associated with chlorine use involves "dioxin," which is a common term for a large number of chlorinated chemicals that are classified as possible human carcinogens by the EPA. It's known that dioxins cause cancer in laboratory animals, but their effects on humans are still being debated. Dioxins, by-products of the chemical manufacturing industry, are concentrated up through the food chain where they're deposited in human fat tissues. A key ingredient in the formation of dioxin is chlorine, and indications are that an increase in the use of chlorine results in a corresponding increase in the dioxin content of the environment, even in areas where the only dioxin source is the atmosphere.[21]

In the upper atmosphere, chlorine molecules from air pollution gobble up ozone; in the lower atmosphere, they bond with carbon to form organochlorines. Some of the 11,000 commercially used organochlorines include hazardous compounds such as DDT, PCBs, chloroform and carbon tetrachloride. Organochlorines rarely occur in nature, and living things have little defense against them. They've been linked not only to cancer, but also to neurological damage, immune suppression and reproductive and developmental effects. When chlorine products are washed down the drain into a septic tank, they're producing organochlorines. Although compost microorganisms can degrade and make harmless many toxic chemicals, highly chlorinated compounds are disturbingly resistant to such biodegradation.[22]

"Any use of chlorine results in compounds that cause a wide range of ailments," says Joe Thorton, a Greenpeace researcher, who adds, *"Chlorine is simply not compatible with life. Once you create it, you can't control it."* [23]

There's no doubt that our nation's sewage treatment systems are polluting our drinking water sources with pathogens. As a result, chlorine is also being used to disinfect *the water we drink* as well as to disinfect discharges from wastewater treatment facilities. It is estimated that 79% of the U.S. population is exposed to chlorine.[24] According to a 1992 study, *chlorine is added to 75% of the nation's drinking water* and is linked to cancer. The results of the study suggested that at least 4,200 cases of bladder cancer and 6,500 cases of rectal cancer each year in the U.S. are associated with consumption of chlorinated drinking water.[25] This association is strongest in people who have been drinking chlorinated water for more than fifteen years.[26]

The U.S. Public Health Service reported that pregnant women who routinely drink or bathe in chlorinated tap water are at a greater risk of bearing premature or small babies, or babies with congenital defects.[27]

According to a spokesperson for the chlorine industry, 87% of water systems in the U.S. use free chlorines; 11% use chloramines. Chloramines are a combination of chlorine and ammonia. The chloramine treatment is becoming more widespread due to the health concerns over chlorine.[28] However, EPA scientists admit that we're pretty ignorant about the potential by-products of the chloramine process, which involves ozonation of the water prior to the addition of chloramine.[29]

According to a U.S. General Accounting Office report in 1992, consumers are poorly informed about potentially serious violations of drinking water standards. In a review of twenty water systems in six states, out of 157 drinking water quality violations, the public received a timely notice in only 17 of the cases.[30]

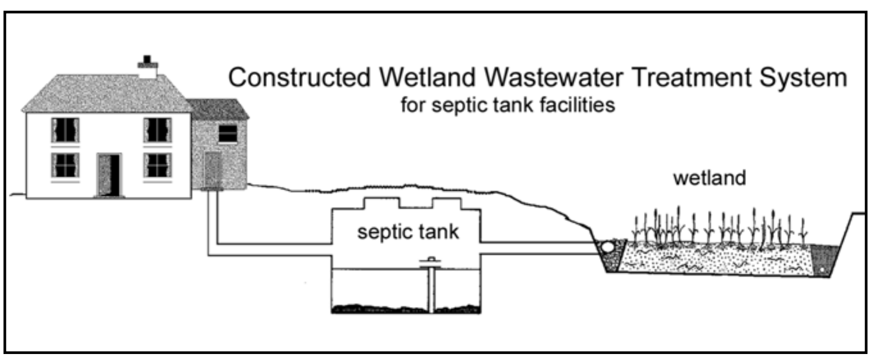
ALTERNATIVE WASTEWATER TREATMENT SYSTEMS

New systems are being developed to purify wastewater. One popular experimental system today is the *constructed,* or *artificial wetlands system*, which diverts wastewater through an aquatic environment consisting of aquatic plants such as water hyacinths, bullrushes, duckweed, lilies and cattails. The plants act as marsh filters, and the microbes which thrive on their roots break down nitrogen and phosphorous compounds, as well as toxic chemicals. Although they don't break down heavy metals, the plants absorb them and they can then be harvested for incineration or landfilled.[31]

According to EPA officials, the emergence of constructed wetlands technology shows great potential as a cost-effective alternative to wastewater treatment. The wetlands method is said to be relatively affordable, energy-efficient, practical and effective. The treatment efficiency of properly constructed wetlands is said to compare well with conventional treatment systems.[32] Unfortunately, wetlands systems don't recover the agricultural resources available in humanure.

