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NATIONAL SMALL FLOWS CLEARINGHOUSE

Small Community Wastewater Issues Explained to the Public

High-strength flows – not your average wastewater

Thousands of homes in the rural areas of the U.S., as well as many businesses, use onsite systems to treat their wastewater. This issue of *Pipeline* will examine problems associated with treating commercially-generated wastewater onsite. It will also suggest ways to treat nonresidential wastewater to an acceptable level.

Commercial establishments—funeral homes, taxidermy shops, car washes, beauty shops, food processing facilities, restaurants and nursing homes—are often located in rural areas and use onsite systems for wastewater treatment. However, a restaurant or dry cleaning establishment produces very different wastewater from what a residence produces, both in quantity and quality. When these differences are not planned for, systems often fail.

This issue describes characteristics of wastewater from various sources and suggests treatment solutions. Wastewater characteristics refers to the contaminants in the effluent. As a rule, an onsite wastewater treatment system design is based solely on how much liquid waste must be treated. Designers commonly assume that the quality of the wastewater, which means the concentration of various elements in the waste, is similar to residential waste. However, wastewater from some commercial enterprises is very different in concentration and flow rates.

Generally, commercial establishments produce wastewater considered high-strength and often produce this effluent at sporadically high flow rates. (Note that some specific commercial installations fall under the U.S. Environmental Protection Agency [EPA]"Class V Injection Wells" ruling and, as such, are not allowed to use any type of onsite wastewater treatment system. Refer to the story on page 7 for more information.

What's Inside...

Defining high-strength

When a wastewater engineer uses the term "high-strength" wastewater, it can mean it contains greater amounts of fats, oils, and greases (FOG) or other organic components than residential wastewater. It can also mean the effluent contains large quantities of suspended solids or high amounts of certain chemicals, such as disinfectants. Any or all of these components can interfere with the normal biological processes most onsite systems use. These characteristics vary from day to day, even hour to hour, and they can have a major impact on how a system performs.

The major concern of having high amounts of organic components (high organic loading) in wastewater is drainfield clogging. Physical clogging occurs when solid material, such as grit, organic material, and grease, flows beyond the septic tank to the soil absorption field, where it is deposited on the biomat. Biological clogging generally occurs when excessive organic elements flow into the biomat. Microbes, bacteria, etc. grow so fast that the effluent can't pass into the soil. Chemical clogging often occurs in clay-type soils when high concentrations of sodium ions (salt) cause the soil to lose its structure and not allow the effluent to flow through.

The major concern of having high amounts of organic components (high organic loading) in wastewater is drainfield clogging.

Treatment plants are generally designed for average peak flow rates and average wastewater characteristics. Designing a treatment plant based only on these average values will result in a treatment plant that may not be able to handle peak conditions. Conversely, if a plant is designed for peak conditions, it may be too big to function well the rest of the time.

Elements to consider in system design

A first step in most system design is to consider the characteristics of the wastewater and make reliable estimates of wastewater flow. Most state regulations include a table of estimated sewage flow rates for different types of facilities.

When it comes to treatment plant design, traditionally the most important factors to consider are the five-day biochemical oxygen demand (BOD5) for a given flow, and the total suspended solids (TSS), which is a measure of the amount of waste particles suspended in the wastewater. BOD5 is a measure of the amount of oxygen that microorganisms need to consume and break down organic matter.

In addition, when dealing with commercial establishments, designers must consider the FOG levels in the waste flow. The public sewer industry uses three classifications for FOG based on waste strength, measured in milligrams per liter (mg/L): weak, medium and strong (50, 100 and 150 mg/L respectively). The average strength of residential wastewater is approximately 20 mg/L.

