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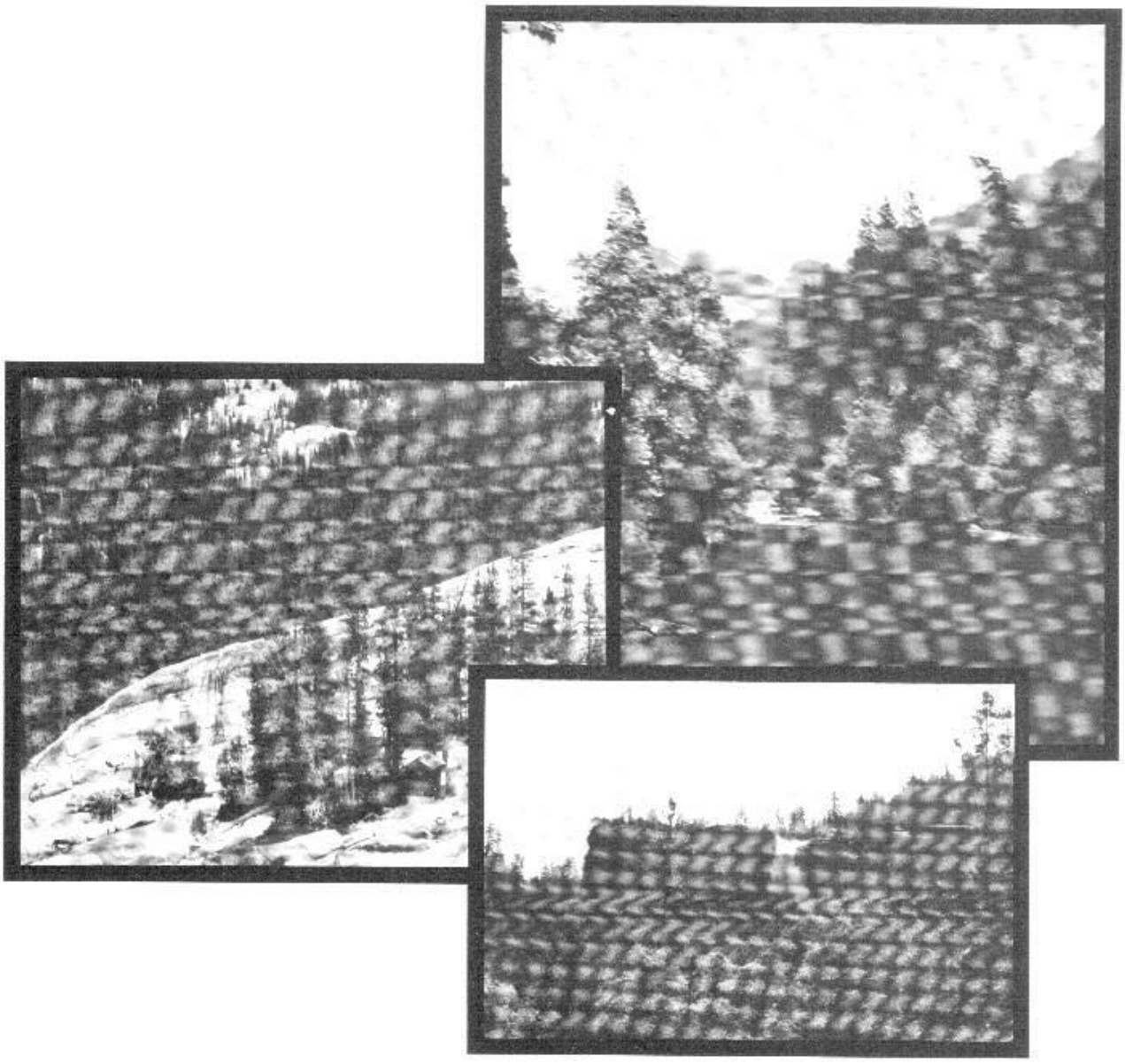
REMOTE WASTE MANAGEMENT



REMOTE WASTE MANAGEMENT

Brenda Land
Project Leader

San Dimas Technology & Development Center
San Dimas, California

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REMOTE WASTE MANAGEMENT

Remote Waste

Managing human waste in backcountry and wilderness areas is a difficult problem. Heavy use of remote areas results in problems ranging from odor and visual nuisance to environmental pollution and health hazards. Managing human waste to eliminate these problems in areas without roads is challenging.

This management problem is not unique to the USDA Forest Service. All agencies that manage backcountry areas must manage remote human waste problems.

INTRODUCTION

This report is a compilation of several methods currently used to manage remote waste. Many factors affect the suitability of each option for a specific site, such as available funds, visitor expectations, site sensitivity, maintenance, level of usage, and wilderness designation. Many of these waste management methods are not appropriate for front country (accessible by road) waste management. Forest Plans, Land Use Plans, Agency or Unit policy, and State Clean Water and Non-point Pollution Control Plans may limit the management options available. This report does not address systems suitable only to small, remote, staffed ranger stations or fire watch towers.

Figure 1. Bench seat. Footprints and scuff marks from people standing on the bench seat in toilet at Nevada Falls, Yosemite National Park (NP).

TOILET STRUCTURES

A toilet structure in the backcountry can be an elevated seat over a pit or container, a seat and privacy screen, or a fully enclosed, roofed structure. Many users prefer a bench seat instead of the traditional toilet riser. They will stand on the bench and squat instead of sitting on a community toilet seat. (See figure 1.) Use a non-scuff, non-slip surface if a bench seat is used.

Traditional toilet buildings may be constructed of wood, logs, or native rock. Buildings may be prefabricated and flown to the site. They may be constructed to be movable when used over pit toilets. Properly vent all toilet buildings to keep odors at a minimum, using SST standards. Use plywood with caution in areas where porcupines, marmots, or other animals will eat plywood for the glue. The interior of buildings should be easy to clean.

Structures and materials used should conform to the appropriate Recreational Opportunity Spectrum Classification (R.O.S. Class). Structures are limited or prohibited in most wilderness areas.

BUILDING MAINTENANCE

Keep toilet facilities clean and neat. This lowers vandalism. Toilet seats and risers should be disinfected. Keep floors clean and free of trash. Stock toilet paper as needed (unless users are required to bring their own). Keep the structures in good repair. Replace broken hardware promptly. Do not let structures become run-down appearing.

ACCESSIBILITY

Any structure built must use universal design standards. Improvements must be accessible regardless of how remote or difficult a site is to reach. Many people with disabilities enjoy horseback riding, kayaking, and challenging trails. Don't build a barrier.

HEALTH AND SAFETY

Good hygiene is essential to all sanitation workers. Human waste has the potential to contain a large number of pathogens and should always be treated as a contaminated material. Rubber gloves should be worn when cleaning and maintaining toilet facilities. To clean hands after working in toilet facilities, a waterless disinfectant hand cleaner or disinfectant towelettes should be available to workers in areas without water. Hands should be washed with soap and water as soon as possible after maintaining toilets.

Rubber boots, coveralls, and protective eye wear should be used when there is a possibility of splashing. Wash coveralls worn while handling waste material with detergent and bleach in hot water. Gloves and boots worn while handling human waste material are contaminated and should not be used for other purposes. Store them at the site, if possible. Transport them in a plastic bag if they cannot be left at the site.

The Health and Safety Code Handbook, sections 3-23 and 3-26, or 29 CFR 1910.141, should be followed when cleaning toilets or handling sewage. Workers should be trained in safety and good hygiene practices.

COLLECTION OPTIONS

Cat Hole

Description

This is the "no action" alternative to waste management. The waste is not collected. Each recreation user digs a shallow hole, 5 to 15 cm (2 to 6 in) deep, and buries their fecal matter. Decomposition of fecal matter is accelerated when it is mixed with soil. Toilet paper is slow to degrade and may be dug up by animals. Policy may encourage users to place toilet paper in a plastic bag and packed out. Public education is required to encourage visitors to dig the cat hole away from water, to mix waste with the soil, and to remove their toilet paper.

Maintenance

Maintenance is not required.

Sewage Treatment

No sewage treatment is provided. The waste decomposes over time, a few months to several years, depending on soil and climate[1].

Cost
The only cost associated with this method is public education.

Advantages
Advantages of the cat hole method include low cost and no maintenance. There is no intrusion of development in the backcountry. Recreational users do not have to handle their fecal matter. They should be instructed to use a stick or small trowel to thoroughly mix the fecal matter with the soil. Minimal education is required. Many books and magazines that target backcountry users address this issue.

Disadvantages
Social trails from popular camp sites cause soil compaction and vegetation damage. Deer may rip up vegetation that has been urinated on for the salt. Animals may dig up the waste, scattering toilet paper. This results in a visual nuisance for other users, and a potential to spread disease.

There is an increased risk of contamination of lakes and streams from nutrient loading and biological contaminants. Nutrient loading increases algae growth and alters the aquatic balance[2]. Animals may dig up the waste, spreading biological contamination to other animals, waterways, and humans. Biological contaminants cause an increased risk of human and animal disease.

Cryptosporidium and giardia are two pathogens that will cause disease in most mammals, including humans. They are spread from feces to water to a new host. Cryptosporidium oocysts can survive for over a year outside of a host. Giardia cysts can survive a few months outside of a host[3].

Appropriate Uses
Cat holes are appropriate for dispersed recreation areas away from water that receive light use and have a minimum of 15 cm (6 in) soil cover.

The disadvantages of cat holes increase in proportion to use. When the pollution potential and resource damage exceeds acceptable limits, the manager may choose to limit use of the area or select an alternate waste management method.

Recreational User Acceptance
There is good recreational user acceptance of this policy in lightly used areas. Recreational user complaints of offensive odor or visual nuisance may be the first indication of overuse in an area.

CARRYOUT
Description
Consistent with a "leave no trace" management policy, recreational users are requested, or required, to collect and carry out all waste, including fecal matter. The waste is taken to a collection/disposal area provided. An education program is required. Information contained in appendix B, "Human Waste Management On Rivers - Why is it Necessary to Remove Human Waste From Rivers?" by Briar Cook, can be used to develop an educational brochure for any

backcountry area. The users must know what is expected, what kinds of containers can be emptied at the disposal site, and the location of the disposal site. Many people refuse to carry their waste out.

There are three primary container types, each requiring a different disposal method: Plastic bags; simple containers; and complex containers.

