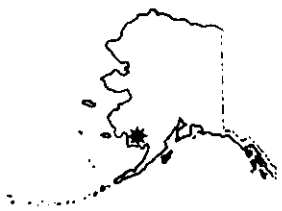
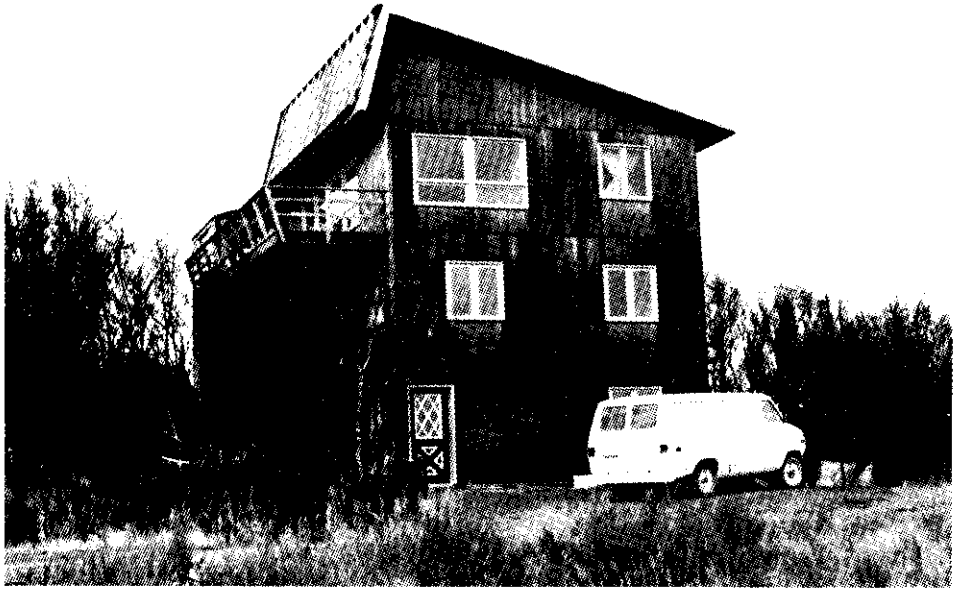
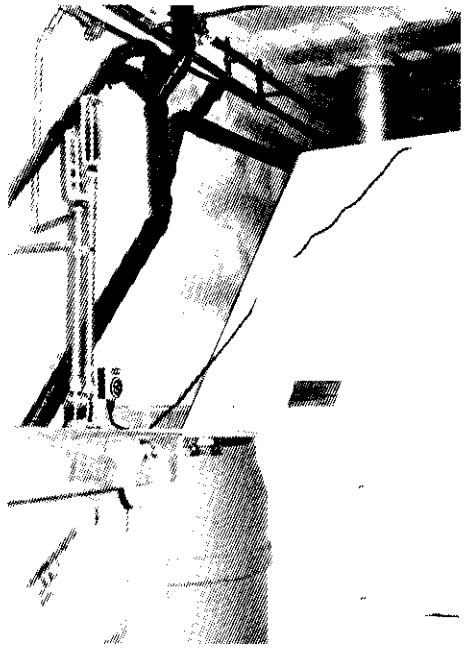


Greywater Treatment for Rural Homes

by Norman Bair





The author's house in Dillingham. Photo to the right shows the greywater system installed in the basement. Thermometers measure the difference between incoming cold water and outgoing preheated water. The white tank is a Clivus Multrum composting tank with clean-out door; the wire from it goes to a Sears electric "Bug Wacker."

Because they live in a harsh climate and a sensitive environment, Alaskans have particular problems in dealing with wastes of all kinds. The federal government is installing costly and high energy-consuming systems in the attempt to meet the waste disposal needs of rural Alaska; the U.S. Public Health Service has been constructing water and sewer systems throughout rural Alaska during the past decade. These systems may be appropriate in places other than Alaska, but they are not always wise choices for far northern use. Although the systems serve their intended purpose, both their installation and operating costs far exceed reasonable expenditures for the number of people being served.

Alternative solutions for sewage disposal are also being used in Alaska. These systems cost from one-fourth to one-tenth the amount that is being spent per household by the Public Health Service. Until recently, however, most of them have been technically illegal.

The Alaska Department of Environmental Conservation (DEC) adopted new wastewater regulations on December 30, 1982. This revision finally allows more innovative solutions for wastewater treatment and disposal. The revised code defines greywater for the first time in State regulations.