Fats and oils are triglycerides and fatty acids. At room temperature, oils are liquid and fats are solid. Obviously then, temperature plays a significant role in the treatment process. FOG can also be divided into two categories based upon origin: animal and vegetable based FOGs are considered to be edible, petroleum and coal-based FOGs (mineral) are inedible. The nonedible ones are especially slow to break down and, in some instances, are toxic. The range of values for FOG in a commercial system can vary according to source. For instance, a full-service restaurant could generate up to two tons per year. Most restaurants today use vegetable oils.

When grease reaches the soil absorption system, it can physically clog the soil pores preventing water and oxygen from moving freely. Bacteria need free moving water and oxygen to digest waste. The high BOD in grease also promotes excessive bacterial growth, causing a thick anaerobic biomat to form. This biomat has little ability to actually treat the waste.

Oil combines with water in three ways: as free oil, as an emulsion or as dissolved oil. Free oil will rise to the surface when the mixture is allowed to rest and, thus, is easy to separate. Most grease traps and grease recovery devices work by collecting this free oil. Emulsified oil has been broken up into very small droplets and occurs either by mechanical or chemical action. Mechanical emulsification frequently occurs when very hot water is briskly agitated with the oil. This type of

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10 Ten Ways to Protect Your Restaurant's Septic System

1. Thoroughly scrape plates and cookware.
2. Install a grease skimmer.
3. Practice water conservation.
4. Install low temperature dishwashers.
5. Use special detergents that promote rapid oil/water separation.
6. Use proper concentrations of solvents, cleaners, and disinfectants.
7. Use shortening instead of liquid vegetable oil.
8. Pump grease trap quarterly at the minimum.
9. Leave most of the liquid in the grease trap when it is pumped. (This is one recommendation. Depending upon the plumbing configuration to the grease trap, you may need to pump all of the contents of the trap.)
10. Pump septic tanks frequently to prevent buildup and carryover of solids.

(Barnstable County, 2002)

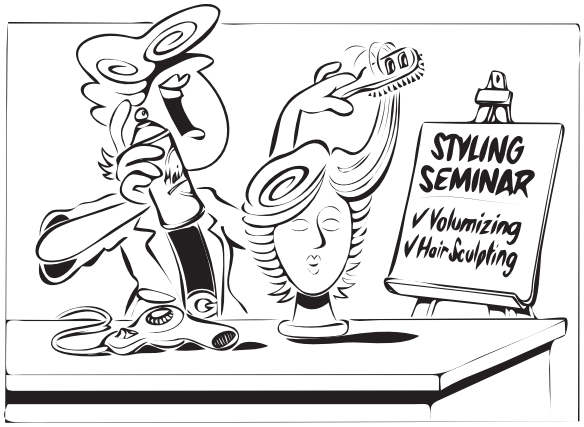
emulsion will separate out again if given enough time.

Detergents produce a chemically emulsified mix of oil and water. Chemically emulsified oil will not rise to the top no matter how much time is allowed. Dissolved oil occurs when the oil is no longer present as discrete particles, generally caused by the use of degreasing compounds.

The most common form of treatment is gravity separation, typically through a grease trap or tank. But gravity separation cannot remove emulsified oils and greases. Mineral oils are not considered biodegradable in biological treatment systems.

Different flows from different sources

It will help to understand the special considerations a treatment plant requires by examining some specific sources.



Car washes

Springing up as quickly as toadstools after a rain, commercial carwashes have become big business. Car washes create high intermittent flows and hefty contaminants, such as oil and grease, detergents, and phosphates. They also produce excessive amounts of grit and sand. Car washes can reduce the amount of toxic materials by using biodegradable soaps instead of solvent based ones, and reducing the amount of detergent, thereby reducing the amount of rinse water required and discharged.

Generally, regulations for onsite system design are based upon an individual home. The number of bedrooms is used to calculate the flow and tank volume required. And while the system is normally sized to treat a greater amount of wastewater than a home will actually generate, it is clear that a commercial car wash will easily overwhelm a standard sized tank. Professional car washes should implement water-saving devices, such as low flow nozzles, and run them at lower pressures. They should repair all leaks and control the flow of water when the facility is not in use.

