Texas A&M AgriLife Extension

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Onsite wastewater treatment systems

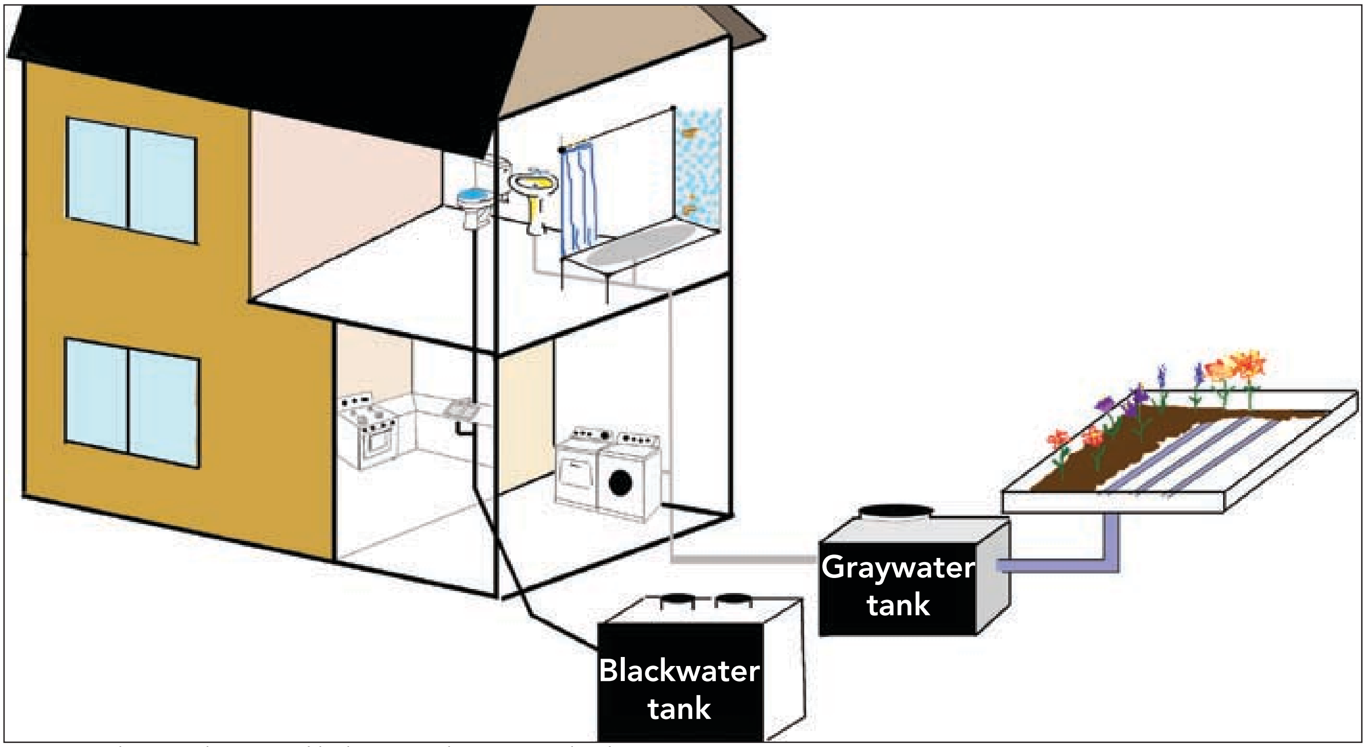

Figure 1: A home with separate blackwater and graywater plumbing systems.

Graywater safety

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When homeowners use graywater to water their lawns, they help preserve limited water supplies, reduce the demand for potable water for lawn irrigation and decr,ease the amount of wastewater entering sewers or onsite wastewater treatment systems.

However, homeowners who irrigate their lawns with graywater need to understand the risks and safety issues associated with such use. They should know the constituents of graywater as well as their potential effects on human, soil, plant, and environmental health.

What is in graywater?

The Texas Administrative Code defines graywater as water from these residential sources:

- ✔ Showers and bathtubs
- ✔ Sinks, except those used for disposal of hazardous or toxic materials or for food preparation or disposal
- ✔ Clothes-washing machines

The code excludes water that has washed materials soiled with human waste (such as diapers) and water that has been in contact with toilet waste.

A graywater system may collect water from a single approved source or from any combination of those sources. The amount and quality of the graywater depends on the sources.