1. Plastic Bags: Plastic bags require a collection container. At Mt. Rainier National Park (NP), the user bags are deposited in a 55-gallon drum. The drums are closed and flown off the mountain when full. The amount of material deposited in the drums is lighter than expected. Whether people are making better use of trail head facilities before starting the climb due to the educational effort, or are just getting farther off the climbing trail is not known. The amount of human waste along the climbing route is noticeably decreased.

2. Simple Containers: Pickle pails (5-gallon plastic buckets with tight fitting lids), rocket boxes (20-mm ammo. cans), and similar containers are available, costing from $5 to $50. They are used primarily on river corridors. (See figures 2 and 3.) Tube toilets (made from four- or six-inch ABS plastic pipe with threaded caps) are available for hikers, kayakers,and mountaineers.

3. Complex containers: Most newer commercially available units can be emptied and cleaned at trailer dump stations. These containers are priced from $50 to $500. They are equipped with fittings to allow them to be drained and rinsed with standard trailer dump station equipment. (See figures 4, 5, and 6.)

Figure 2.
"Pickle pail" being loaded into a SCAT Machine.

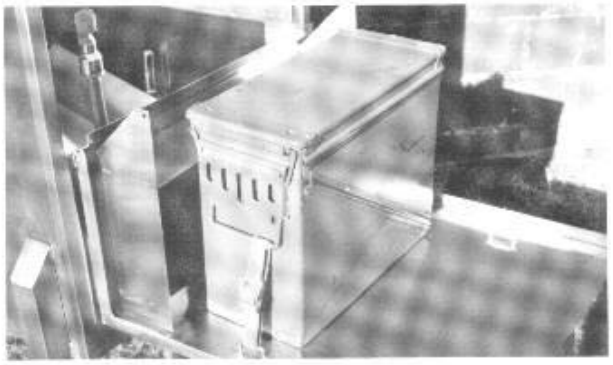

Figure 3.
"Rocket Box" being loaded into a SCAT Machine.

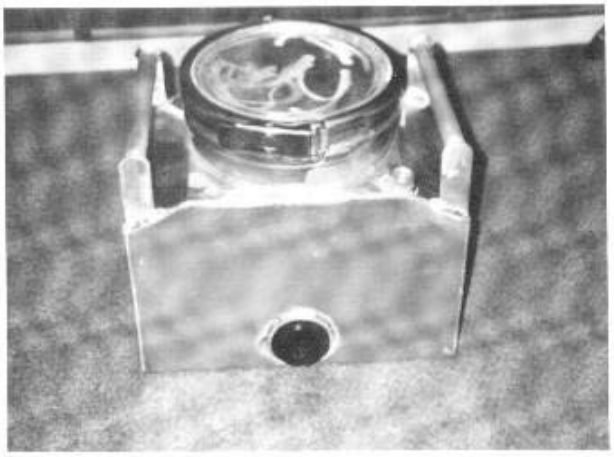

Figure 4. Jon-E-Partner with lid.

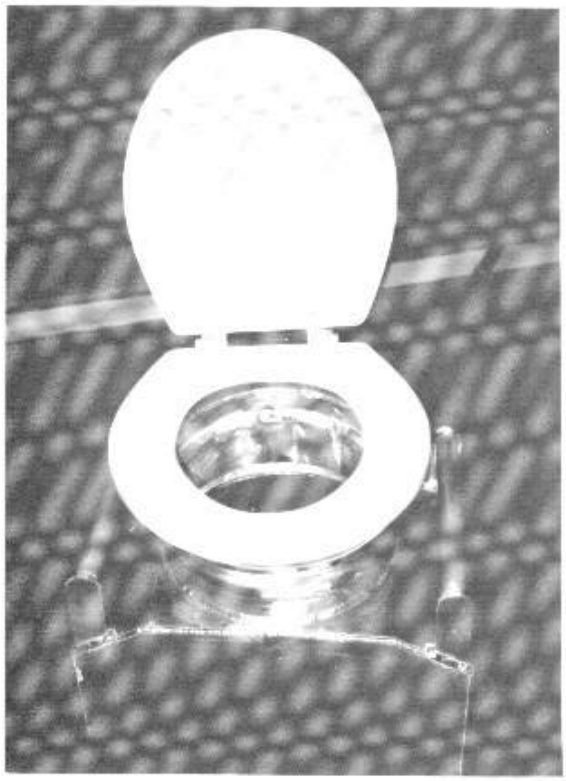

Figure 5. Jon-E-Partner with seat attached.

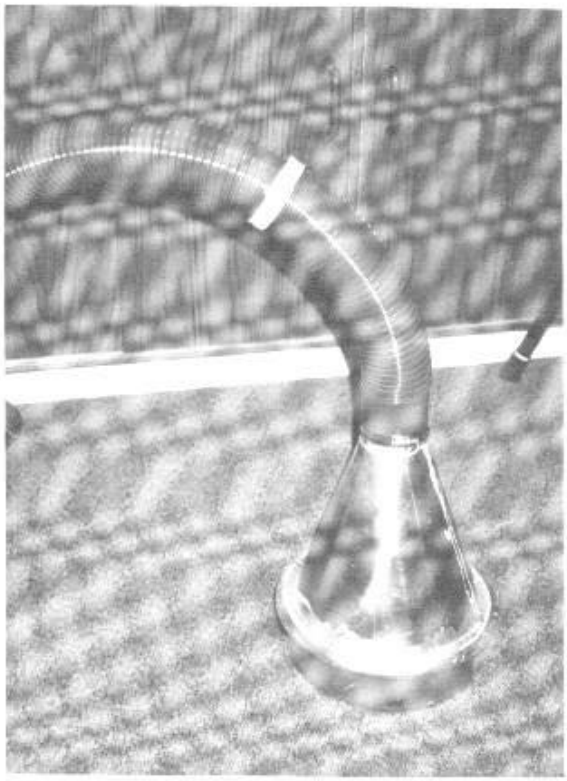

Figure 6. Optional trailer dump station attachment for Jon-E-Partner.

Maintenance

There is no agency maintenance related to the containers. Owners maintain their own. The collection/disposal facilities can have high maintenance needs.

Sewage Treatment

Some form of waste disposal or sewage treatment must be provided to minimize inappropriate disposal. Plastic bags will be thrown behind rocks, in gullies, in dumpsters, or elsewhere out of sight if no appropriate disposal site is provided. Containers have been emptied into toilet vaults (splashing the toilet seat), private dumpsters, and even on the ground.

Availability of waste disposal or sewage treatment is a limiting factor and must be determined before selecting carryout as a waste management method.

1. Plastic Bags: Plastic bagged waste is difficult to dispose of. Landfills and sewage treatment plants cannot take it. Incinerating waste disposal companies will still take the plastic bagged waste. At Mount Rainier, the individual bags are transferred to a large plastic bag in a cardboard box labeled infectious waste. An infectious waste disposal company collects the labeled boxes for incineration. Availability and cost of waste incineration must be verified before selecting this method.

2. Simple Containers: Simple containers may be cleaned with a SCAT Machine (Sanitizing Containers with Alternative Technology), or at a wash table. (See figure 7.) The cleaning station should be located near the trip end point.

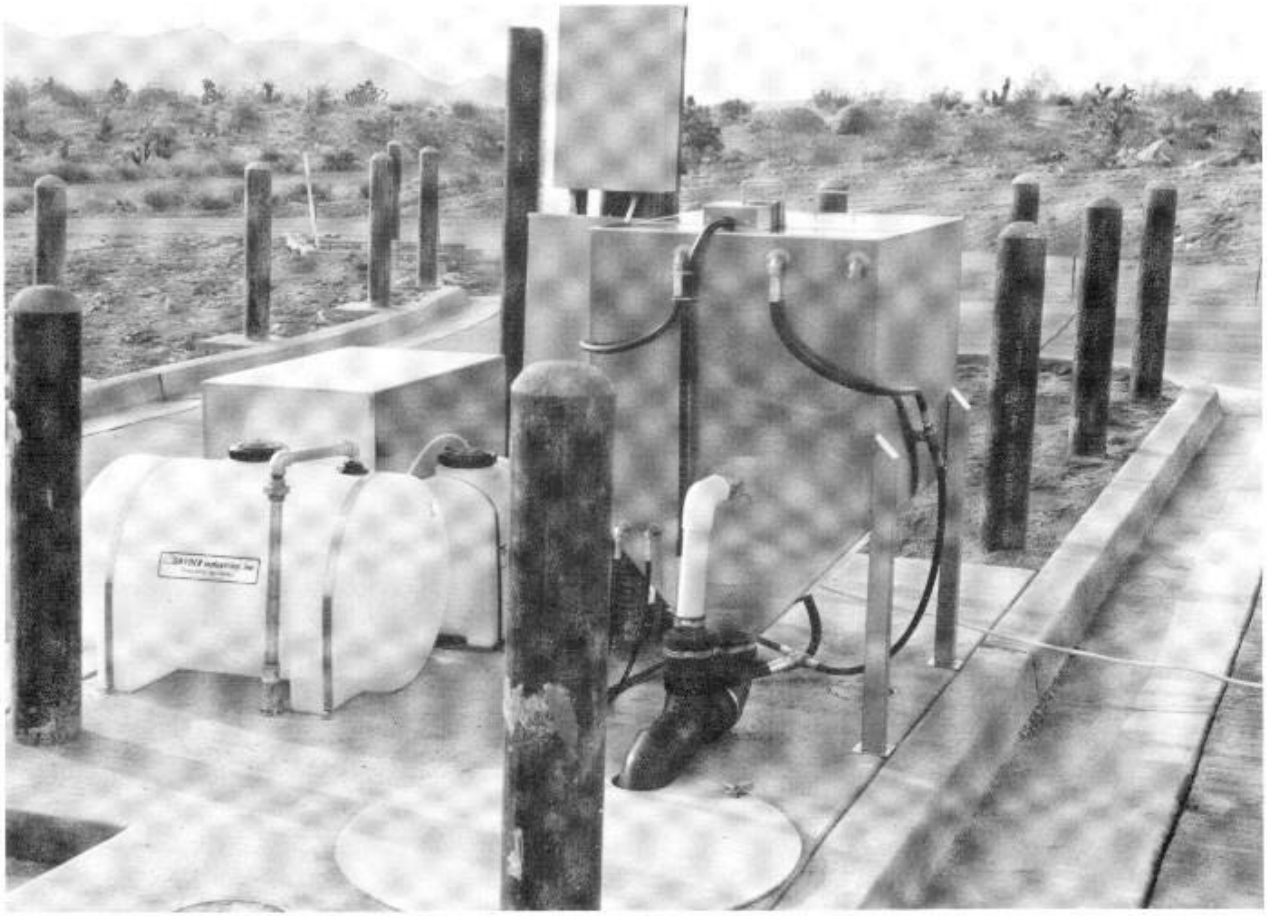

Figure 7. SCAT Machine at Meadview, AZ.