Another system uses solar-powered, greenhouse-like technology to treat wastewater. This system uses hundreds of species of bacteria, fungi, protozoa, snails, plants and fish, among other things, to produce advanced levels of wastewater treatment. These Solar Aquatics systems are also experimental, but appear hopeful.[33] Again, the agricultural resources of humanure are lost when using any disposal method or wastewater treatment technique instead of a humanure recycling method.

When a household humanure recycling method *is* used, however, and sewage is *not* being produced, most households will still be producing graywater. Graywater is the water that is used for washing, bathing, and laundry, and it must be dealt with in a responsible manner before draining into the environment. Most households produce



sewage (blackwater). Households which compost their humanure may produce no sewage at all — these households are prime candidates for *alternative* graywater systems. Such systems are discussed in Chapter 9.

AGRICULTURAL USE OF SEWAGE SLUDGE

Now here's where a thoughtful person may ask, "Why not put sewage *sludge* back into the soil for agricultural purposes?"

One reason: government regulation. When I asked the supervisor of my local wastewater treatment plant if the one million gallons of sludge the plant produces each year, from a population of 8,000 people, was being applied to agricultural land, he said, *"It takes six months and five thousand dollars to get a permit for a land application. Another problem is that due to regulations, the sludge can't lie on the surface after it's applied, so it has to be plowed under shortly after application. When farmers get the right conditions to plow their fields, they plow them. They can't wait around for us, and we can't have sludge ready to go at plowing time."* It may be just as well.

Problems associated with the agricultural use of sewage sludge include groundwater, soil and crop contamination with pathogens, heavy metals, nitrates, and toxic and carcinogenic organic compounds.[34] Sewage sludge is a lot more than organic agricultural material. It can contain DDT, PCBs, mercury and other heavy metals.[35] One scientist alleges that more than 20 million gallons of used motor oil are dumped into sewers every year in the United States.[36]

America's largest industrial facilities released over 550 million pounds of toxic pollutants into U.S. sewers in 1989 alone, according to the U.S. Public Interest Research Group. Between 1990 and 1994, an additional 450 million pounds of toxic chemicals were dumped into sewage treatment systems, although the actual levels of toxic discharges are said to be much higher than these.[37]

Of the top ten states responsible for toxic discharges to public sewers in 1991, Michigan took first prize with nearly 80 million pounds, followed in order by New Jersey, Illinois, California, Texas, Virginia, Ohio, Tennessee, Wisconsin and Pennsylvania (around 20 million pounds from PA).[38]

An interesting study on the agricultural use of sludge was done by a Mr. Purves in Scotland. He began applying sewage sludge at the rate of 60 tons per acre to a plot of land in 1971. After fifteen years of treating the soil with the sludge, he tested the vegetation

Table 5.1

BRAND NAMES OF SEWAGE SLUDGE FERTILIZERS ONCE MARKETED

SOURCE CITY	NAME*
Akron, OH	Akra-Soilite
Battle Creek, MI	Battle Creek Plant Food
Boise, ID	B.I. Organic
Charlotte, NC	Humite & Turfood
Chicago, IL	Chicagro & Nitroganic
Clearwater, FL	Clear-O-Sludge
Fond du Lac, WI	Fond du Green
Grand Rapids, MI	Rapidgro
Houston, TX	Hu-Actinite
Indianapolis, IN	Indas
Madison, WI	Nitrohumus
Massillon, OH	Greengro
Milwaukee, WI	Milorganite
Oshkosh, WI	Oshkonite
Pasadena, CA	Nitroganic
Racine, WI	Ramos
Rockford, IL	Nu-Vim
San Diego, CA	Nitro Gano
San Diego, CA	San-Diegonite
S. California	Sludgeon
Schenectady, NY	Orgro & Gro-hume
Toledo, OH	Tol-e-gro

*Names are registered brand names.