Greywater is commonly understood to be water coming from sinks, showers and washing machines, and not containing toilet wastes. Previously, the State required a minimum 1000-gallon septic tank or holding tank for each residence

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with its own sewage system no matter what kind of wastes entered that system. This requirement places an unnecessary cost burden on homes that do not flush toilet wastes into the sewer system.

Like many Alaskans, I did not first learn of the wastewater regulations by reading about them. In 1976 I began building a house in Dillingham, on Bristol Bay, about 360 air miles from Anchorage. My design included two toilets and a garbage chute feeding into a Clivus Multrum composting toilet and garbage unit, a Swedish system that has been tested and used for many years in Scandinavia. This system uses no water, so the only wastewater from the house is greywater. The greywater waste flows into an underground gravel leachbed 30 feet from the house. When it came time to close on the house mortgage, DEC would not approve the wastewater disposal system because it did not include a 1000-gallon septic tank. My assertions about the adequacy of the system fell on deaf ears at DEC; my system simply wasn't what the regulations specified. To halt the high interest on my interim construction loan, I was able to obtain DEC's temporary approval to allow a closing on the mortgage.

Rather than giving up and installing a costly septic tank, I decided to submit a proposal to the ACST's Northern Technology program for a grant to construct an experimental greywater treatment system. Kyle Cherry, who was then working for DEC, helped me develop the preliminary design. After receiving the grant, I continued to work with ideas about such a system. What finally evolved is a great improvement over the original concept.

SYSTEM DESIGN

There were several specific objectives that I wanted the greywater treatment system to meet. First, the system had to function well enough so that the treated water would meet State health and safety standards. That also meant it had to be able to handle comparatively large surges of water effectively, since household water use is uneven. Second, I wanted a do-it-yourself system that could be put together in rural Alaska. The components had to be inexpensive, easily obtained and assembled, and the system had to be compact and simple to install. Third, the system had to be easy to live with; I wanted something durable and long-lasting, simple to maintain, and preferably not requiring service more than once a year. Finally, I had one additional requirement: The system must provide a means for recovering some of the heat present in the wastewater.

TABLE 1
MATERIALS LIST

1 — Plastic 55-gallon drum (a steel drum can be substituted with the addition of a rubber lid)
2 - Plastic 5-gallon buckets
1 — Plastic 55-gallon drum liner
100 feet 3/4" polyethylene tubing
8 feet — 2" ABS pipe
4 — 2" ABS male adapters
3 2" ABS female adapters
4 — 2" ABS tees
2 — 2" ABS street 45-degree elbows
6 2" spud washers
2 — 3/4" Plastic by male pipe thread adapters
4 — 1" Stainless steel clamps
1 — 3" Stainless steel clamp
1 — 18" Wood 2 x 4
1 5" Diameter scrap piece of rubber inner tube
ABS cement and other plumbing necessities for the rest of the house plumbing system.

The device that came out of the design process is basically two buckets within a 55-gallon drum. The buckets baffle the water flow in the drum, allowing the grease to come out of suspension, congeal and float to the top of the drum. The system is assembled from non-corrosive components basically plastics. Materials (Table 1) cost about $100 in Anchorage. The system is compact enough to fit into a crawl space, and the required plumbing is not difficult.

Figure 1 shows a vertical section through the drum. To start the system, and to test it for leaks, the drum is filled with clean water. Greywater from the household drains enters the covered drum and flows into the top bucket. Water flowing out of that bucket is directed to the bottom of the drum. The greases and solids collect principally in the top bucket. Some solids collect in the bottom of the drum; very little collects in the bottom bucket where the water goes into the outlet piping. Most of the grease that does not stay in the top bucket comes out of suspension in the cold water at the bottom of the drum and floats to the top of the drum where it collects. The treated

GREYWATER TREATMENT AND HEAT RECOVERY SYSTEM

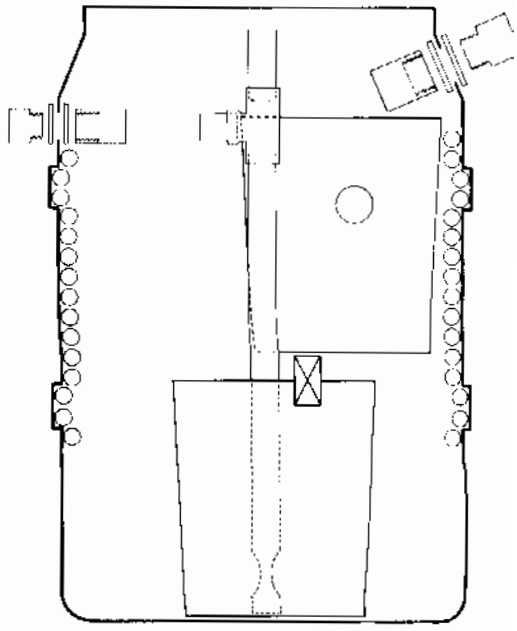


Figure 1. Vertical section through drum. For clarity's sake, inflow pipe carrying water from top bucket to bottom of the drum is not shown.

greywater that leaves the drum is piped into the same gravel leachbed that was used before the drum was installed.