Residential wastewater can be classified as either blackwater (sewage containing fecal matter or food wastes) or graywater. If graywater is collected separately from blackwater, it can be dispersed as irrigation water with less treatment than is required for blackwater.

Table 1 includes a partial list of constituents that may be present in graywater, illustrating that if something is washed down the drain, it will end up in the graywater.

Several factors affect the composition of graywater, including the quality of the water supply; the residents' personal habits; soaps, detergents, and cleaners used in the home; the age and number of residents in the home; the graywater treatment process (if any); and the length of graywater storage time.

For example, a study in 2001 by the University of Arizona found that a home with two adults and a child had a significantly higher concentration of fecal coliform (microorganisms found in human waste) in the graywater than did a household of just two adults.

Graywater will have higher concentrations of chemicals from detergents and cleaners if strong products are used in the home and if the products are used often. Also, any treatment of the graywater and the length of time it is stored before application will influence its levels of suspended solids, nutrients, bacteria, viruses, and odor.

When homeowners use graywater for landscape irrigation, they should understand that the water contains constituents that may influence whether it is appropriate for use. As shown by several research studies, the amount of contaminants in graywater varies greatly (Table 2). The quality of graywater is lower than that of drinking water but higher than that of raw municipal wastewater.

Table 1. Wastewater constituents from various residential sources.

	Shower and bathtub	Sinks (not kitchen)	Laundry
Bacteria	•	•	
Bleach			•
Grease and oil	•	•	•
Hair	•		
High pH			•
Hot water	•	•	•
Nitrogen			•
Odor	•	•	
Organic matter (BOD)†		•	•
Phosphorus			•
Salinity			•
Soap	•	•	•
Sodium			•
Suspended solids	•	•	•
Turbidity	•	•	•

†Biochemical oxygen demand, a measure of organic contamination

Preventing harm to people

The risk that graywater may pose to human health is not as great as is often assumed. Although many of the contaminants in graywater may harm your health (Table 3), the damage occurs only if the graywater is ingested or otherwise contacted physically.

Often graywater has already come into contact with humans—at sinks and in showers and tubs—before it enters the graywater system. There is some concern that bacteria can accumulate and grow in the graywater storage system and that graywater can be exposed to people who do not live in the house where it originated.

To eliminate possible exposure, homeowners should choose the distribution method and application areas carefully. For example, never use spray distribution (sprinklers) to apply graywater because it is the method most likely to cause human exposure. The method least likely to cause human exposure is a subsurface distribution system.

If graywater is applied to the soil surface (in a method other than spray), take these steps to prevent exposure to people:

- ✔ Apply the graywater to areas that receive little or no traffic.
- ✔ Avoid irrigating edible fruit and vegetable gardens with graywater.
- ✔ Discourage children from playing in areas where graywater is regularly applied.
- ✔ Never use graywater to wash down driveways, patios, or other impervious surfaces.

In addition to using graywater in areas that reduce the risk to human health, homeowners should make sure that the system is designed and operated to prevent inadvertent exposure to people:

- ✔ Prevent cross-contamination by using backflow prevention valves.
- ✔ Direct the overflow from the graywater reservoir to an onsite wastewater treatment system or municipal sewer.
- ✔ Color-code all graywater components with purple markings to identify the water in them as unsuitable for drinking.
- ✔ Wear latex or surgical gloves when handling components of

Table 2. Concentrations of contaminants in graywater and raw wastewater and the maximum allowable concentrations in drinking water.

Constituent	Units	Drinking Water Standard (Environmental Protection Agency, 2006)	Typical Raw Wastewater (University of Arizona, 2001)	Graywater studies						
				University of Michigan, 1974	Urban Water Research Association of Australia (includes kitchen waste)	University of Arizona, 2001	University of Arizona, 1991	New Mexico, 1998	Journal of Environmental Health, 1978	University of Arizona, 1995
Barium	mg/L	2		<1	41					
BOD†	mg/L		300	328	159	65		260	149	120
Cadmium	mg/L	0.005		0.1						
Chloride	mg/L	250*	30–100	25		21	9.0			
Copper	mg/L	1.3 (1*)		0.11	130					
Fecal coliform	CFU/100 mL		10^7–10^{10}			8.03 X10^7			1.4 X10^6	7.6± 0.8 Log_{10}
Iron	mg/L	0.3*		0.11	700					
Lead	mg/L	0.015		0.04						
Manganese	mg/L	0.05*		<0.05	31					
Nitrate/nitrite	mg/L	10/1		0.9	0.3		9.3		0.12	1.8
pH	mg/L	6.5–8.5*		7.2	7.3	7.5	6.5		6.8	6.7
Phosphorus	mg/L			59	8.1		9.3	26		
Sodium	mg/L			80	73					
Sulfate	mg/L	250*		117	35	60	23			
Suspended solids	mg/L		192	33				160	162	40.3
Turbidity	mg/L	5		49	100	43	76			
Zinc	mg/L	5*		0.62	100					