Beauty shops

According to recent research by the state of New Jersey, the wastewater generated by a beauty salon is not very different in substance from household waste. The analyses suggested that beauty salons should be able to use a standard septic system. The study looked at the levels of lead, cadmium, chloroform, dimethyl phthalates, and ammonia nitrogen in the effluent. All levels were found to be within levels EPA considers safe.

Designers should consider the flow criteria as extremely important. New Jersey onsite wastewater treatment regulations provide the criteria of 120 gallons per day per sink. Following this criteria, only salons with more than 15 sinks exceed the normal permitted amount of flow. However, engineers should be aware that beauty shop wastewater may be lower in solids and carbon content, and the designs may need to be modified accordingly.

Whenever possible, salon owners should use only nonhazardous, nontoxic substances if an onsite system serves them. Hair dyes, bleaches, and permanent wave solutions should be used as sparingly as possible.

RV dumping stations

The wastewater at recreational vehicle (RV) dumping stations is often very high-strength due to the fact that campers who live in RVs are usually very conservative with water and, therefore, produce wastewater that contains highly concentrated solids. In addition RV owners use special products to cover up odors in RVs, but these chemicals often kill the anaerobic bacteria, which is the primary treatment mechanism in an onsite sewage system. These deodorizing chemicals present a special

problem to wastewater treatment designers.

Restaurants

Restaurants present special challenges to onsite wastewater treatment plant designers. Considerations specific to each restaurant that affect the flow rate and strength of the wastewater include hours of operation, disposable serving ware, sanitization schedule with chemicals or hot water, use of a deep fryer, and number of meals served. Even the type of food served can affect the wastewater strength: fast food usually involves a larger amount of FOG than a family diner. If a restaurant uses ice cream and yogurt machines, these put a lot of extra protein into the wastewater system. If they use a garbage disposal, total suspended solids become a problem.

Personal care homes

Personal care homes and nursing facilities produce wastewater with high levels of pharmaceuticals and cleaning products. Expect high BOD and TSS. However, a project in Colorado is successfully treating the wastewater a nursing home generates.

Constructed in 1988, the Horizon Nursing Home treatment wetland is the oldest recorded treatment wetland in Colorado. The facility consists of two aerated lagoons, a settling pond, and a surface flow wetland followed by a meadow area. Prior to discharge, the effluent is disinfected with chlorine as needed.

The nursing home houses 220 clients, producing an average wastewater flow of 10,000 gallons per day. The grease from the kitchen, which uses no grease trap, plus pharmaceuticals and cleaning products resulted in BOD and TSS values above permit limitations. The wetland has been very successful in bringing these values down. The average monthly TSS in the influent has been 195 mg/L, with an effluent of 8 mg/L. BOD values are averaging 213 mg/L dropping to 12 mg/L as effluent after treatment. The system has been operating in compliance of its discharge permit since it was brought on line.

Handling high strength flows

Commercial onsite systems have normally been designed in the same manner as household systems. However, this design principle often leads to system failure. Designers must consider flow variations, organic loading, and other factors. They must consider the type of organic content (soluble, settleable or colloidal), the site characteristics, the final steps in the onsite system, how the effluent is introduced to the environment, and how much preprocessing is required to effectively handle the high organic strength.

Onsite systems that have been used to treat commercial strength wastewater include grease traps and grease interceptors, septic tanks, aerobic treatment units, sand filters, constructed wetlands, drip irrigation, and mound systems.

If the majority of the organic waste emerges from a highly concentrated, low-volume source in the facility, a holding tank/hauling solution may be the most cost-effective choice. The fraction that contains the majority of the excess contaminants might be readily removable by a specific process. For instance, soluble and biodegradable components can be effectively treated in an aerobic unit.

Handling FOG

Regulatory agencies use both BOD and TSS in wastewater as indicators to assess treatment and potential impact on the environment. A grease trap or collector, which separates by gravity, is the most common way to remove oil and grease. But emulsified fats can be more difficult to remove from the waste stream. If the liquid is above room temperature, solid fats may liquefy and pass through to the onsite system.

