K-STATE
Kansas State University

FARM•A•SYST
Farmstead Assessment System

Fact Sheet 6

Reducing the Risk of Groundwater Contamination by
Improving Household Wastewater Treatment

The most satisfactory treatment and disposal of household wastewater is through a municipal sewage system. Where municipal systems are available, onsite systems should not be used. In rural areas, however, most homeowners must resort to some type of onsite system for treatment and disposal of household wastewater. A properly installed and maintained system for treating and disposing of household wastewater will minimize the impact of that system on groundwater and surface water.

In Kansas, onsite household wastewater systems are regulated by the county through the local health department, or planning and zoning department. The county adopts a sanitary code, issues permits and inspects construction. In counties which have not yet adopted a sanitary code, the guidelines set by the Kansas Department of Health and Environment (KDHE) should be followed (KDHE bulletin 4-2, *A Manual of Recommended Standards for Locating, Constructing and Operating Septic Tank Systems for Rural Homes*, or its replacement). Check with your local health department or KDHE. The codes established are a minimum, but consider whether the minimum requirement is sufficient for your site.

Two types of private onsite treatment systems are in general use in Kansas—septic tank-soil absorption systems and wastewater stabilization ponds (lagoons). The septic system is the most common form of onsite wastewater treatment, and where soil conditions are suitable, it is the most desirable onsite system to use. Since the septic tank and laterals are completely covered with soil, the system is not visible and odor is nonexistent as long as wastewater does not surface. In areas of poor soil drainage, however, it can be difficult and expensive to build soil absorption fields which will effectively treat and absorb wastewater. Lagoons should be considered for household wastewater treatment in these areas. There are other types of systems, but excessive cost, state regulations or county codes often restrict their use.

1. Quantity and collection of wastewater

Strategy: Minimize the volume of household wastewater. Collect all wastewater that needs treatment, but exclude from the system all water that doesn't need treatment.

Reducing the volume of wastewater entering the treatment system is important because less flow (volume) means better treatment, longer system life and less chance of overflow. Excess flow is a principal reason for system failure (wastewater surfacing or backing up in house). All wastewater needing treatment should be collected, however, to avoid contamination of groundwater or surface water.

For glossary, see page 2 of Worksheet 6.

Water use

The quantity of wastewater is dependent upon the number of people using the dwelling, how water is used, and maintenance of the water distribution system. Average water use in rural households is 40 to 50 gallons per person per day. With low-use fixtures and individual awareness and concern, a reduction to fewer than 25 gallons per person per day is possible. However, even conservative use by several people may exceed the capacity of an improperly designed wastewater treatment system.

Less flow entering the system improves treatment by increasing the time waste spends in the system, thus providing more time for solids separation, settling and decomposition. Less flow also means improved aeration and increased soil contact, providing better treatment in a soil absorption field.

Consider the following ways to minimize water use:

- Eliminate nonfunctional uses, such as flushing toilets to dispose of tissues or other wastes that should be handled as solid waste. Turn off water between uses, fix plumbing fixture leaks, and try to eliminate sources of clear water and infiltration into the system. For example, divert roof drains and surface runoff away from the soil absorption field.

- Consider which actions use the most water. Toilet flushing usually ranks highest. Low-flow models could decrease water use by more than half. In the United States, 35 to 40 percent of the population are affected by plumbing codes that require low-volume toilets on all new construction. Composting toilets allow even greater reductions, but they can present other waste disposal challenges.

- Bathing and clothes washing are usually next in order of water use. For bathing, consider such reduction options as low-flow or controlled-flow showerheads which give good cleansing with less water, taking shorter showers, or taking “wet-down—soap-up-without-water—then-rinse” showers.

- For clothes washing, use a suds saver and run full loads. Front-loading washers use much less water. When running small loads, be sure to use the reduced water level setting.

- Modern efficient plumbing fixtures, including 1.5- to 2.5-gallon toilets, 1.5- to 2.0-gallons per minute (gpm) showerheads, faucets of 1.5 gpm or less, and front-loading washing machines of 20 to 30 gallons per 10- to 12-pound dry load, offer the potential of substantial reduction in residential water use. These reductions have commonly amounted to between 30 and 70 percent of total in-house water use (see Table 1).

- In hard water areas, the water softener may be a significant user of water. Proper adjustment and timing of the softener’s regeneration mechanism and using softened water for only essential uses can reduce excessive water use.

- **Keep in mind that your awareness of your family’s water use and how each of you can reduce it is as important as using water conservation devices.**

Collection of wastewater

Leaky piping or treatment tanks (“leakage losses”) can allow wastewater to enter the groundwater supply without adequate treatment, causing contamination. Don’t allow water that doesn’t need treatment (foundation drains, infiltration of rain water, roof drainage) to add to your waste volume. Divert clear water, which doesn’t require treatment, away from the house, well and wastewater treatment system.