Sources: Rodale, J. I. et al. (Eds.). (1960). The Complete Book of Composting. Rodale Books Inc.: Emmaus, PA. pp. 789, 790. and Collins, Gilbeart H., (1955). Commercial Fertilizers - Their Sources and Use, Fifth Edition. McGraw-Hill Book Co., New York

grown on the plot for heavy metals. On finding that the heavy metals (lead, copper, nickel, zinc and cadmium) had been taken up by the plants, he concluded, *"Contamination of soils with a wide range of potentially toxic metals following application of sewage sludge is therefore virtually irreversible."* [39] In other words, the heavy metals don't wash out of the soil, they enter the food chain, and may contaminate not only crops, but also grazing animals.[40]

Other studies have shown that heavy metals accumulate in the vegetable tissue of the plant to a much greater extent than in the fruits, roots, or tubers. Therefore, if one must grow food crops on soil fertilized with sewage sludge contaminated with heavy metals, one might be wise to produce carrots or potatoes instead of lettuce.[41] Guinea pigs experimentally fed with swiss chard grown on soil fertilized with sewage sludge showed no observable toxicological effects. However, their adrenals showed elevated levels of antimony, their kidneys had elevated levels of cadmium, there was elevated manganese in the liver and elevated tin in several other tissues.[42]

Estimated to contain 10 billion microorganisms per gram, sludge may contain many human pathogens.[43] "*The fact that sewage sludge contains a large population of fecal coliforms renders it suspect as a potential vector of bacterial pathogens and a possible contaminant of soil, water and air, not to mention crops. Numerous investigations in different parts of the world have confirmed the presence of intestinal pathogenic bacteria and animal parasites in sewage, sludge, and fecal materials."* [44]

Because of their size and density, parasitic worm eggs settle into and concentrate in sewage sludge at wastewater treatment facilities. One study indicated that roundworm eggs could be recovered from sludge at all stages of the wastewater treatment process, and that two-thirds of the samples examined had viable eggs.[45] Agricultural use of the sludge can therefore infect soil with 6,000-12,000 viable parasitic worm eggs per square meter, per year. These eggs can persist in some soils for five years or more.[46] Furthermore, *Salmonellae* bacteria in sewage sludge can remain viable on grassland for several weeks, thereby making it necessary to restrict grazing on pastureland after a sludge application. Beef tapeworm (*Taenia saginata*), which uses cattle as its intermediate host and humans as its final host, can also infect cattle that graze on pastureland fertilized with sludge. The tapeworm eggs can survive on sludged pasture for a full year.[47]

Another interesting study published in 1989 indicated that bacteria surviving in sewage sludge show a high level of resistance to antibiotics, especially penicillin. Because heavy metals are concentrated in sludge during the treatment process, the bacteria that survive in the sludge can obviously resist heavy metal poisoning. These same bacteria also show an inexplicable resistance to antibiotics, suggesting that somehow the resistance of the two environmental factors are related in the bacterial strains that survive. The implication is that sewage sludge selectively breeds antibiotic-resistant bacteria, which may enter the food chain if the agricultural use of the sludge becomes widespread. The results of the study indicated that more knowledge of antibiotic-resistant bacteria in sewage sludge should be acquired before sludge is disposed of on land.[48]

This poses somewhat of a problem. Collecting human excrement with wastewater and industrial pollutants seems to render the organic refuse incapable of being adequately sanitized. It becomes contaminated enough to be unfit for agricultural purposes. As a consequence, sewage sludge is not highly sought after as a soil additive. For example, the state of Texas sued the U.S. EPA in July of 1992 for failing to study environmental risks before approving the spreading of sewage sludge in west Texas. Sludge was being spread on 128,000 acres there by an Oklahoma firm, but the judge nevertheless refused to issue an injunction to stop the spreading.[49]

Now that ocean dumping of sludge has been stopped, where's it going to go? Researchers at Cornell University have suggested that sewage sludge can be disposed of by surface applications in forests. Their studies suggest that brief and intermittent applications of sludge to forestlands won't adversely affect wildlife, despite the nitrates and heavy metals that are present in the sludge. They point out that the need to find ways to get rid of sludge is compounded by the fact that many landfills are expected to close and ocean dumping is now banned.

Under the Cornell model, one dry ton of sludge could be applied to an acre of forest each year.[50] New York state alone produces 370,000 tons of dry sludge per year, which would require 370,000 acres of forest each year for sludge disposal. Consider the fact that forty-nine other states produce 7.6 million dry tons of sludge. Then there's figuring out how to get the sludge into the forests and how to spread it around. With all this in mind, a guy has to stop and wonder — the woods used to be the only place left to get away from it all!

The problem of treating and dumping sludge isn't the only one. The costs of maintenance and upkeep of wastewater treatment plants is another. According to a report issued by the EPA in 1992, U.S. cities and towns need as much as $110.6 billion over the next twenty years for enlarging, upgrading, and constructing wastewater treatment facilities.[51]

Ironically, when sludge is *composted*, it may help to keep heavy metals *out* of the food chain. According to a 1992 report, composted sludge lowered the uptake of lead in lettuce that had been deliberately planted in lead-contaminated soil. The lettuce grown in the contaminated soil which was amended with composted sludge had a 64% lower uptake of lead than lettuce planted in the same soil but without the compost. The composted soil also lowered lead uptake in spinach, beets and carrots by more than 50%.[52]

Some scientists claim that the composting process transforms heavy metals into benign materials. One such scientist who designs facilities that compost sewage sludge states, *"At the final product stage, these [heavy] metals actually become beneficial micro-nutrients and trace minerals that add to the productivity of soil. This principle is now finding acceptance in the scientific community of the U.S.A. and is known as biological transmutation, or also known as the Kervran-Effect."* Other scientists scoff at such a notion.