The small circles shown at the edge of the drum in Figure 1 represent sections through the polyethylene pipe that constitutes the waste heat recovery portion of the system. (Not shown in the drawing is the waterproof liner that separates the greywater from the clean water in which the heat recovery piping is immersed. Section 1003(f) of the Uniform Plumbing Code requires the double-wall protection provided by the liner; the code does not allow potable water piping to be immersed directly in non-potable wastewater.) It amounts to a very straight forward heat exchanger.[1] Cold household water flows through the polyethylene pipe at the bottom of the drum, where the water is coolest, and then ascends in the coiled piping to the top of the drum into plumbing directing it to the domestic water heater. This direction of flow maximizes heat recovery. The heat that is in the wastewater is transferred through the plastic liner, the clean water between the liner and the drum, and through the polyethylene of the piping, to the cold water flowing through the pipe.

OPERATION AND MAINTENANCE

The greywater treatment system in Dillingham has been in service since October 1981. It has done an excellent job of collecting the major portion of the greases and solids that may be in the wastewater. Without any actual test information being available, I can only describe the effluent from the system as being basically clear, with some small — barely visible — globules of grease.

The heat recovery system has also worked well. The outlet temperature of the circulating water is raised a minimum of 10°F over the inlet temperature; the cold water temperature has increased by as much as 40°F when hot wastewater flows into the drum. I estimate that it saves about 30% on the domestic hot water heating energy consumption.

The system is designed so that three of the pipe connections inside the drum come apart, allowing the two five-gallon buckets to be lifted out for cleaning. It appears to me that the system will have to be cleaned every one or two years — depending on how careful the home's occupants are in keeping greases out of the kitchen sink.

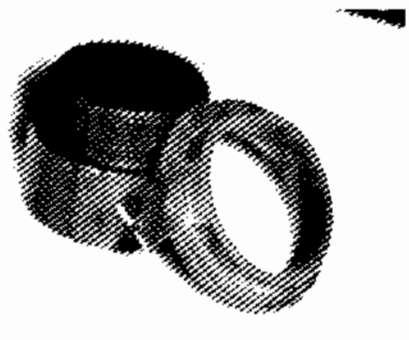
The new regulations require that greywater receive primary treatment, which amounts to a mechanical separation of the greases and solids without any antibacterial or chemical purification — exactly what my system does. During wet portions of the year, the water table is just four feet below the ground surface at my Dillingham homesite. Because of that, discharging the treated wastewater to the gravel leachbed conflicted with previous regulations — but is allowable under the new rules. This greywater treatment system should meet the new requirements, but it has not yet been recognized by DEC officially.

BUILDING THE SYSTEM

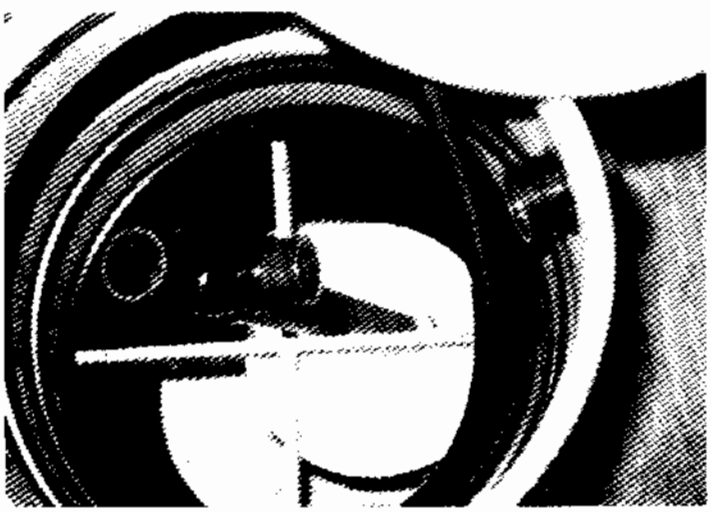
The drum system for treating greywater can be located in a crawl space or basement that does not freeze. It should be placed somewhere below the drain lines yet still be accessible for cleaning and servicing. The following is a basic step-by-step description of how to construct the system, which takes about three hours.