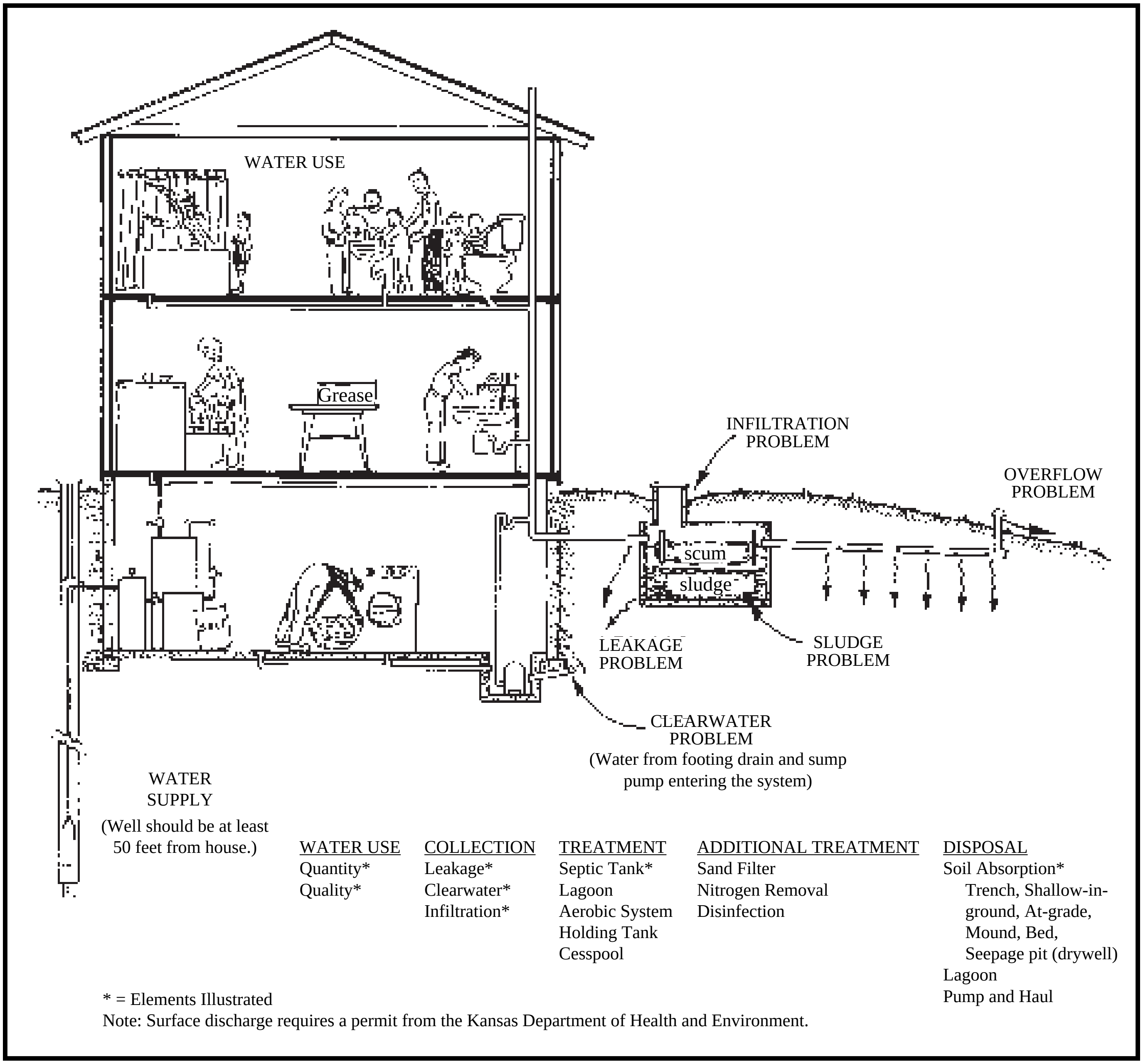

Figure 1: Typical household wastewater collection and treatment system with problems. *Adapted from an illustration by Andy Hopfensperger, University of Wisconsin-Madison Department of Agricultural Engineering.*

Figure 1 shows a typical household wastewater system. Systems for many farmsteads may have similar components for generation, collection, treatment and disposal (water-using appliances, septic tank, soil absorption treatment and disposal). The chart at the bottom of the diagram follows the flow of wastewater through the treatment system. You may wish to circle the parts found in your system. The “leakage,” “overflow,” “infiltration” and “clearwater” components represent possible problems with the system. Unfortunately, these problems are often difficult to recognize. Overflow from systems may be noticed as wet spots, odors and changes in vegetation. Water entry (infiltration and clearwater) will be more difficult to detect, involving tracing where floor drains, roof drains, foundation drains and sumps are directing waters that do not need treatment into the treatment system. Leakage from the collection and treatment system—as well as infiltration of water into the system through unsealed joints, access ports and cracks—can be very difficult to assess.