With the additive, the biomat absorbs the BOD, but it may increase the hydraulic resistance, possibly leading to malfunction. Therefore, it is strongly recommended that no additives be used in the septic system.

There are several consumer products available that claim to reduce the effects of FOG in a septic tank system. These often are a combination of bacterial cultures and enzymes. Some appear to be effective in metabolizing the FOG into more soluble or dispersible compounds that, nonetheless, still have a relatively high BOD. But, by making the FOG soluble, they increase the TSS in the septic tank effluent, which increases the potential carryover into the drainfield. This additional BOD passing to the drainfield is a concern. Without the additive, the FOG remains in the septic tank, accumulating until the tank is

pumped out. With the additive, the biomat absorbs the BOD, but it may increase the hydraulic resistance, possibly leading to malfunction. Therefore, it is strongly recommended that no additives be used in the septic system.

Grease traps are an effective means of removing grease if the trap is routinely pumped. As water and grease enter the grease trap, the water velocity is reduced. This allows the grease, which is lighter than water, to float to the surface. The plumbing configuration allows the water to enter and exit below the grease level, thus providing a space above the water for the grease to collect.

Wastewater engineers used to recommend passing everything from the kitchen into a common, large, grease trap (usually a modified septic tank) before this effluent mixes with toilet waste and wastewater from sinks and bathtubs in the larger main septic tank. This was usually satisfactory in the days of hand-washing utensils, providing the frequency of pumping was adequate.

Modern automatic restaurant dishwashers have changed the situation. The higher temperatures and harsher detergents and other chemicals tend to emulsify the FOG. The resulting emulsion does not separate out in this warmer and more turbulent environment, but passes through to the septic tank and on to the drainfield as an emulsion. This can adversely impact the biomat.

Grease traps are sized based upon wastewater flow and calculated from the number and kind of sinks and fixtures discharging to the trap. A grease trap needs to be rated on its grease retention capacity, which means the amount (in pounds) that the trap can hold before it is no longer 90 percent efficient. Grease traps must be cleaned regularly

Three strategies may help control the problems associated with FOG. The first is to institute new maintenance practices, such as making sure all food scraps are removed from dishes and utensils before washing, or using shortening instead of liquid cooking oil. The second is to redirect the dishwashing machine discharge directly to the septic tank. (As mentioned earlier, the dishwashing discharge is at a much higher temperature and may emulsify the FOG.) This will help avoid disruption of the separation process in the external grease trap, which still takes the load from the prewash sink. The purpose is to reduce the additional organic loading on the system and reduce the potential for carryover to the drainfield. The third is to consider using an active oil and grease separator on the discharge from the prewash sink. There are several commercial applications on the market.

Handling high BOD/TSS

Aerobic units, or small extended aeration package plants, use a suspended growth wastewater treatment process, which may remove substantial amounts of BOD and suspended solids. When wastewater temperature rises above room temperature, the fats remain in a liquid form and pass through into the treatment system. But the long detention times of extended aeration treatment work to lower the temperature of the water so that separation can occur (cooled, hardened fats separate out from the main flow). There are some proprietary aerobic units that are specifically designed to handle high organic loads.

Handling high chemical loads

Conventional onsite treatment systems are unable to handle high levels of chemicals. It is recommended that wastewater generated from processes that involve high levels of chemicals be removed from the general waste stream and treated separately.

REFERENCES

Bowers, Fred. *Characterizing Beauty Salon Wastewater for the Purpose of Regulating Onsite Disposal Systems*, NJ Department of Environmental Protection. Division of Water Quality. 2002. *www.state.nj.us/dep/dwq/pdf/salonreport.pdf.*

Barnstable County (Massachusetts) Health Department. 2002. *www.barnstablecountyhealth.org/AlternativeWebpage/Grease/Grease.htm.*

The following articles can be ordered from the National Small Flows Clearinghouse (NSFC) at (800) 624-8301, or email nsfc_orders@mail.nesc.wvu.edu. A shipping and handling charge will apply.