1. With a razor blade or box knife, cut the flanges from six 2" spud washers to make six flat washers. (Be careful always to direct the sharp blade away from your body when cutting.) These spud washers are available at most plumbing stores.

2. Locate the inlet hole as high as possible on the plastic drum by holding a

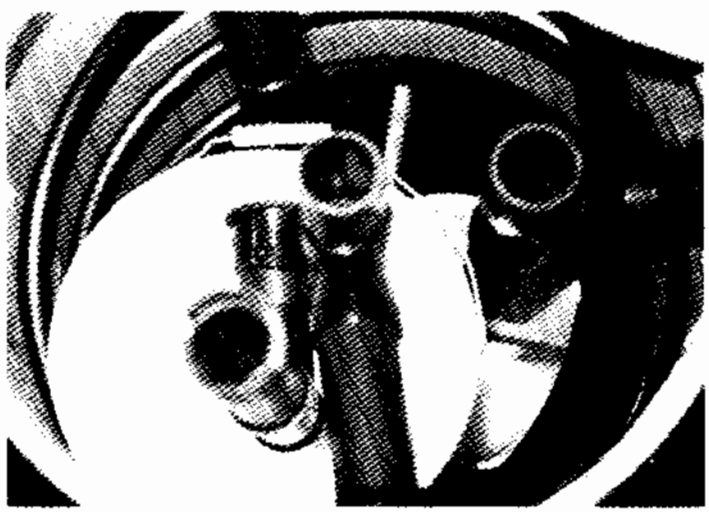


A 2" ABS male adapter and a 2" spud washer; a razor blade is used to cut off the flange.



The outlet pipe from the lower bucket disengaged from the outlet fitting on the drum. This fitting is not glued so that the pipe can be removed. Crossed 2 x 2's were used to support the upper bucket; later Bair found a 2 x 4 "worked fine and was simpler."

Top view of buckets and pipes.

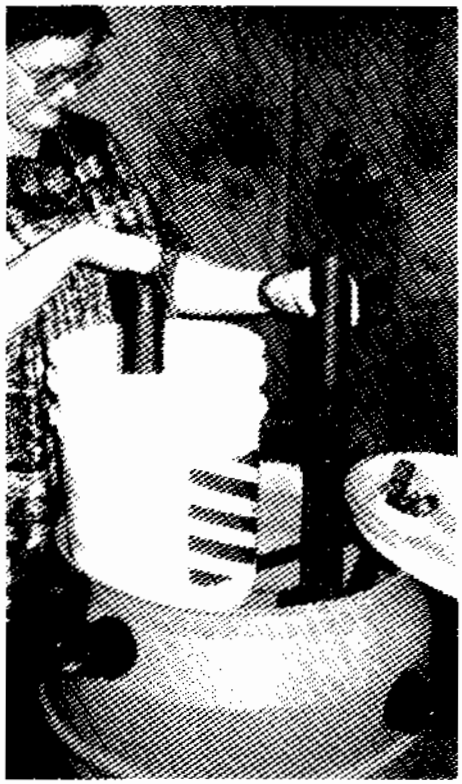


spud washer on the sloped ring, so it is lying flat on a smooth surface with no ridges. With a pencil mark a circle tracing the inside edge of the washer. Center the male end of a straight ABS pipe fitting over this circle and scribe a slightly smaller circle using the inside edge of the fitting as a guide. This circle should be 2-3/8" in diameter, which is the size of the hole that will be cut out.

3. Select a place around the drum from the inlet location that will be handy for the outlet pipe. This should be at least a quarter of the way around the drum from the inlet pipe. Scribe the hole with a pencil on the highest horizontal band on the drum below the inlet hole, using the same method as in step 2.

4. Cut out the holes using either a 2-3/8" hole saw or by drilling the biggest hole possible along the inside edge of the circle, and then using a sheetrock or similar saw to cut out the hole. A file can be used to smooth the hole, so that one of the male ABS adapters can be threaded through it. Drill a 1/4" hole in the drum about 1" below the outlet pipe hole. Water will leak out this hole if either the plastic liner or the polyethylene pipe ever ruptures, letting you know that something is wrong and needs to be fixed.