Conventional fixture	Gal. used	Water-saving fixture/device*	Gal. used
Toilet	4–6/flush	Low-volume toilet	1.5–2.5/flush
Shower head	4–6/min.	Low-flow shower head	1.5–2.0/min.
Faucets: Bathroom and kitchen	4-6/min.	Faucet-flow-control aerators: Bathroom Kitchen	0.5/min. 1.5/min.
Top-loading clothes washer	40-55/load	Front-loading clothes washer	22-33/load

*Installation of all these water-saving devices could reduce water use by about 35 percent.

Table 1: Water use by conventional and water-saving fixtures and devices. *Adapted from Penn State Cooperative Extension Circular 302.*

2. Quality of wastewater

Strategy: Minimize the amount of contaminants in the wastewater.

The quality of water refers to what is in the water, not to the water itself. Even wastewater is more than 99 percent water. Wastewater usually contains relatively small amounts of contaminants—but they make a big difference in the usefulness of the water.

Contaminants found in wastewater include:

- **Bacteria and viruses**, some of which can cause disease in humans. These microorganisms are usually removed by settling, or through filtration in the soil. Many will die from aging or the adverse conditions in the system.

- **Suspended solids**, particles which are more dense (sludge) or less dense (scum) than water. Most can be separated from liquid waste by allowing enough time in a relatively calm septic tank or lagoon. Grease and fats are a part of the suspended solids. Soil absorption fields can be quickly clogged by wastewater high in suspended solids.

- **Organic chemicals** from cleaning solvents, pesticides and fuels usually are not degraded or removed through treatment and can pass along with the wastewater into the water supply.

- **Nutrients**. Nitrogen from human wastes and phosphorus from detergents and some chemical water conditioners are the most notable. Nitrate-nitrogen is a common groundwater contaminant and phosphorus often overfertilizes surface water.

Oxygen demand is used as an indicator of wastewater strength. The microorganisms that decompose organic contaminants in wastewater use oxygen. The amount of oxygen required to break down wastewater is measured as biochemical and chemical oxygen demand. Organic wastes or contaminants such as blood, milk residues and garbage grindings have high oxygen demand. Aerobic processes—in the presence of oxygen—produce stable, low-odor effluent when given enough time. Wastewater with excess oxygen demand can cause problems for soil absorption fields, groundwater, streams and lakes by reducing levels of oxygen.

Improving wastewater quality

Consider the following ways to improve wastewater quality:

- Minimize use of the garbage disposal unit. Garbage disposal use contributes a large load of suspended solids and organic matter to wastewater, as well as using additional water.

- Do not put items that may clog your disposal system down drains—such as fats, grease, coffee grounds, paper towels, sanitary napkins, tampons or disposable diapers.

- Toxic substances—such as solvents, degreasers, acids, oils, paints, disinfectants and pesticides—should not be put down drains since they may end up in groundwater. This does not include using bleach to disinfect laundry or to wash clothing worn for pesticide applications.

- Do not use chemicals to clean or "sweeten" a septic system. They may interfere with the biological action in the tank, cause the drainfield to be clogged by sludge and scum carried into the field or add toxic chemicals to groundwater.

3. Treatment and disposal of wastewater

Strategy: Make wastewater more suitable for further treatment, disperse wastes, take advantage of the additional treatment afforded by contact with soils, and minimize the opportunity for wastewater to contaminate water supplies.

In areas where a municipal sewage system is not available, an onsite system for treatment and disposal of household wastewater is needed. The systems available for use in Kansas include—septic tank-soil absorption systems, wastewater lagoons, aerobic biological systems and holding tanks. Direct discharge of household wastewater to the soil surface is against Kansas regulations.

A sketch of the existing wastewater disposal system should always be retained by the owner. Any underground components should be shown on the sketch with reference points and distances to at least two permanent objects at cross angles to each other. This allows location of buried components with minimal problems.

Septic tank-soil absorption system—The most common system

In the septic tank-soil absorption system, wastewater flows from the household sewer into an underground septic tank. In the septic tank the waste components separate—the heavier solids (sludge) settling to the bottom, and the grease and fatty solids (scum) floating to the top (Figure 2). Up to 50 percent of the solids retained in the tank are decomposed by bacteria in the anaerobic digestion process. The partially treated water moves on to additional treatment and disposal in the soil absorption system.

Design and construction of septic tanks influence their water tightness and effectiveness of retaining sludge and scum. Among the most important components of a septic tank are the baffles. Baffles are placed in the tank to provide maximum retention of solids, prevent inlet and outlet plugging, and prevent short circuiting of wastewater through the tank.