The SCAT Machine requires water, AC electricity, and connection to a sewage treatment plant. It uses 46.5 gallons of water per flush, and can use over 500 gallons in an hour during heavy use. A holding tank is not recommended. In areas with very good soil percolation and a deep water table, a septic tank with large leach field may be possible.

To use the SCAT Machine, the container is strapped in machine, the lid is removed from the waste container and placed in a rack, and the SCAT Machine door is closed. The SCAT Machine flushes the waste, and pressure washes the container and lid.

Wash tables function much like fish cleaning stations. Waste containers are dumped through a hole into a vault and the container is hosed out. The wash table requires water and a holding tank, compost digester, or septic tank. Venting is very important to control odors.

3. Complex Containers: These containers are designed to be emptied and rinsed at trailer dump stations. Trailer dump stations require potable water and connection to a large septic tank, sewage treatment plant, or large holding tank. If a holding tank is used, it must be pumped when full.

Cost

1. Incineration: Mount Rainier pays about one dollar a pound for collection and disposal (1993). Availability of hospital incineration and cost must be verified before initiating a plastic bag program.

2. SCAT Machine: The SCAT Machine costs $17,200 (1994). Installation and utilities hookup vary by area, generally $1000 to $3000 if utilities are at the site. Annual operation and maintenance are $2500 to $3500, excluding utilities.

Wash Table: Installation cost for a wash table is between $5000 and $20,000, if water is available at the site.

3. Trailer Dump Station: A trailer dump station can be installed for $25,000 to $100,000. The availability of potable water and sewage treatment has a large affect on cost.

Advantages

Facilities are not constructed and maintained in the backcountry area. Recreational users are instructed to carry their own waste to a designated disposal point. Watershed pollution can be minimized if moderate compliance is achieved.

Disadvantages

Recreational users must handle their fecal waste matter. Compliance is varied among different user groups, but generally low. Collection point facilities are expensive to construct and maintain. Waste may be disposed of in garbage cans or vault toilets if designated disposal points are inconveniently located or are not operating.

Appropriate Use

Carryout is used as a human waste management technique with fair to good success on several wild and scenic river corridors. Trip permits, outfitters, and limited river access points can aid in education and enforcement.

Some lightweight containers used in rafts and canoes can be used on backcountry trips using horses and pack animals, when trip permits, outfitters, and limited access points are established. Compact, lightweight tube toilets are available for hikers and mountain climbers.

Plastic bags have been used as a human waste management technique on mountain climbing routes. The amount of compliance is not known, but the climbing routes are cleaner. Speculation is that peer pressure causes climbers that do not comply with the regulation to hide their wastes better.

Recreational User Acceptance

Recreational user acceptance is mixed, but fairly poor. Some user groups are more environmentally conscious than others. These groups will accept a little inconvenience to

keep the backcountry pristine. A good educational program is required. The users must know what is required of them and where disposal sites are located. For river and pack trips, the user must know what types of disposal systems are available and what containers are accommodated.

PIT TOILET

Description

A pit is dug in the ground at least one and one-half millimeters (five feet) deep. A floor and toilet seat are placed over the hole. A privacy screen or enclosed building structure may be built for privacy and protection from the weather. When the pit is full to within 18 inches of the top, a new pit is dug, the floor, seat, and building structure are moved to the new pit and the old pit is covered over with dirt. The dirt from the new pit is frequently used to cover the old pit.

IMPORTANT: PIT LOCATIONS SHOULD BE MADE, or APPROVED BY A SANITARY ENGINEER TO PREVENT GROUND WATER AND SURFACE WATER POLLUTION.

Maintenance

The pit and structure need periodic relocation and the old pit needs to be covered with 18 inches of dirt. Toilet paper may be provided, or visitors can be instructed to bring their own. Lime may be added to the pit to reduce odors.

Sewage Treatment

No sewage treatment is provided. Urine in the pit leaches into the ground. Fecal matter and toilet paper remain in the hole. Material in a pit remains contaminated for several years, decades in some areas.

Some areas that have exhausted all usable pit sites auger out the old pit and place the excavated material in barrels for removal. This material is treated as vault waste or domestic septage for disposal.

Cost

Costs range from $500 to $5000. This includes labor to dig the pit and material for the building structure. The cost can be fairly low, as the labor may be seasonal employees or volunteers.

Advantages

Human waste is collected and contained, minimizing some of the problems of cat holes in heavily used areas. The septage is not usually carried out of the backcountry, so nether maintenance personnel nor recreational users have to handle the fecal matter. This is a low-cost human waste management method.

Disadvantages

Strong odors and flies are associated with pit toilets. SST ventilation standards should be followed in all toilet buildings to minimize this problem. There is a potential for ground water and surface water contamination in improperly located pits. Usable pit sites do not exist in some locations. Many areas have used all available pit sites. The pits may be filled with garbage. Animals may become trapped in the pit. The material is very slow to decompose and remains contaminated for many years.

Appropriate Use

Pit toilet sites are limited by soil type and depth, surface water location, terrain, and ground water depth. They SHOULD BE LOCATED BY A SANITARY ENGINEER under the guidelines for locating a septic leach field. Pits need to be far enough from surface water (150 to 300 feet) to prevent contamination.

Recreational User Acceptance

Recreational user acceptance is fairly good. Some users object to any development in the backcountry. Some users object to the pit odor and flies.

DRUM PRIVY (TRANSPORTABLE VAULT)

Description

A drum privy consists of a toilet seat and building structure placed over a removable drum or small fiberglass vault. The building structure may be a toilet seat and privacy screen or a fully enclosed building. (See figures 8 and 9.) The drum or vault is replaced when it is full, and the full container is removed from the site to be emptied. Removal is generally done by helicopter but can be done by ATV in some areas. (See figure 10.)

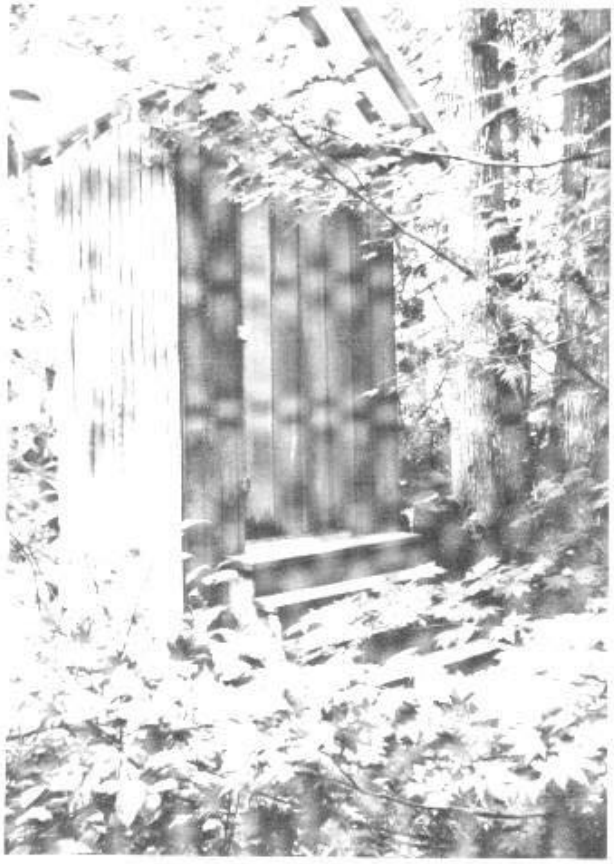

Figure 8. ATV vault toilet building at Packwood, WA, front view of fully enclosed building.

Figure 9. ATV vault toilet building, back view.

Maintenance

Drums or vaults are replaced when full, and the full containers stored until they are removed from the site. Drums are examined for dents and rust. Plastic and fiberglass containers are examined for cracks or leaks.

Figure 10. ATV vault with lid in place for transport.

Sewage Treatment

Material removed from drums must be treated as domestic septage and disposed of in a sewage treatment plant or other locally approved manner. The material may be stored in a larger vault in the front country until enough is accumulated to have a pumper truck remove it. (See figure 11.)

Figure 11. ATV vault being dumped into a holding tank.

Cost

Initial cost of the building structure and drums or small vault is between $500 and $5000, excluding labor. The cost of transporting building materials to a backcountry site by helicopter range from $500 to $1500.

Advantages

Surface and ground water pollution potential is reduced. Recreational users do not have to handle their waste. Social trails from camp sites are reduced. Toilet site is not restricted by soil type or ground water depth. Toilet site does not need to be relocated when containers are full.

Disadvantages

Using helicopters in mountainous areas can be hazardous. Occasional spills occur during transport. Noise intrusion of helicopters or ATV's in backcountry areas is objectionable to many recreational users. Cost of helicopter transportation is high.

Appropriate Use

The area must be accessible by helicopter or ATV. At campsites, 55-gallon drums must be emptied after 150 to 200 visitors, or every 400 to 500 visitors, if they are asked to urinate elsewhere. The volume of campers must be considered. Enough drums must be stored on site to last until they are removed to be emptied. (See figure 12.)