5. Coil the 100 feet of 3/4" polyethylene pipe into the drum so that only one end sticks out about one foot above the lip of the drum. Pull at the end of the pipe in the bottom of the drum enough to allow the coil to seat itself well within the drum, and then pull this end up so that about a foot of it can stick out from the drum alongside the other end of the coil.



The author's wife, Louise Fowler, lifting the upper bucket out of the drum.

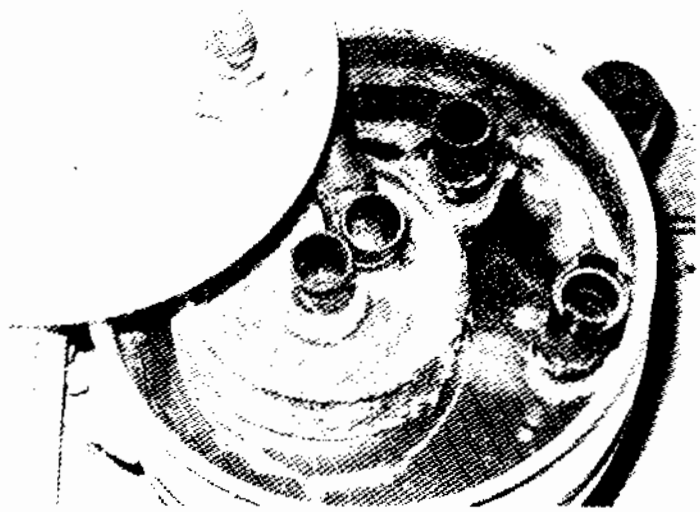
6. Place the plastic drum liner inside the drum and make sure that the liner will not be stretched and torn from its fastenings when the drum is filled with water. It may be helpful to fill the liner in the drum with water to a level just below the outlet hole. This will ensure that the liner is well seated before the holes are cut into it. Locate the liner against the two holes in the side of the drum and, with a razor blade, cut out holes in the liner to match the holes on the side.

7. Place a flattened spud washer over the threads of all three 2" ABS male adapters and thread two of the adapters into the holes in the side of the drum. Insert the plastic drum liner over the threads and place another flattened spud washer on the threads protruding inside the drum through the plastic liner. Apply three or four rotations of teflon tape over the threads, and thread the female ABS adapter onto the protruding threads as tightly as possible. (If there is water in the drum, drain it out at this point.)

8. Place one of the five-gallon buckets into the bottom of the drum toward the side where the outlet pipe is. Place the piece of 2 by 4 wood on edge on the bucket an inch or two off center, and mark on the narrow edge of the board where it rests on the bottom bucket. With a saw, notch into the 2 by 4 about one and a half inches so the 2 by 4 will rest securely on the lower bucket.

9. Make a 2-3/8" hole as high as possible in the side of the second bucket. On most buckets, this is just below a thick reinforcing ridge. Fit the male and female ABS adapters with the two

The outlet pipe that sits in the lower bucket is notched on the sides to allow water to flow in while the pipe holds down the bucket and keeps it from floating.



Four months of grease accumulation, with the majority of the grease appearing in the upper 5-gallon bucket. Grease marks on bucket and pipes show how high the water has risen.

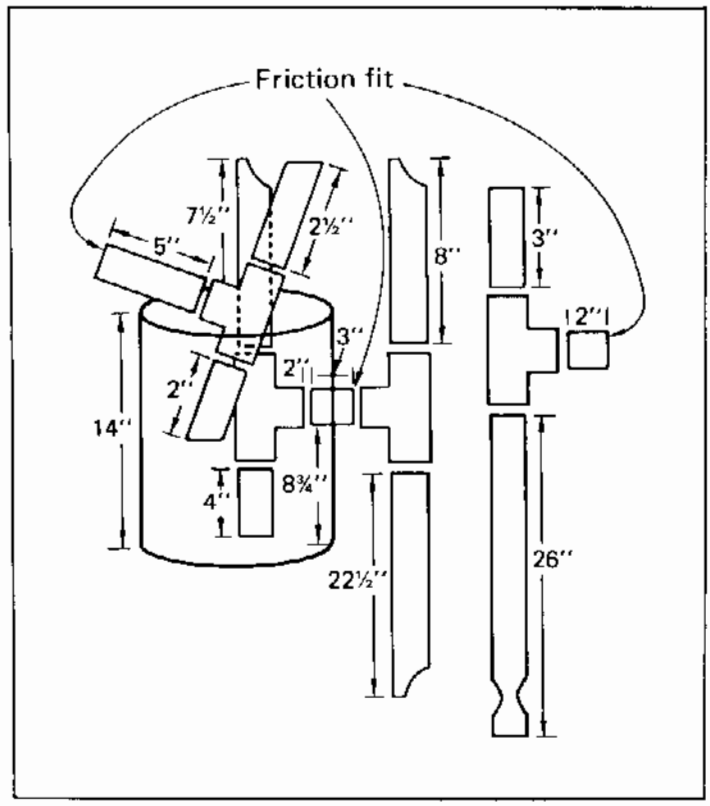


Figure 2. Cut, dimensions, and relative position of pipes for grey-water system (not to scale).