Indicates EPA secondary water quality standard, which means that removal of these constituents is not required. If the concentration exceeds this standard, the effect to the water will only be aesthetic (odor, color, bad taste, corrosion etc).

† Biochemical oxygen demand, a measure of organic contamination

the system to perform maintenance activities, such as cleaning filters.

Avoiding harm to the environment

The greatest environmental effect of using graywater is that it decreases the demand for fresh water, preserving limited water supplies. The use of graywater also reduces the amount of wastewater entering sewers or onsite wastewater treatment systems.

Generally, most of the graywater and the nutrients in it will be used by plants, and the dynamics of the soil should break down the other contaminants. If the system is maintained properly, the graywater should have little if any effect on groundwater (the water beneath the ground surface, such as in an aquifer) or surface water (water in rivers, lakes, and streams).

However, graywater can pollute groundwater and surface water if it is not applied properly. The amount of harm depends on the quality of the graywater, the type of soil, and the geology of the site.

Groundwater may become contaminated if it contains large amounts of industrial chemicals that are not broken down by biological and/or environmental processes. It can also become contaminated if the graywater is applied to ponded soils or saturated soils.

Surface water may be affected if the graywater is applied to the ground

Table 3. Potential health effects of contaminants.

Contaminant	Effect
Barium	Increase in blood pressure
Cadmium	Kidney damage
Copper	Short-term exposure: gastrointestinal distress Long-term exposure: liver or kidney damage
Fecal coliform	Short-term effects: diarrhea, cramps, nausea, headaches or other symptoms. Fecal coliform does not cause these symptoms, but its presence indicates that the water may be contaminated with micro- organisms that do cause the symptoms.
Lead	Infants and children: delays in physical or mental development Adults: kidney problems; high blood pressure
Nitrate	Infants below the age of 6 months who drink water containing nitrate above the drinking water standard could become seriously ill.
Turbidity	Although turbidity has no health effects, it can interfere with disinfection and provide a medium for microbial growth. Turbidity mayindicate the presence of disease-causing organisms, including bacteria, viruses and parasites that can cause symptoms such as nausea, cramps, diarrhea and associated headaches.

Source: Adapted from U.S. Environmental Protection Agency, 2006

surface and it runs off into streams or lakes. To limit the risk to surface water resources, choose a site where the soil can absorb the graywater and does not allow ponding. Apply the graywater at a low rate and distribute it uniformly. You may need to move the drag hose to limit ponding and distribute the contaminants.

Graywater cannot be discharged into a lake, river, or stream or into a ditch leading to these water resources.

Reducing effects on soil

Applying graywater can have long-term effects on the soil, primarily an increase in pH or alkalinity, and an accumulation of sodium.

Laundry detergents often contain alkaline chemicals such as sodium, potassium, and calcium. Adding these chemicals to the landscape can raise the pH of the soil.

Monitor this change by periodically measuring the soil pH of the distribution area. An acidic soil will have a pH of 6.9 or lower; an alkaline soil will have a pH of 7.1 or higher. If the pH is excessively high (7.5 to 8), you can bring the pH closer to neutral (7) by incorporating into the soil an agricultural sulfur or an acidic fertilizer such as ammonium sulfate.

Sodium not only increases the alkalinity of a soil, but it also can greatly damage the soil structure and, over time, inhibit the soil's ability to accept water. To counteract the effects of sodium and help restore the soil structure and water absorption rates, periodically add organic matter such as compost or agricultural gypsum to the distribution area.

You can minimize the buildup of sodium and other contaminants by periodically flushing the soil with fresh water (this includes heavy rainfall), rotating the area to which the graywater is distributed, and distributing the graywater over large areas.

The soil type will also influence the effect of graywater on the site. For example, a well-draining sandy soil will be less affected by water composition than will a clay soil.