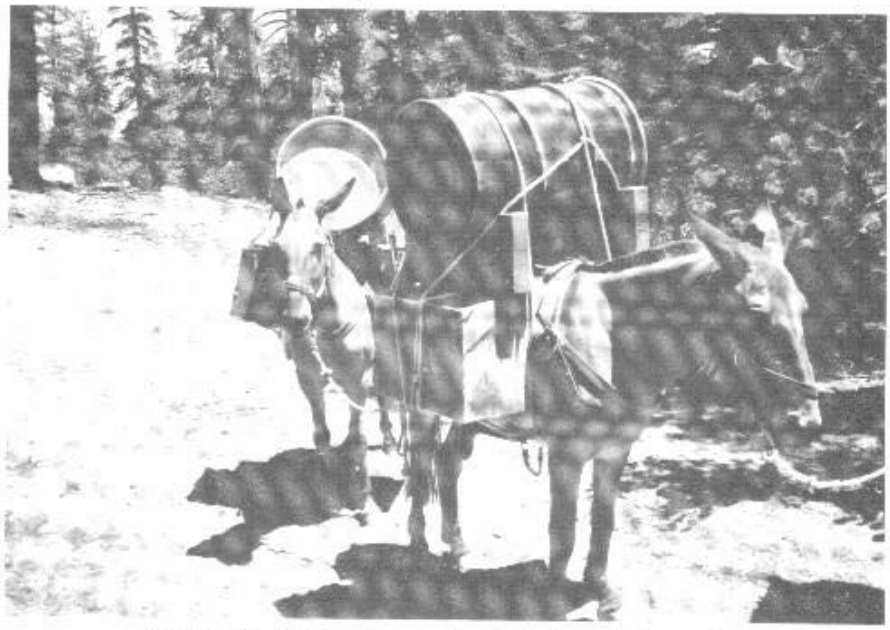

Figure 12. Transporting empty drums to a site by mule.

Recreational User Acceptance

Recreational user acceptance is good. Some users object to the use of helicopters or ATV's in the backcountry. Odor from a poorly ventilated drum privy is similar to odor in poorly ventilated pit or vault toilet. SST ventilation standards should be followed in building design.

COMPOST

Description

Compost toilets use an aerobic process in a digester tank to decompose the human waste into compost or humus. Composted material has no offensive odor or texture. Compost toilets, currently in use, include several commercially manufactured digester tanks, site fabricated digester tanks, and combination holding tank/batch composters. (See figures 13 through 16.)

Maintenance

Maintenance is critical. Compost toilets need a carbon source, preferably wood chips, added regularly to maintain the decomposition process. The fecal cone must be knocked down and mixed with the carbon source regularly. The schedule of maintenance varies from once a month to twice a week, depending on digester tank size, level of use, temperature, and climate. Finished compost must be removed as needed, generally about a bushel every one to two years, but some units have operated for 10 years without removing any material.

A user maintained composting toilet has been used with fair success in very remote, low vandal areas, and huts or cabins. A bin of wood shavings is located next to the toilet riser with a scoop attached. Instructions are posted to add one scoop per use. Maintenance personnel must still mix the waste, remove the composted material as needed, and refill the bin with wood shavings.

Figure 13. Yosemite site fabricated compost toilet at Nevada Falls, front view.

Figure 14. Yosemite compost toilet, basement view. Double doors to basement open to allow easy access to the maintenance and clean-out areas of the digester.

Figure 15. Sunergy Systems LTD. building at Yoho NP (Canada) for a Phoenix digester, side view.

Figure 16. Accessible ramp to Yoho toilet.

Sewage Treatment

Disposal of composted material depends on location and local, regional, or national unit policy, as well as State requirements. The compost material must be treated as domestic septage for further treatment, unless it is documented to meet 40 CFR 503 requirements as a Class A or Class B sludge. Some states require a permit or permit waiver for surface application. The material may be burned, buried, removed from the site for further treatment, or (with a permit or permit waiver) used as a fertilizer or soil amendment.

Composted material is not as unpleasant to remove as vault waste. It is shoveled into triple heavy-duty plastic or heavy rubber bags for transport by pack animal or maintenance personnel, or into barrels for transport by helicopter.

Composted material can achieve a Class A sludge rating, depending on level of maintenance, level of use, and climate. A permit or permit waiver may be needed from the governing EPA office to incorporate the material into the soil as a soil amendment or for reclamation projects. Compost may be used to reclaim rock quarries, slide areas, or mine sites. Maintenance records may be required. Contact the State Office for permit requirements.

A liquid waste disposal method should be incorporated into the system. This may be a subsurface leach line, holding tank, or evaporation trays. (See figure 17.) The amount of liquid waste depends on type of use (day use or overnight use), humidity, and temperature.

Cost

Commercial composter toilets cost from $10,000 for smaller units to $30,000 for larger units (including building, digester, and photovoltaic electrical system). Constructing a basement is difficult without heavy equipment. A compost toilet needs a DC power source to operate a fan. This can be provided by a photovoltaic panel in sunny areas, wind turbine generator, or a thermoelectric generator. Exchanging batteries on each maintenance trip is possible. A battery that will operate one fan for 7 days, weighs 65 pounds. Basements need to be insulated and heated in colder areas. A solar heat collector, thermoelectric generator, or catalytic heater can be used to supply heat.

A commercial passive composter, the "Trail Site", by Romtec, is designed for backcountry applications. It is available for $500 (1994 price). This "black box" direct deposit unit is based on a design by North Cascades NP. It does not need a basement or solar power. It can be used at sites that have up to 12 visitors a day. (See figures 18 and 19.)

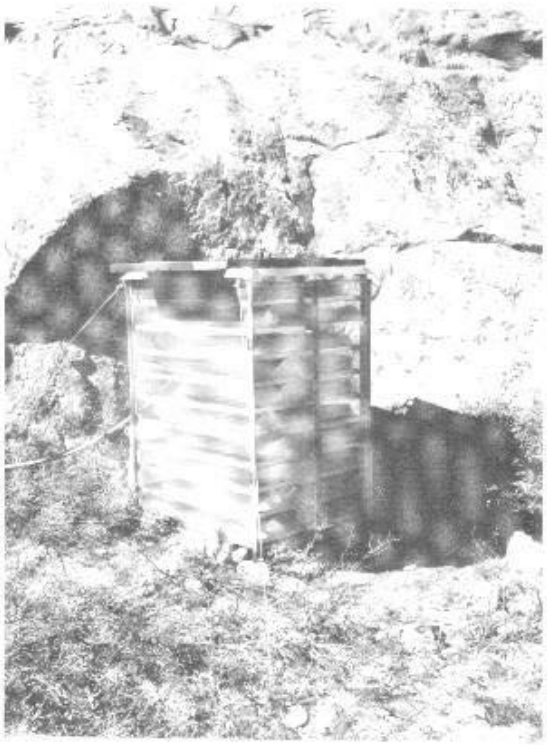

Figure 17. Evaporation trays at Chasm Meadows, Rocky Mt. National Park.

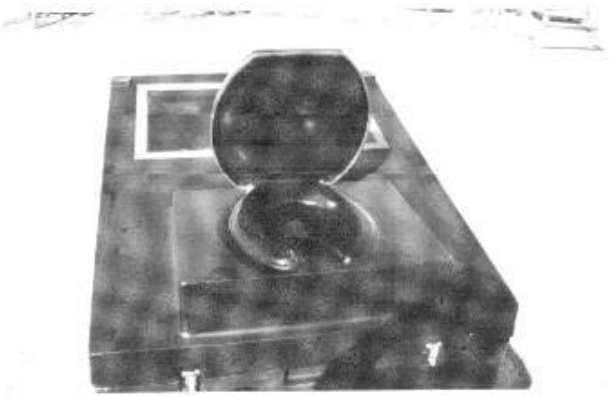

Figure 19 "Trail Site" composter by Romtec. The seat is an integral part of the unit. This unit is designed for just a privacy screen.

Figure 18. "Trail Site" composter by Romtec.

The Trail-Head passive composter by Clivus Multrum, complete with building and solar ventilation system, costs less than $10,000 delivered. It is designed with lifting hardware to allow it to be flown to a remote location. (See figure 20.)

Advantages

Compost toilets can handle a higher use than many other backcountry systems. The amount of waste material to be removed from the site is reduced in weight and volume, up to 80 percent. Material can be transported by pack animal. There is no offensive odor to the composted material. Texture of the compost is not offensive. Compost toilets can work in areas where dehydrating toilets are not appropriate due to humidity.

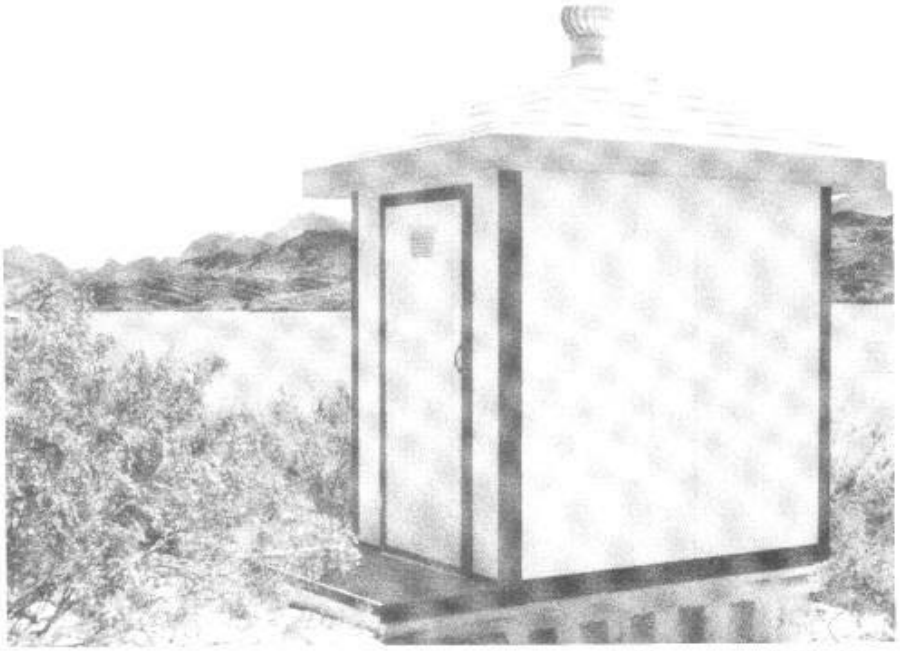

Figure 20. Trail-head toilet. The building is by Restroom Solutions, Inc. (RSI), with a Clivus Multrum direct burial compost digester.

Disadvantages

Disadvantages include high installation costs and high maintenance costs. Wood chips must be transported to the site. The wood chips must be mixed with the waste on a regular basis. The composting biomass must be raked weekly for optimum decomposition. Electricity is needed to operate the fans.

The compost material must generally be removed from the site for further treatment or disposal. COMPOST TOILETS THAT ARE OVERLOADED, NOT MAINTAINED, NOT DESIGNED FOR THE CLIMATE, OR OTHERWISE FAIL TO FUNCTION ARE VERY UNPLEASANT TO DEAL WITH. Raw waste, or anaerobic septage must be shoveled out and transported to a sewage disposal facility.