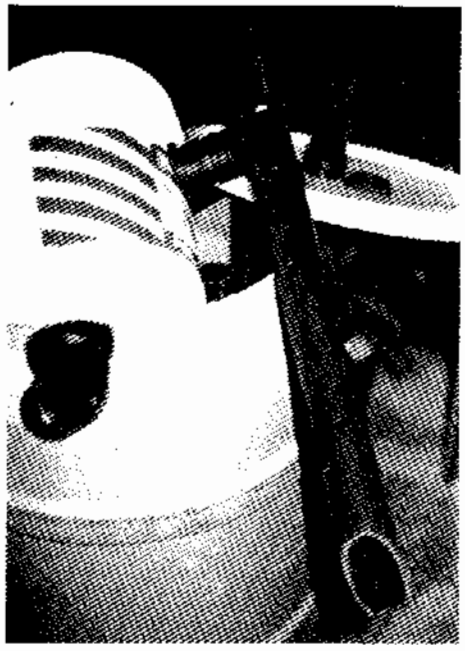
flattened spud washers through the bucket (using the same procedure as on the drum).

10. Cut all the pieces of 2" ABS pipe as shown in Figure 2. Where angle cuts are shown, the pipe can be cut slightly longer than required. The end of the angle cut is then flattened by cutting the pipe to the proper length. The end of the 26" outlet pipe is cut square so that it will hold the bottom plastic bucket down. (The plastic buckets will float out of position if they are not held down.) To allow the water to flow into the bottom of the pipe, two notched holes are cut into the opposite sides of the pipe about 1" from its bottom end.

11. Place the plumbed upper bucket in the drum so that it rests partly on the 2 by 4. The top bucket should fit just under the inlet fitting at the top of the drum.

12. All except three of the ABS pipe fittings are glued together. The stub pipe pieces going into the two fittings through the drum and the one coming out of the five-gallon bucket are just friction fit. This allows the system to be taken apart for cleaning and servicing.

13. With all the components assembled inside the drum, the system is ready to be plumbed into the house sewer system. The inlet fitting through the plastic drum is set at an angle. Two 2" ABS street 45's can be used to accept the inlet pipe from any direction. Before cementing them together, set them at the proper angle and with a pencil mark the alignment on the two fittings and on the fitting going into the drum where no cement will cover the marks. After applying the cement, join the fittings and quickly line up the marks.



Upper bucket with beveled pipe that carries water to bottom of the drum.

14. After the cement has set for an hour or so fill the drum with clean water. Then carefully pull the plastic liner away from the drum sides, enough to pour clean water between the drum and the plastic liner. This water is to provide better heat transfer between the waste-water and the cold water that will be flowing through the polyethylene pipe on its way to the hot water heater. Check for any leaks outside the drum other than the planned one from the 1/4" hole.

15. Thread the remaining 2" ABS male adapter into the bung hole in the plastic lid of the drum. Place the two ends of the polyethylene pipe through the hole. Make two 3/4" holes in the piece of rubber inner tube, and insert the pipe through the two holes. This rubber will be clamped to the adapter with the 3" stainless steel band after all the plumbing is complete. This provides an airtight seal on the drum system.

16. Insert the two threaded pipe adapters into the pipe. If the adapters do not go into the pipe easily, the pipe can be heated by inserting its ends into hot water. With the adapters inserted, place two stainless steel bands on each pipe. Tighten the clamps with the screws on opposite sides of the pipe for a leak-proof joint. Connect the cold-water piping to the end of the polyethylene pipe that extends to the bottom of the drum, and connect the other end of the polyethylene pipe to the water line going to the hot water heater. Test for leaks in the domestic water system, preferably with 100 psi air, or with water pressure if no air compressor is available.

17. Fasten down the lid and the grey-water treatment and waste-heat recovery system is complete.

REFERENCE

[1] Nelson, Glenn. 1981. Greywater heat recovery. *Solar Age*. August, p. 50–53. ♦