• Stuth , William L. *Treatment and odor control of high strength commercial wastewater*, #L005233. $0.15 per page.

• Jacobson, N. *Treatment of Restaurant Wastewater Using a Recirculating Sand Filter*. #L005840. $0.15 per page.

• *Small Flows Quarterly*, Spring 02, Q & A: Grease Traps. #SFQUNL10, $1.00. Also can be found on line at: *www.nesc.wvu.edu/nsfc/nsfc_archive.htm.*

• NSFC. 1997. *Sand Filters Provide Quality, Low-Maintenance Treatment. Pipeline*, vol. 8, no.3. NSFC #SFPLN10, cost is $.40. Also can be found on line at: *www.nesc.wvu.edu/nsfc/nsfc_archive.htm.*

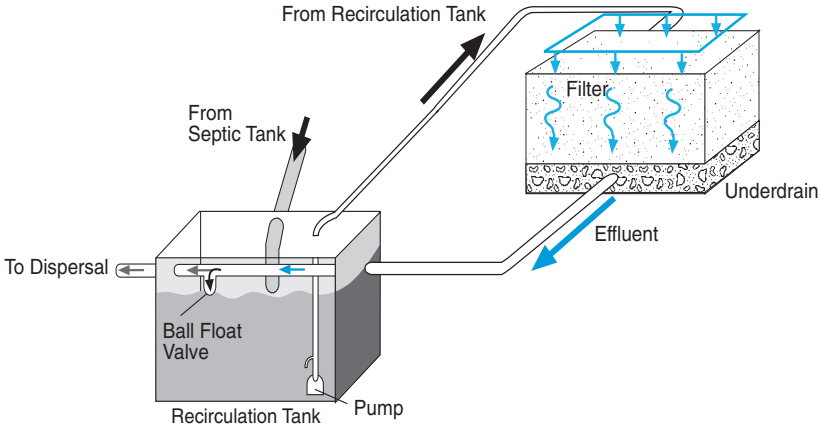
Recirculating Sand Filter Handles Restaurant's High Organic Loading

It only took four years for the original subsurface sewage disposal system that served a restaurant in Chester, Connecticut to fail. Even though additional attempts were made to improve the original septic tank and leaching galleries, partially treated septic tank effluent continued ponding on the surface of the parking lot. Needless to say, the restaurant's management was desperate to fix this extremely unappetizing problem.

After several frustrating years, a consulting engineering firm designed a new wastewater pre-treatment plant and disposal facilities using a recirculating sand filter. The new facilities have been successfully treating the restaurant's high strength wastewater since 1985.

Beyond the high organic content of the effluent, with average readings of biochemical oxygen demand (BOD) of 685 and total suspended solids (TSS) of 398, the site suffered from seasonally high groundwater conditions and soils of low permeability. The new system employs two grease traps, and a septic tank, before the recirculating sand filter.

The technology of intermittently applying wastewater to the surface of the filter has been used successfully to purify the effluent for many years. A sand filter is capable of producing a high quality product with under drains to collect and discharge the effluent from the bed. The biochemical action of microorganisms living within the filter bed purifies the wastewater. Originally the wastewater passed through the sand filter only one time, but by recirculating the effluent back through for several passes, quality was improved and odor problems reduced.



In a recirculating sand filter, wastewater flows by gravity from a septic tank to a recirculation tank equipped with a pump, timing controls, and float valves. The wastewater is pumped to the filter in timed doses.

Sand filters do not need much maintenance, mostly keeping the pumps running, checking the controls, and occasionally raking or replacing the sand. If properly maintained, they tolerate infrequent peak hydraulic and organic loadings well.