Appropriate Use

Compost toilets are appropriate when the level of use exceeds the capacity of other human waste management methods in remote areas. A COMMITMENT MUST BE MADE BY THE SITE MANAGER TO PROVIDE FOR THE REQUIRED MAINTENANCE BEFORE CHOOSING TO INSTALL A COMPOST TOILET. Digging raw septage out of a tank that has become anaerobic and transporting it out of the backcountry is a very messy job.

Recreational User Acceptance

Recreational user acceptance is extremely high. FUNCTIONING compost units have no offensive odor. Composting is viewed by many people as an environmentally sound waste disposal method.

DEHYDRATING TOILETS

Description

The purpose of dehydrating toilets is to evaporate the liquid from the fecal matter. This can substantially reduce the volume and weight of the material that must be removed. Dried sludge has very little offensive odors and may be transported by pack animal, ATV, or helicopter. "Remote Area Management, Waste Disposal," Michael E. Jensen (RAMWAD Study) *National Park Service*, Dec. 1984 documents extensive study conducted by the National Park Service on dehydrating toilets.

Dehydrating toilets include commercial basket type dehydrating units, site-modified commercial basket type units, dehydrating/composting units, and site-constructed units.

The original commercial basket type units consisted of a perforated fiberglass strainer basket fitted into a fiberglass or lined concrete vault. Urine drains through the perforated basket into the vault. Convection air movement or a solar powered fan pulls the air across the liquid and around the biomass in an attempt to evaporate the urine and dehydrate the solids. The RAMWAD Study found that "Drying the large accumulation of solids was not successful. No solution for easy removal of the solids was identified. The vulgar task of hand shoveling a moist, odorous visually unchanged material still remained."

In site-modified commercial basket type units, developed during the RAMWAD Study, several field changes to the commercial unit were made to improve performance. These changes included: (1) diverting the urine stream away from the solids mass to prevent continually re-wetting, (2) increasing air movement, (3) heating the air entering the unit to assist drying, (4) dividing the perforated basket into two or more chambers to allow the solids more drying time, and (5) providing for liquid overflow into a leach field or holding tank. These changes increase the amount of dehydration achieved, but the bio-solid mass remains difficult and unpleasant to remove.

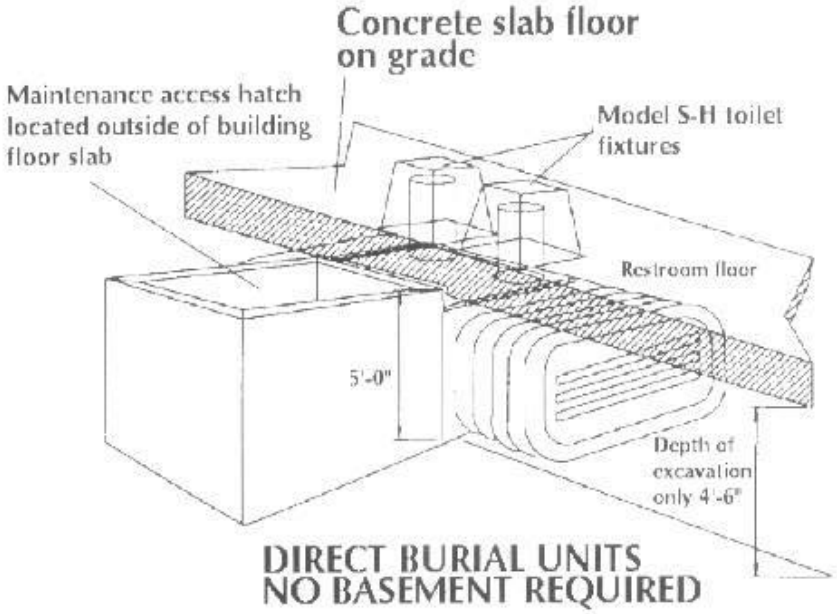

Figure 21. Bio-Sun dehydrating/composting tank schematic.

The commercial dehydrating/composting tank can be direct buried. (See figures 21 and 22.) It is similar in function, operation, and maintenance to a compost digester. The liquid is vaporized to speed evaporation and exhausted through the vent. This unit requires AC or DC electric power.

Rocky Mountain National Park and Mount Rainier National Park designed site-constructed dehydrating units during the RAMWAD Study. Work was started in 1983 to develop a dehydrating system that worked

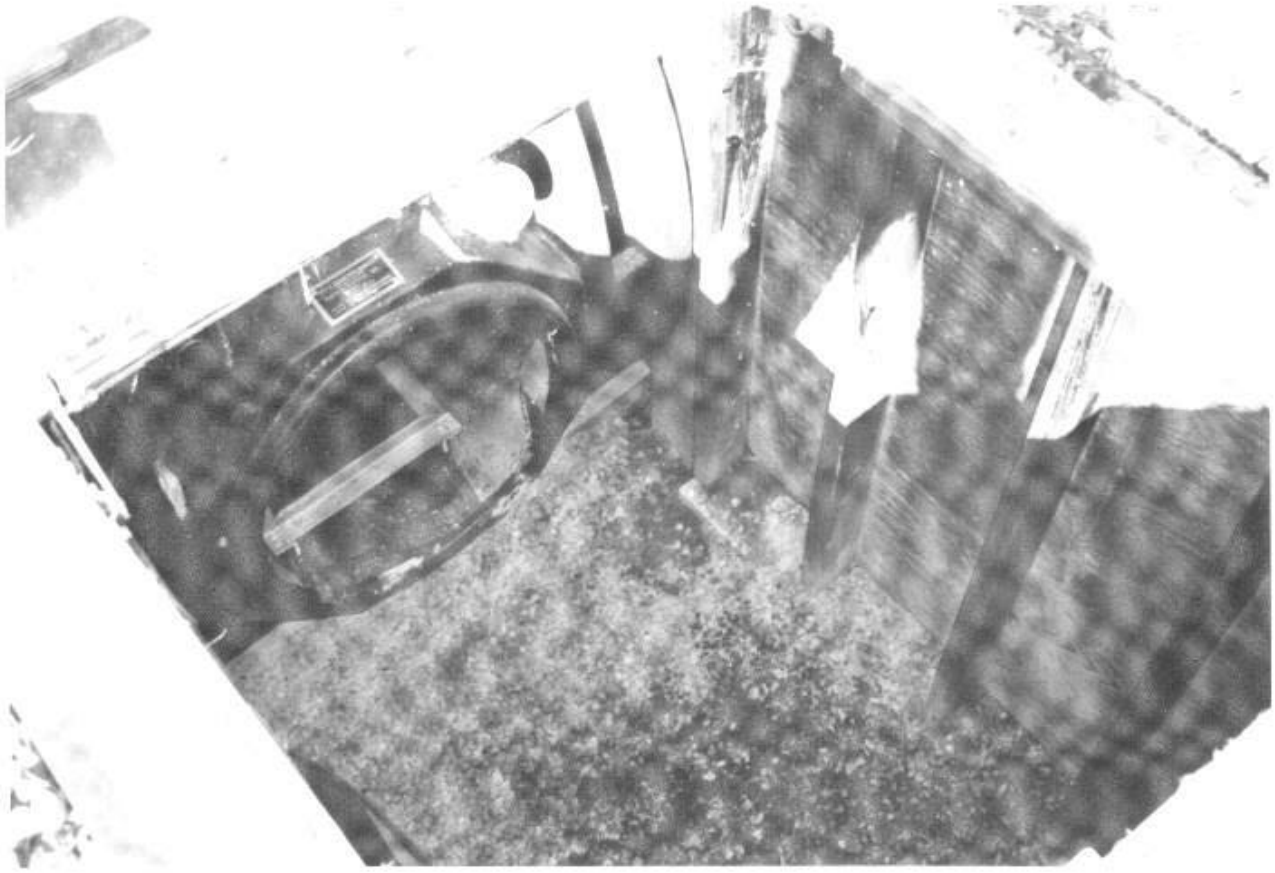

Figure 22. Bio-Sun dehydrating/composting tank viewed through open access hatch.

better than the commercially available units. The Rocky Mountain NP designed a unit that uses a small perforated basket for solid waste collection and drying, and excelsior pads in cascaded trays for urine evaporation. The waste is heated by passive solar heat collectors and solar powered fans to facilitate dehydration of the solids and reduce weight. (See figures 23 and 24.) Both Rocky Mountain and Mount Rainier NP units can achieve a 75 percent reduction in solids weight and total liquid evaporation.

Maintenance

Commercial dehydrating basket units have not met maintenance expectations. Air movement has not been adequate to evaporate the urine and dehydrate the solid material. The liquid must be pumped frequently to keep the liquid level below the perforated basket. The liquid must be treated as black water for disposal.

Saturated solid material must be dug out and placed in an appropriate container for transportation. Odor and texture of the solid material is little changed.

The perforated basket can be transported by helicopter if the building is designed to be tipped or slid off the tank. Weight of 250 gallons of saturated solids is one ton. **Do not remove a basket by helicopter if the liquid level is above the bottom of the basket.** Rotor driven liquid will splatter the entire area.

Modified basket units are substantially improved in function. The bio-solids are drier due to the cumulative contributions of the changes. Fans must be checked periodically for operation. Bio-solids must still be dug out of the basket, or the basket may be removed by helicopter.

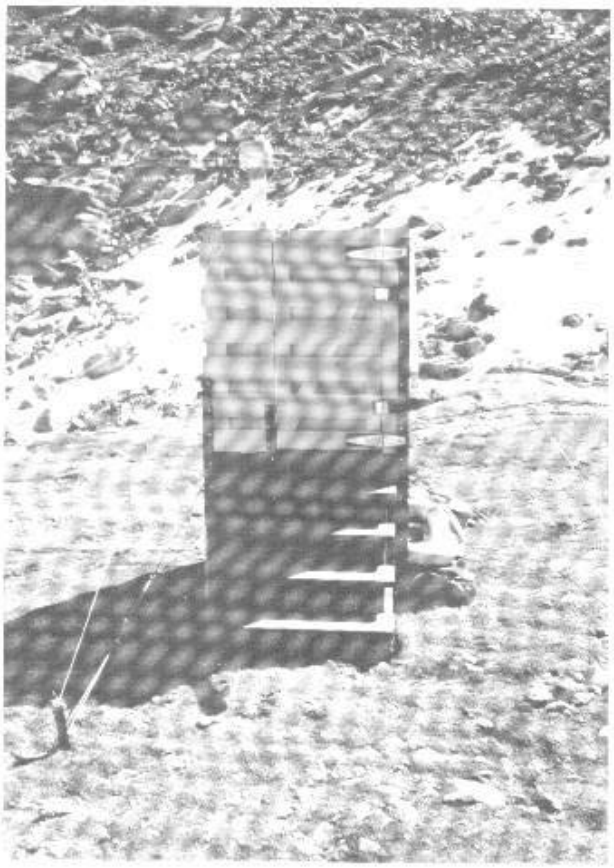

Figure 23. Rocky Mountain dehydrating toilet at Chasm Meadows, front view. Elevation 11,500 feet. Guy wires are needed due to high winds. Four-sided privacy screen is used to keep building height to a minimum.