The amount of water that the soil will be able to accept unaffected depends largely on:

- ✔ The physical characteristics of the soil. For example, do not distribute large amounts of graywater in an area that drains poorly.
- ✔ The quality of the graywater. You can improve your graywater quality by treating it before distribution or by preventing or limiting the amount of harmful elements entering the graywater streams, such as by selecting a laundry detergent low in sodium.

Reducing effects on plants

A study in 2004 by North Carolina State University showed that graywater's effect on ornamental plants depends on the sources of the graywater and the species of plant. The study found that graywater streams from kitchens (which are not approved for graywater reuse under the Texas code) killed all the plant species tested.

Conversely, the plants irrigated with laundry graywater all survived, although some of them differed in size and physical appearance compared to the test group, which was irrigated with tapwater. Just as not all plants can grow in certain climates and soil types, not all plants thrive when irrigated with graywater. For example, because graywater makes the soil more alkaline, plants that grow best in acid soils should not be used where graywater is applied.

However, a lush landscape can be achieved with the proper graywater distribution methods and plant selection. Of the many types of plants that could be used, only a small percentage of them are damaged by graywater. Table 4 shows examples of plants that should not be used in a graywater reuse area as well as those that do well.

The quality of the graywater can influence plant health. Plants can be harmed by high sodium, boron, and chlorine levels in graywater. Sodium inhibits water intake to the plant, and large amounts of chlorine can be toxic. Signs of excessive chlorine and sodium include leaf burn, yellowing leaves, and twig die-back.

Although plants require some boron for growth, too much boron can cause problems such as leaf tip and margin burn, leaf cupping, yellowing leaves, branch die-back, premature leaf drop, and reduced growth.

You can decrease the damage from sodium, chlorine, and boron by reducing the amount of these chemicals in the graywater. To do this, choose your detergents carefully. The California Water Conservation's *Using Graywater in Your Home Landscape: Graywater Guide* suggests using soaps and detergents that are low in sodium-rich "fillers" (ingredients added to the detergent that do not affect the cleaning effectiveness). Concentrated liquid detergents usually have lower sodium content than do regular detergents because the concentrated varieties do not contain fillers.

Many cleaning agents contain large amounts of chlorine. Although the chlorine is often expended in the cleaning process, it should still be a goal to prevent high chlorine concentrations in the irrigation water.

The California guide also recommended that homeowners with graywater systems not use detergents that contain:

- ✔ Bleaches
- ✔ Softeners
- ✔ Whitening ingredients
- ✔ Enzymatic powers
- ✔ Borax
- ✔ Peroxygen
- ✔ Sodium perborate
- ✔ Petroleum distillate
- ✔ Alkylbenzene sodium trypochlorite

The amount of graywater used can also influence the health of your landscape. Sometimes the amount produced is only enough to provide supplemental water to the landscape, and additional water is needed to meet the plants' needs. Other times, the system may produce more graywater than is needed for the distribution area, and the landscape suffers from overwatering.

Plants typically do better if the soil is allowed to dry between watering. Do not apply more water than the soil can handle, or the graywater will pond. Ponding can result in runoff, groundwater contamination, human contact, mosquito breeding areas, and plant disease.

Over time, the soil may become less able to accept water because of the effects of the graywater. You may need to periodically adjust the application rates and/or distribution area size.

Summary

Graywater can meet part of our landscape's need for water. To limit health risks to people and the environment, homeowners must manage the constituents in graywater properly. Select the soil application site and method carefully, take steps to prevent contact of graywater with people, monitor the soil quality and correct it if needed, and choose plants that are not sensitive to graywater constituents.

For more information

Additional information on graywater reuse systems is available in Extension publication B-6176, *On-Site Wastewater Treatment Systems: Graywater.*

Table 4. Plant suitability for graywater irrigation.

Plants that will probably not do well with graywater	Plants susceptible to high sodium and chloride	Plants that will probably do well with graywater
Azalea, begonia, bleeding hearts fern, camellia, foxglove, gardenia, hydrangea, impatiens, oxalis (wood sorrel), philodendron, primrose, rhododendron, violets	Crape myrtle, deodar cedar, holly, redwood, star jasmine	Agapanthus, Arizona cypress, Australian tea tree, Bermuda grass, bougainvillea, cottonwood, fan and date palms, honeysuckle, ice plant, Italian stone pine, juniper oleander, olive, oak, purple hopseed bush, rose, rosemary

Source: Using Graywater in Your Home Landscape: Graywater Guide, California Water Conservation

Texas Water Resources Institute

make every drop count

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