Design parameters

To provide optimum treatment, the designers had to consider what flow rates and pollutant concentrations to expect. Calculations involving the allowance of flow per meal, the number of meals served per day, and the number of seats available produced estimated peak flow rates upon which the treatment system was designed.

Possible TSS and BOD values were derived from EPA figures. Table 1 compares typical values of household wastewater to restaurant wastewater.

The system was set up in this order: main grease trap, main septic tank, secondary grease trap, recirculation tank, and sand filter. The filter media was sized to between 0.9 and 2.0 millimeters. The sand depth was 30 inches. Perforated underdrain pipe collected the filtrate. The dosing schedule was five minutes in every 30 minutes to 15 minutes in every two hours. Recirculation ratio was set at 4:1, which means that each gallon of wastewater is dispersed four times over the filter. Final disposal is to a new subsurface sewage disposal system.

After a few minor adjustments, this system has reduced BOD by 99 percent and TSS by 96 percent.

After enduring the soggy, smelly parking area for so many years, the restaurant owners are thrilled by the success of this new facility. With minor maintenance, the new treatment plant has been more than satisfactory. Recirculating sand filters, if designed properly, can provide excellent treatment of the high strength wastewater typically discharged from restaurants.

Table 1

Comparison of some typical restaurant effluent components to household wastewater

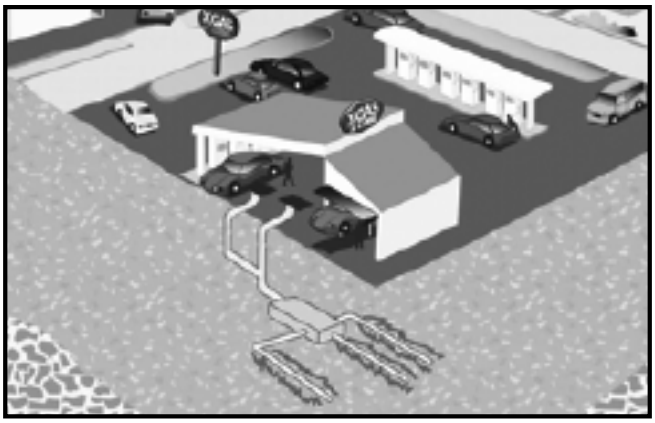
	Restaurant	Household
BOD range (mg/L)	280—960	100—450
TSS, mg/L	202—1985	100—375

Class V Injection Wells and the Underground Injection Control Program

In an attempt to more carefully protect our groundwater from endangering injection practices, the EPA was directed by the Safe Drinking Water Act to establish minimum federal requirements for state and tribal Underground Injection Control (UIC) Programs. This includes the oversight of construction, operation and closure of injection wells.

For our purposes here, an injection well can be considered any underground storage of fluids as long as the storage unit's depth is greater than it is wide. Underground injection wells are classified according to their depth and injection practice. Class I wells are used to inject fluids into the lower most formation. Class V wells are those that are used to inject non-hazardous fluids into shallow formations. These shallow formations may also be used as a source of drinking water for residents. The UIC Program manages these wells to protect underground sources of drinking water from unsafe injection practices.

A common septic tank and drainfield fall under this classification if they have the capacity to serve 20 or more persons/day or if the system accepts other than solely sanitary waste. The purpose of this requirement is to ensure that industrial or commercial wastewater is disposed of properly. The standard septic tank/drainfield system is not designed to treat industrial or chemical waste thereby allowing chemicals to pass through the system unchanged and to enter the groundwater, posing a serious contamination threat.



Motor Vehicle Waste Disposal Wells: Shallow waste disposal systems that receive or have received fluids from vehicle repair or maintenance activities, such as auto body or automotive repair, car dealerships, or other vehicular repair work, are required to meet additional protective requirements.

The UIC program is concerned about businesses that inadvertently use their septic system as a Class V well. In other words, a business that is producing wastewater from an industrial or commercial process and sending it directly to a septic system is in violation of UIC Program requirements. Businesses that could be inadvertently operating a Class V well include food processing, photo processing, electroplating, and dry cleaning businesses. Very possibly the sort of establishment discussed in this issue of *Pipeline* would be considered a Class V well.