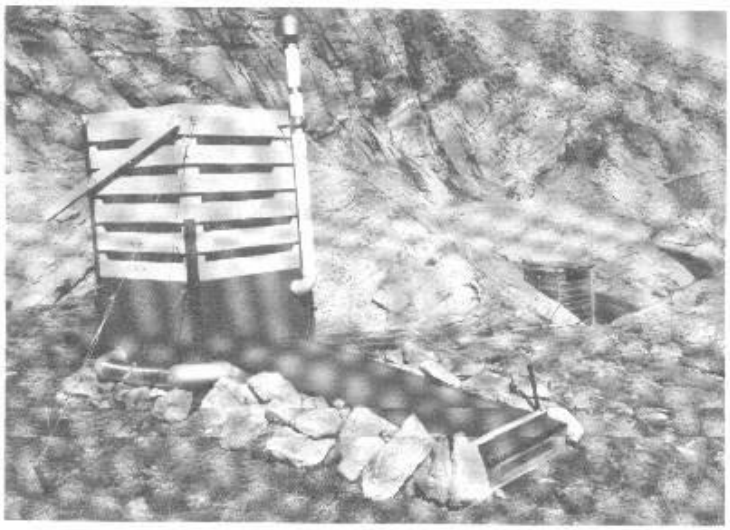

Figure 24. Rocky Mountain dehydrating toilet, back view. The heat collector is located below basement. Liquid evaporator is behind the hill.

The dehydrating/composting unit is maintained similarly to a composting unit. Wood shavings are added at regular intervals. A bushel of dehydrated/composted material is removed every two to five years, depending on level of use.

Site-built dehydrators at Rocky Mountain NP are maintained once a week. The use compartment is cleaned and toilet paper is stocked. The dehydrating basket is slid out of the vault to allow easy access for removal. Dried waste is shoveled into triple-thick plastic bags and hauled off the mountain by llamas. During periods of light use, material is removed every other week. They estimate a 75 percent reduction in weight through solar dehydration, and total evaporation of urine. Evaporator trays have the salt deposits removed once a year and the excelsior pads are also changed.

Sewage Treatment

Dried or de-watered sludge may be incinerated, buried, disposed of in sewage treatment plant, or other locally approved manner. Smaller municipal treatment plants may be reluctant to accept the concentrated solids.

Cost

Initial cost of commercial basket type dehydrating units range from $4000 to $10,000, depending on building structure and size. The cost to modify a commercial unit is between $500 and $2500.

Cost of the dehydrating/composting units is between $10,000 and $20,000, depending on building and basement type. Digging a basement in backcountry areas by hand is labor intensive. A direct burial model is available.

Cost of site-built dehydrators is approximately $8000, including materials and labor. Cost to transport the materials to the site by helicopter are usually between $1000 and $2000, but may be greater, depending on site elevation and air distance to site.

Advantages

Surface and ground water pollution potential is reduced. Recreational users do not have to handle their waste. Social trails from camp sites are reduced. Toilet site does not need to be relocated when containers are full.

Weight of material to be transported can be reduced 50 to 80 percent in properly designed and maintained units. Removing the dehydrated material is not as unpleasant as removing raw waste.

Disadvantages

COMMERCIAL BASKET DEHYDRATING UNITS HAVE SHOWN LITTLE OR NO DEHYDRATION. Removing and transporting the soggy material is not a pleasant job. Using helicopters in mountainous areas can be hazardous. Occasional spills occur during transport. Noise intrusion of helicopters or ATV's in backcountry areas is objectionable to many recreational users. Cost of helicopter transportation is high.

Modified commercial dehydrating units produce some volume and weight reduction, otherwise the disadvantages are the same.

Dehydrating/composting units have the same disadvantages as composting toilets. Wood chips must be transported to the site and mixed with the waste. Electricity is required. Improper design, location, or lack of maintenance can cause the unit to fail.

Site-constructed dehydrating units must be maintained weekly. Missing a service during peak use has very messy results. Maintenance workers must handle raw waste. Very dry material has little odor as long as it remains dry, but returns to full strength if it gets wet during transport.

Appropriate Use

Dehydrating toilets have a better chance of functioning in low humidity climates. THE COMMERCIAL BASKET TYPE DEHYDRATORS SHOULD NOT BE USED UNLESS THEY ARE SITE-MODIFIED. A greater volume can be removed by helicopter at one time if a reduction in weight is achieved through dehydration. Care must be taken not to overfill the basket before removal and exceed the helicopters' lifting capacity.

Dehydrating/composting units have a large capacity. They require electrical power.

The site-built dehydrator makes carryout by personnel easier, particularly where helicopters, ATV's, or pack animals cannot be used. Ten to twenty pounds of dried material must be removed for every 160 visitor uses (campground). It must be maintained weekly during peak use.

Recreational User Acceptance

Recreational user acceptance is high. SST ventilation guidelines should be followed for all toilet structures.

LOW VOLUME FLUSH TOILETS

Description

Low volume flush toilets have limited uses in the backcountry, but may be appropriate for sensitive areas. The water used may be non-potable, if no lavatory for hand washing is provided. Water supply may be gravity feed or pumped.

Maintenance

The system needs to be winterized annually to prevent water and sewer lines from freezing. Pumps need service annually. If an electric generator is used, it needs to be fueled and checked frequently.

The septic tank must be pumped when solids accumulate. Pack animals and/or helicopters are needed to transport equipment and barrels into the backcountry for pumping. Septic tank sludge is pumped into barrels and flown out of the backcountry. The septage should be taken to a sewage treatment plant for disposal. (See figures 25, 26, and 27.

Sewage Treatment

Effluent can be treated by a septic tank and leach field, sand mound, or constructed wetland in the backcountry. A sanitary engineer should design the system. State permits may be needed.

Figure 25. Pumping a septic tank in the backcountry.

Figure 26. Pumping a septic tank. The sludge is pumped with the aid of a vacuum tank.

Figure 27. Pumping a septic tank. The sludge is pumped into barrels, then flown out of the backcountry.

Cost

Prefabricated, pre-plumbed building, two toilet, costs $10,000. Septic tank and leach fields cost between $3500 and $10,000 installed, excluding transportation. A 4-inch gravity line from building to septic tank costs about $16 per foot.

Advantages

Visitors and maintenance personnel do not have to handle the fecal material. High visitor use with low impact are achievable with low-volume flush toilets. Potential surface and ground water pollution is minimized in the sensitive area.

Disadvantages

Plumbing is an intrusion of civilization in the backcountry area. Flush valves can stick in the open position, overloading the effluent disposal system. Pumping the septic tank and flying the septage out of the backcountry every five years is labor intensive.

Appropriate Use

Low-volume flush toilets are appropriate for high use areas.

Recreational User Acceptance

Recreational user acceptance is mixed. There are few objectionable odors from flush toilets.

Users are familiar with the equipment. Flush toilets are unexpected in backcountry areas and may be perceived as an unwelcome intrusion of civilization.

TRANSPORTATION

Flyout

Description

Vaults or barrels are transported out of the backcountry by helicopter. Barrels are collected and stored in an area accessible to helicopter. They are arranged in a cargo net for transportation, or may be flown out individually by using a special lifting device. A dolly is used to position full barrels for lifting. (See figures 28 through 31.)

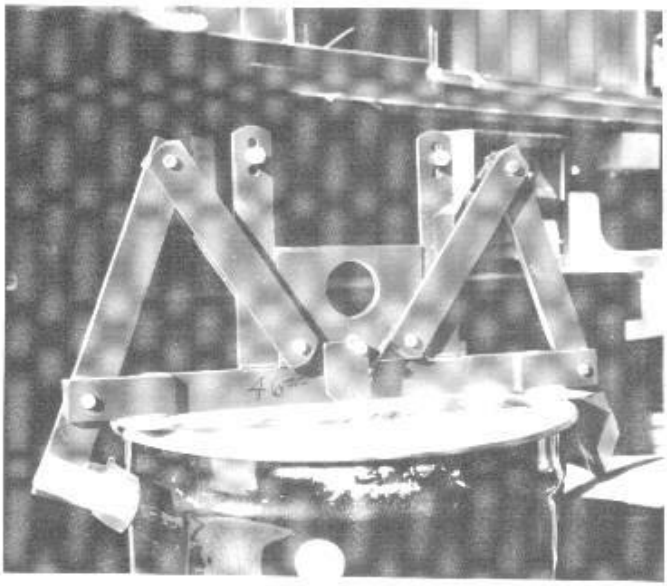

Figure 28. Barrel-lifting device.

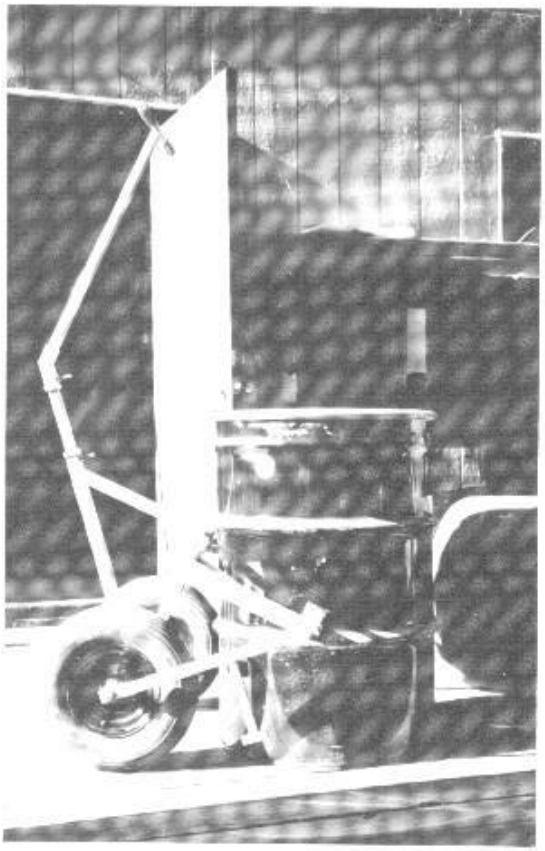

Figure 29. Barrel dolly.