Composted sewage sludge that is microbiologically active can also be used to detoxify areas contaminated with nuclear radiation or oil spills, according to researchers. Clearly, the composting of sewage sludge is a grossly underutilized alternative to landfill application, and it should be strongly promoted.[53]

Other scientists have shown that heavy metals in contaminated compost are *not* biologically transmuted, but are actually *concen-*

trated in the finished compost. This is most likely due to the fact that the compost mass shrinks considerably during the composting process, showing reductions of 70%, while the amount of metals remains the same. Some researchers have shown a decrease in the concentrations of *some* heavy metals and an increase in the concentrations of others, for reasons that are unclear. Others show a considerable decrease in the concentrations of heavy metals between the sludge and the finished compost. Results from various researchers *"are giving a confusing idea about the behavior of heavy metals during composting. No common pattern of behavior can be drawn between similar materials and the same metals . . ."* [54] However, metals concentrations in finished compost seem to be low enough that they are not considered to be a problem largely because metal-contaminated sludge is greatly diluted by other clean organic materials when composted.[55]

GLOBAL SEWERS AND PET TURDS

Let's assume that the whole world adopted the sewage philosophy we have in the United States: defecate into water and then treat the polluted water. What would that scenario be like? Well, for one thing it wouldn't work. It takes between 1,000 and 2,000 tons of water at various stages in the process to flush one ton of humanure. In a world of just six billion people producing a conservative estimate of 1.2 million metric tons of human excrement daily, the amount of water required to flush it all would not be obtainable.[56] Considering the increasing landfill space that would be needed to dispose of the increasing amounts of sewage sludge, and the tons of toxic chemicals required to "sterilize" the wastewater, one can realize that this system of human waste disposal is far from sustainable and cannot serve the needs of humanity in the long term.

According to Barbara Ward, President of the International Institute for Environment and Development, *"Conventional 'Western' methods of waterborne sewerage are simply beyond the reach of most [of the world's] communities.They are far too expensive. And they often demand a level of water use that local water resources cannot supply. If Western standards were made the norm, some $200 billion alone [early 1980s] would have to be invested in sewerage to achieve the target of basic sanitation for all. Resources on this scale are simply not in sight."*

To quote Lattee Fahm, *"In today's world [1980], some 4.5 billion people produce excretal matters at about 5.5 million metric tons every twenty-four hours, close to two billion metric tons per year. [Humanity] now* *occupies a time/growth dimension in which the world population doubles in thirty five years or less. In this new universe, there is only one viable and ecologically consistent solution to the body waste problems — the processing and application of [humanure] for its agronutrient content."* [57] This sentiment is echoed by World Bank researchers, who state, *"[I]t can be estimated that the backlog of over one billion people not now provided with water or sanitation service will grow, not decrease. It has also been estimated that most developing economies will be unable to finance water carriage waste disposal systems even if loan funds were available."* [58]

In other words, we have to understand that humanure is a natural substance, produced by a process vital to life (human digestion), originating from the earth in the form of food, and valuable as an organic refuse material that can be returned to the earth in order to produce more food for humans. That's where composting comes in.

But hey, wait, let's not rush to judgement. We forgot about incinerating our excrements. We can dry our turds out, then truck them to big incinerators and burn the hell out of them. That way, instead of having fecal pollution in our drinking water or forests, we can breathe it in our air. Unfortunately, burning sludge with other municipal waste produces emissions of particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, lead, volatile hydrocarbons, acid gases, trace organic compounds and trace metals. The leftover *ash* has a high concentration of heavy metals, such as cadmium and lead.[59] Doesn't sound so good if you live downwind, does it?

How about microwaving it? Don't laugh, someone's already invented the microwave toilet.[60] This just might be a good cure for hemorrhoids, too. But heck, let's get serious and shoot it into outer space. Why not? It probably wouldn't cost too much per turd after we've dried the stuff out. This could add a new meaning to the phrase "the Captain's log." Beam up another one, Scotty!

Better yet, we can dry our turds out, chlorinate them, get someone in Taiwan to make little plastic sunglasses for them, then we'll sell them as Pet Turds! Now that's an entrepreneurial solution, isn't it? Any volunteer investors out there?

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