Some examples of Class V wells include:

- A gas station with a service floor drain that leads to a septic system
- An apartment building with a septic system for sanitary waste disposal
- A rest stop that uses a cesspool
- A municipality where stormwater flows into drywells
- A strip mall, with small businesses such as a photo processor and a dry cleaner, that discharge sanitary wastes mixed with process chemicals into a septic system
- An office building that injects water passed through a heat exchanger to cool the building
- A carwash where the wastewater enters a floor drain that leads to a drywell or septic system

To prevent contamination of underground sources of drinking water contact a local UIC official if you suspect a septic system is currently receiving industrial or commercial waste. For more information about this program, you can visit the UIC website at *www.epa.gov/safewater/uic/*. A phone number for general information is the Safe Water Drinking Act Hotline: (800) 426-4791.

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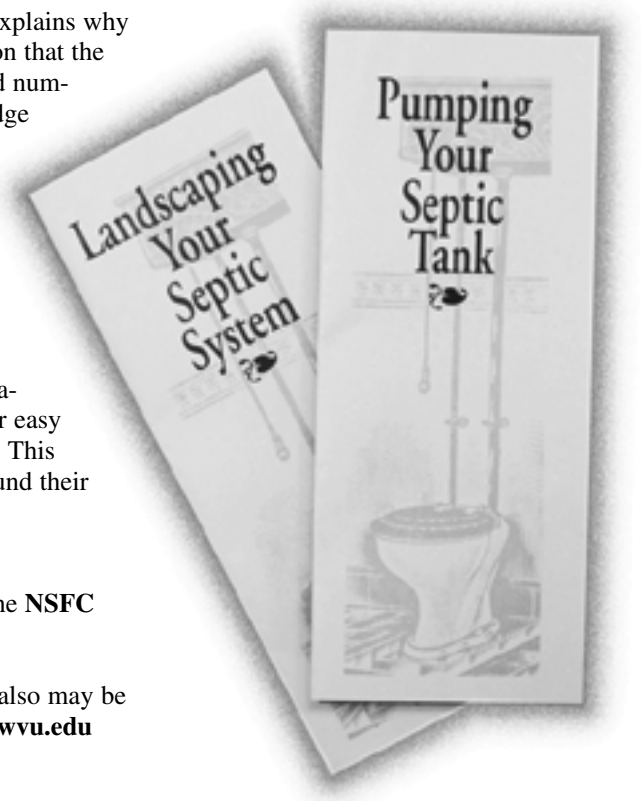
Readers are encouraged to reprint *Pipeline* articles in local newspapers or include them in flyers, newsletters, or educational presentations. Please include the name and phone of the National Small Flows Clearinghouse (NSFC) on the reprinted information and send us a copy for our files. If you have any questions about reprinting articles or about any of the topics discussed in this newsletter, please contact the NSFC at (800) 624-8301.

Two New Products Now Available From NSFC

"Pumping Your Septic Tank," (Item #WWBRPE71), this brochure explains why it is necessary to regularly pump your septic tank. It lists the information that the pumper should include on a receipt, such as tank size, construction, and number of compartments; effluent levels, tank condition, and scum and sludge levels; baffle condition; outlet baffle effluent filter; pump chamber and pump; drainfield condition; sewage disposal location; and any abnormal findings. The brochure includes a brief description about watertight septic tanks. Homeowners, public health officials, and local officials will find this information useful. The cost of this brochure is $.40.

"Landscaping Your Septic System," (Item#WWBRPE72), describes different ways to plan a landscape design for optimum septic tank operation. Information is provided about marking your septic components for easy access, and choosing the right plants. A suggested plant list is included. This brochure will be useful for homeowners as they landscape the area around their septic system.
The cost of this brochure is $.40.



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