Slings are attached to lifting eyes in vaults. Always check lifting eyes for rust, wear, or defects.

Cost

Cost varies depending on availability of helicopters, location of site from base, and elevation. Lifting capacity of rotor-wing aircraft is reduced at higher elevations, therefore, more trips or a larger helicopter may be required. Average cost of a Type II helicopter is $1500 to $2500 per round trip air hour. A Type II helicopter can lift up to 3000 pounds. Average cost of a Type III helicopter is $300 to $1200 per round trip air hour. A Type III helicopter can lift up to 500 pounds, which is the weight of one full barrel.

Advantages

Large amounts of human waste can be removed from very remote locations in a short time.

Figure 30. Loading the barrels.

Disadvantages

Helicopters are a noise intrusion in the backcountry. There have been several accidents using helicopters in mountainous country. There have been spills from improperly loaded cargo nets, defective or corroded vault attachments, and broken slings.

Appropriate Use

Helicopters are appropriate to use to remove waste from backcountry areas where waste removal is required, and helicopter use is not restricted. They are used where the soil cannot assimilate the waste, heavy use make ignoring the waste impractical, and no more cost-effective method is available to remove the human waste from the area.

Figure 31. Loading vaults into a net for transportation.

PACKING OUT

Pack animals, ATV's, or maintenance personnel may be used to pack waste from the backcountry. Pack animals may be used to remove raw waste, composted material, or dried sludge. The material needs to be placed in containers that can be loaded onto pack saddles. Horses can carry 200 to 300 pounds. Mules can carry about 200 pounds. Llamas can carry 80 to 100 pounds. Pack animals must be properly loaded to prevent injury to the animal and spills from unbalanced loads. ATV's can haul up to 500 pounds of waste material. A utility trailer to haul 30- to 55-gallon containers is needed. (See figure 32.)

Maintenance personnel can carry up to 50 pounds of waste material. The waste material must be placed in containers that will fit a pack frame.

Cost

Pack stock is usually contracted. The cost and availability of pack stock vary and must be checked before selecting this alternative, unless the district owns and maintains its own pack string. (See figure 33.)

An ATV trailer costs between $500 and $1000 to have constructed. An ATV rated for towing is needed.

Salary and time of maintenance personnel need to be considered in all pack out alternatives.

Figure 32. ATV with vault trailer.

Advantages

Pack animals can be used in many wilderness areas where helicopters and ATV's are prohibited. They can carry more weight than maintenance personnel. There is no intrusion of vehicles or helicopters in the backcountry. Llamas have been particularly well accepted by the public in high use areas due to their docile nature and exotic appearance. They cause less trail damage than horses or mules.

ATV's can be used in some backcountry areas where helicopters cannot be used because of terrain or tree cover. They can haul larger loads than pack stock or maintenance personnel.

Figure 33. Backcountry pack string.

Maintenance personnel can carry the waste out of restricted wilderness areas not accessible to pack animals. There is no intrusion of vehicles or helicopters in the backcountry.

Disadvantages

Pack animals can cause trail damage. Personnel must be trained to handle and load pack animals. The waste material must be transferred into containers that can be loaded onto pack animals. Using pack animals is slower and more labor intensive than helicopters.

ATV's are restricted in many backcountry locations. There is a higher risk of spills than with pack animals. Trails must be constructed and maintained for ATV's.

Maintenance personnel can only carry about 50 pounds of waste material. That is one trip for every 100 to 300 recreation visitor days, depending on amount of dehydration/composting done. The waste material must be loaded into containers that will fit a pack frame.

Appropriate Use

Pack out is appropriate to remove waste from backcountry and wilderness areas where waste removal is required, and flying out is not available or appropriate. It is an alternative when the soil cannot assimilate the waste, heavy use makes ignoring the waste impractical, and no more cost-effective method is available to remove the human waste from the area.

SEWAGE TREATMENT

All sewage treatment and disposal must meet EPA regulations. Under the Clean Water Act, all point discharge must have a State permit. All non-point discharge must be consistent with the State non-point source pollution management program and are subject to State review for their effect on water quality. Under the "Federal Facilities Compliance Strategy," EPA, Nov. 1988, federal employees can be held liable for pollution. Contact your local EPA office for any required permits.

Municipal Sewage Treatment Plants

For a fee, municipal sewage treatment plants will usually accept septic tank sludge and septage pumped from vault toilets. They may accept dried or composted septage, depending on their treatment plant capacity and the volume of the dried material. Fees for disposal vary with each treatment plant. Municipal treatment plants that have reached their capacity may refuse to take any waste generated outside their jurisdiction.

Septic tanks and vaults are pumped into a "honey wagon," which may be agency owned or contracted. The "honey wagon" transports the septage to a municipal treatment plant. The price of contracted pumping varies by area.

Forest Service Owned and Operated Treatment Plants

Most Forest Service treatment plants have a smaller capacity than municipal sewage treatment plants. They are designed for the expected volume of sewage they need to treat. They may not be able to handle shock loads from septic tank sludge or vault septage if that loading was not considered during design.

Septic Tanks

Septic tanks treat the solid waste through anaerobic digestion. The effluent is discharged to a leach field, sand mound, constructed wetland, or other treatment method. Most of the solid waste is liquefied through anaerobic digestion. The build-up of sludge (settleable solids) and scum (floating material) should be monitored annually. The septic tank must be pumped when solids accumulation reduce the design retention time. Septage should be disposed of in a sewage treatment facility, batch composter, incorporated into the soil in a restricted area, or buried.

Batch Composters

Batch composters can be used to finish treating material from a compost toilet. Sewage from vaults and barrels, and dried sludge can also be processed in a batch composter. When proper process and controls are used, a Class A sludge can be produced. A Class A sludge may be surface applied as a fertilizer or soil amendment without restriction (CFR 40.503).

Land Application

Domestic septage applied to the land surfaces shall be incorporated into the soil within six hours of placement on the land (CFR 40, 503.15(d) and 503.33(b)(10)(i)). Public access to the land shall be restricted for one year after application. Animals shall not be allowed to graze on the land for 30 days after application. Food crops shall not be grown on the land (CFR 40, 503.32(c)(1)).

Land application will not be permitted if a threatened or endangered species will be adversely affected; if the ground is flooded, frozen or snow covered; or within 10 meters from waters of the United States.

The Forest Plan may restrict areas of land application or prohibit any disposal on forest land.

Composted material from a batch composter or a composting toilet should be treated as domestic septage unless temperature is monitored in accordance with CFR 40, 503 Appendix B, or the end product is tested in accordance with CFR 40, 503.8 for pathogens.

Composting toilets have been shown capable of reducing pathogens to Class A levels even though the temperatures generated are lower than required by the CFR 40, 503 regulations. With maintenance records and pathogen tests, a waiver may be obtained from the regulating agency. Class A material may be surface applied without restriction.

Trenching or Burial

Domestic septage may be disposed of by placing in a trench or pit and covering with soil at the end of each day (CFR 257.3-6(b)). This includes toilet vault septage, septic tank sludge, and composting toilet end product.

Incineration

Dehydrated, composted, or de-watered sludge can be incinerated, either on site or in a designated location. The fuel/sludge ratio needed for incineration is 50/50 for de-watered sludge. The drier the biomass, the less fuel needed. Local fire permit requirements must be met.

SUMMARY

Managing human waste in the backcountry is challenging. One of the first challenges is to distinguish between actual and perceived pollution potential and health risk. Sun, rain, and soil organisms will break down human waste over time. Popular backcountry camping locations, narrow river corridors, mountain climbing routes, and an ever increasing use of backcountry areas concentrate human waste in small areas at a rate that nature cannot assimilate and neutralize.

When nature's ability to handle the waste is exceeded, the backcountry manager must decide either to limit use or to set up a waste management system.

Maintenance must be addressed during the planning stage. There are no maintenance free toilets. A commitment to provide the maintenance is required for any waste management program to succeed.

Disposal options must also be addressed during the planning stage. Verify that the municipal treatment plant will accept the additional sewage before planning this as a disposal option.

APPENDIX A

The following list of manufacturers is offered as a guide. This list is not complete because there are many manufacturers across the country that make similar containers. Costs, when given, are average 1993 prices unless otherwise noted.

CARRYOUT CONTAINERS:

Pickle Pails" - Five-gallon plastic buckets with lids are available from most hardware or building supply stores.
Cost per unit: $5 to $10.
Method of disposal: plastic bags, Wash Table, or SCAT Machine

"Rocket Boxes" - 20-mm ammunition cans are available from most
military surplus stores. Cost per unit: $10 to $20.
Suitable for use with plastic bags, Wash Table, or SCAT Machine

Harvey Partners Toilet
(also known as Jon-E-Partner)
Partner Steel Company
3187 Pole Line Road
Pocatello, ID 83201
Phone (208) 233-2371
Cost per unit: about $500
Method of disposal: SCAT Machine or trailer dump station

The Scat Packer
Wilson Enterprises
18660 S. Greenwood Dr.
Oregon City, OR 97045
Phone (503) 631-3844
Cost per unit: $145
Method of disposal: SCAT Machine or trailer dump station

Paco's Reusable Bags
(designed to fit Rocket Box)
Jack's Plastic Welding
Box 3173
Durango, CO 81302
Phone (303) 259-5380
Cost per unit: $40 to 50
Method of disposal: Wash Table, or trailer dump station

Green Machine
Headgear
14287 Warner
Lewiston, ID 83501
Phone (208) 743-0625
Cost per unit: about $300
Method of disposal: trailer dump stations

Port-a-potties (several sizes)
Thetford Corporation
P.O. Box 1285
Ann Harbor, Michigan 48106
Cost per unit: $100-$400
Method of disposal: trailer dump stations

The Bano
Complex Fabricators, Inc.
375 North 500 West
Salt Lake City, UT 84116
Phone (801) 355-2830
Cost per unit: $500
Method of disposal: trailer dump stations

Coyote Bagless Toilet
Four Corners River Sports, Inc.
P.O. Box 379
Durango, CO 81302-0379
Phone 1-800-426-7637
Cost per unit: $120
Method of disposal: trailer dump stations

Magic Groover
P.O. Box 638
Westminster, CO 80030
Cost per unit: $255
Method of disposal: trailer dump stations

PORTABLE CONTAINER SANITIZER:

SCAT Machine
Frenchglen Blacksmiths
Highway 205
Frenchglen, OR 97736
(503) 495-2315
Cost of Unit: $17,200 plus installation.

COMPOST DIGESTERS:

Clivus Multrum, Inc.
4025 E Chandler Blvd. Suite 70-A16
Phoenix, AZ 85044
1-800-962-8447
(602) 940-9508

CTS
P.O. Box 1928
Newport, WA 99156-1928
(509) 447-3708

Advanced Composting Systems
Phoenix Digester
195 Meadows Rd.
Whitefish, MT 59937
(406) 862-3854

PASSIVE COMPOSTERS:

Romtec, Inc.
Backcountry Passive Composter
15587 N. Bank Rd.
Roseburg, OR 97470
(503) 496-3541
Cost: $500

DEHYDRATING/COMPOSTING TOILETS:

Bio-Sun Systems. Inc.
Box 134A-R.D. #2
Millertown, PA 16936
(717) 537-2200

Biological Mediation Systems, Inc.
P.O. Box 8248
Fort Collins, CO 80526
1-800-524-1097
(303) 221-5949

SITE-BUILT TOILETS, PLANS AVAILABLE FROM:

ATV VAULT TOILET DESIGN:
Gifford Pinchot National Forest
Packwood Ranger District
Packwood, WA 98377
(206) 497-7565
Attn: Gary Deibold

YOSEMITE COMPOSTING TOILET:
Yosemite National Park
BackCountry Utilities
P.O. Box 577
Yosemite, CA 95389
(209) 372-4510 Attn: Korwin Kirk

ROCKY MOUNTAIN DEHYDRATING TOILET
Plans included in pamphlet;
"Performance Evaluation for Backcountry Solar Toilet,"
Joseph R. Arnold, Jr., Jan. 1993
Available from:
Rocky Mountain National Park
Estes Park, CO 80517
(303) 586-2371

APPENDIX B

HUMAN WASTE MANAGEMENT ON RIVERS: WHY IS IT NECESSARY TO REMOVE HUMAN WASTE FROM RIVERS?

Author: Briar Cook

INTRODUCTION

Human waste removal from river rafting and boat trips is becoming an ever increasing management and health problem. More and more people are finding that river trips are one of the most exciting experiences of their lives and it is a relatively inexpensive source of entertainment. This increased interest translates into increased use of the resource, more concentration of people, more people that do not understand the fragile balance of nature, increased transmission of diseases to humans and animals, and a potential degradation of the natural resource.

ANIMALS LEAVE THEIR WASTE IN THE ENVIRONMENT, WHY CAN'T I?

Animals have been using the woods for a bathroom since the world began. There is, however, a significant difference between animal waste and human waste. Animals range over a vast area of land and each waste deposit may be miles apart. The animals may leave their waste in a river on one occasion and then not again for another year. As each river is developed for visitors, we concentrate everyone into a narrow corridor. The potential for disease getting into the river is extreme. On one river site in the country, approximately 75 tons of human waste is removed each summer. Think of the potential contamination if only a portion was allowed to enter the water.

Another problem with leaving our waste along the river is that we can contaminate various animals. They then become the host for the disease and transmit it back to us. This cross transmission of disease from human to animal and animal to human is called "Zoonosis".

There are many of us who can be carriers of disease and yet show no sign of that disease. When our waste is deposited in the river corridor, it can be a major source of contamination. However small you think your waste is in comparison to the vast area of the river corridor, remember that it is very important that you carry your waste out with you.

BY SHALLOW BURYING MY WASTE (CAT HOLE METHOD), WON'T IT QUICKLY DEGRADE?

A study was conducted by the Department of Microbiology, Montana State University where forty eight samples of human feces were buried at each of six sites. The depth of the burial was at 5 centimeters (1.97 inch) and 20 centimeters (7.87 inch). A thin layer of human waste inoculated with a strain of Escherichia coli and salmonella typhimurium (bacteria similar to many intestinal pathogens) was sandwiched between two layers of the soil found at each site. The sample burial time was nearly one year (51 weeks). The bacteria count at the end of the study was significant, clearly illustrating that burial of human waste did not result in the degradation that was previously thought to happen. The samples of human waste that were used were very thin samples. Normally when the "Cat Hole" method is used, the waste would be deposited in a pile and lightly covered, thus increasing the probability that bacteria would survive in very large numbers.

HOW DOES HUMAN WASTE CONTRIBUTE TO THE PROBLEM?

Each of us, as individuals, has the perception that if we simply bury our own waste that this small amount of biological matter will not be a problem in the vast area of a river corridor. Besides, we have all been led to believe that the natural bacteria in the soil will neutralize our waste in a very short time if we bury the waste in the top six to eight inches of the soil. As the last paragraph illustrates, both of these assumptions are flawed.

We have to condition ourselves to understand the number of people that have been to the same place before we got there; and the number of people that are going to follow. As we go down the river corridor, the river takes each raft about the same distance each day (jet boats are different). Each boat operator has a favorite site, to camp at each night. Consequently, each site that is one person's favorite site is also many other peoples' favorite site. On some rivers there are only so many sites where the boaters can land. At each one of these sites there is always one or two excellent spots to use as the "toilet area." It is not difficult to understand that everyone that lands at this favorite camping site ends up selecting the same spot as the best spot for the toilet area. Now, if each of us buried our own waste at this same spot, within this favorite camping site, one can easily see that the concentration would be overwhelming.

Human waste can contribute to contamination in a waterway by several means: (1) by heavy rains running over sloped topography and washing out uncompacted, shallow buried waste, (2) by animals digging up the waste and then rain water runoff washing it into a water body (3) by rainwater or swelling rivers saturating the soil and then percolating the contaminated waste water into the water body (this is especially true of sandy soils or waste buried in close proximity to the water body), and (4) by animals digging up the waste, becoming infected, and then transmitting the infection back to the water body by depositing their waste directly into the water or by rainwater runoff carrying their waste into the water body. Once the waterway is contaminated, then humans and animals can become infected simply by drinking the water.

WHAT KIND OF DISEASE CAN I EXPECT TO ENCOUNTER IN THE ENVIRONMENT?

At one time people were concerned with the disease called entamoeba histolytica, which was affectionately called "Montezuma's Revenge," a moderate form of diarrhea. Entamoeba histolytica is now taking a back seat to a recently diagnosed disease called giardia duodenalis (or giardia lamblia), which causes giardiasis, a severe form of diarrhea. Giardia is the most commonly identified pathogen in waterborne outbreaks of diarrhea in the United States. Giardia is a parasite that can reproduce only in the intestines of warm-blooded animals including muskrats, beavers, dogs, wading birds and humans. Animals that live around water are critical to the giardia life cycle. Once giardia enters the host through water or food, it multiplies and attaches to the intestinal wall. Giardia cysts pass from the intestines by means of excreted fecal matter. From the feces the cysts may enter the water, where they can survive for months. An animal or human that drinks that water becomes infected and provides a new host for the giardia and the life cycle continues.

Now that we have been educated to these two pathogens, here comes another one called cryptosporidium. Cryptosporidium is classified as a coccidian protozoan. It is an obligate, intercellular parasite, whose life cycle involves both asexual and sexual multiplication. Infection occurs as a result of ingestion of an environmentally resistant stage referred to as an oocyst.

Unlike giardia, which is known to last only a couple of months in the environment, cryptosporidium can last for well over a year (up to 18 months in a laboratory in water at 4 degrees Celsius). Other differences are: (1) it is smaller than giardia, (2) it is a lot hardier, (3) it is more resistant to disinfection, and (4) there is more potential for human to human disease transmission and it is suspected that there is more potential for animal to human transmission than from giardia.

Cryptosporidium symptoms usually take about 8 to 10 days to appear but the range can be from 1 to 3 days and as long as 25 to 26 days. One of the conditions that make cryptosporidium long lasting in the environment is that healthy people who seem to have recovered from the symptoms can excrete oocysts for up to 60 days.

Cryptosporidium oocysts are nearly spherical and have diameters from 3 to 6 microns whereas giardia range from 6 to 8 microns with a maximum of 15 microns. (One inch requires 25,000 microns). Chlorine disinfection apparently has no hope of killing the cryptosporidium oocysts under conditions that are practical in a normal water treatment plant.

Another known bacteria that is transmitted from rodents to humans is called salmonella enteritis, another form of dysentery. There are also other protozoans, bacteria and viruses that can be ingested the next time you drink from a stream or lake. Just because the water looks sparkling and totally clear, there is no guarantee that it is safe to drink. In fact, this perception of purity causes many of the existing problems today.

PLASTIC BAGS ARE NO LONGER ALLOWED, SO HOW DO I CARRY OUT MY WASTE?

Plastic bags are no longer allowed because the waste contained in the plastic bags is a serious health hazard, the plastic does not degrade when buried, and plastic degrades very slowly when exposed to sunlight. More and more State agencies are not allowing plastic bags to be deposited in landfills, in local town dumpsters, in trailer dump stations, or in deep slit trenches. This translates to not using plastic anymore for the removal of human waste off of rivers.

The new acceptable method is to use a holding container that can be emptied at the end of the river trip or a container that is completely biodegradable and can be deposited into an acceptable treatment system. This container method will require that we as individuals tolerate a little odor while using the toilet. However, this small sacrifice is worth it to protect our precious environment and to prevent disease for spreading to each other and to other animals.

Care should be taken to use biodegradable deodorants in these carry out containers so that the final treatment process is not adversely affected.

WHAT DO I DO WITH THE WASTE AFTER THE TRIP IS OVER?

It is the responsibility of the Agency managing the river to designate a place to dump the individual containers. It will be your responsibility to know what the waste disposal regulations and procedures are before you float a river.

[1] *Health Hazard from Human Wastes in Wilderness, Temple, Camper, Lucas, Journal of Soil and Water Conservation, Volume 37, November-December 1992*

[2] *"Human Waste Management in Backcountry Areas," Peter O. Nelson, Feb. 1991.*

[3] *"Cryptosporidium-The Industry's New Superbug," Silverman, Gary P., Journal AWWA, Waterborne Disease, Feb. 1994.*