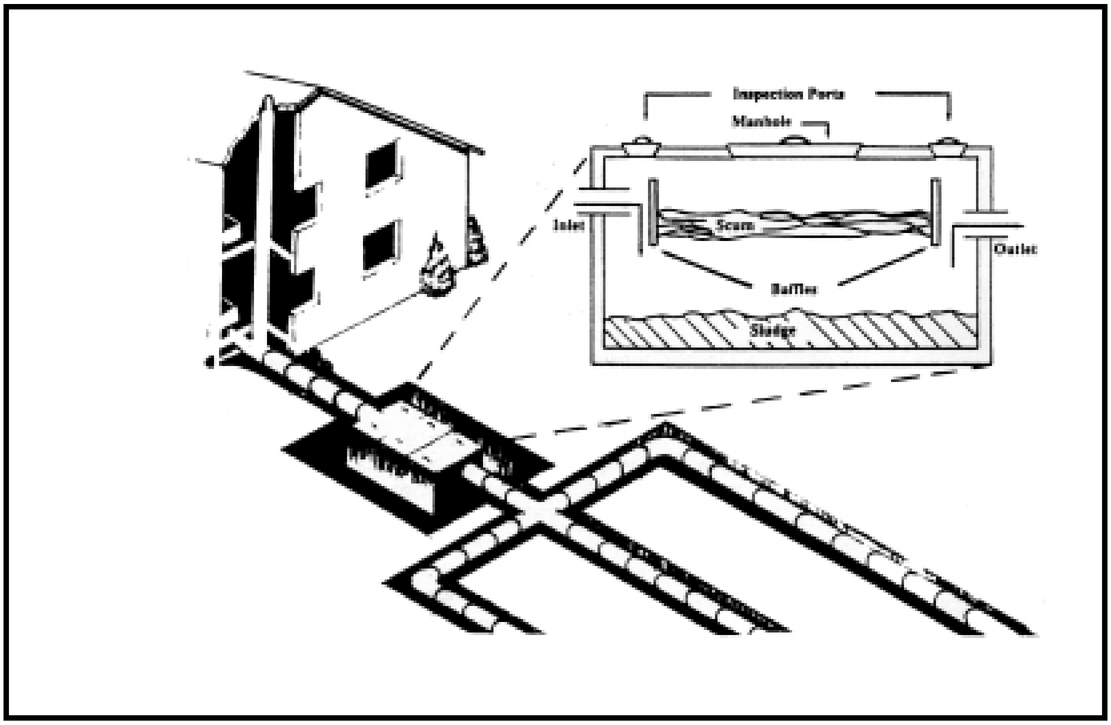

Figure 2: Septic tank-soil absorption system with cross section of septic tank. *Adapted from Septic Tank-Soil Absorption System, MF-944 Revised.*

Multiple chambers or tanks in series improve sludge and scum removal, and effluent quality. Some Kansas counties require multiple chambers or tanks, especially for larger homes. Gas deflectors and effluent filters also help minimize solids carryover.

Septic tanks remove solids by holding wastewater in the tank, which allows the solids to settle and the scum to rise to the top. Tanks should be sized to hold at least 24 hours of wastewater flow, while still allowing for sludge and scum retention. Properly selected tanks have enough space for sludge to accumulate for an average of three to five years without needing solids removal.

Subsurface treatment and disposal using soil absorption—such as trenches, beds, mounds or seepage pits (drywells)—is the common practice for household wastewater after treatment in a septic tank (Figure 2). The liquid portion (effluent) flows through the septic tank outlet to the soil absorption field, which is usually a series of parallel trenches (laterals), each containing a distribution pipe or tile embedded in drainfield gravel or rock. The effluent flows out through holes in the pipe or seams between tile sections, then down through the drainfield gravel or rock and into the soil. The soil filters out remaining solids and pathogens (disease-producing microorganisms), and dissolved substances degrade, as the wastewater slowly percolates through the soil to groundwater.

Absorption fields must be maintained properly to operate at peak efficiency and minimize potential health hazards:

- Do not drive over an absorption field. Compaction from vehicles or equipment will cause settling, shifting, or breakage of lateral lines. This can lead to wastewater surfacing and the creation of a health hazard.

- Never plant a vegetable garden over an absorption field. Microbes from the effluent may travel through the soil and contaminate the crop, especially root crops.

- Do not allow trees to grow over the system. Roots from the trees can cause damage to lines, as well as plug them.

- Keep a grass cover over the absorption field. This will help use some of the nutrients available and aid in evapotranspiration.

There are sites where soil absorption systems are not suitable because of slow soil permeability, shallow depth to restrictive soil layer or bedrock, shallow water table depth, or other factors. Deep, well-drained, well-developed, medium-textured soils (such as silt loam and loam) are most desirable for soil absorption systems. Coarse, sandy soils allow effluent to flow too quickly downward to groundwater, not providing adequate time for filtering solids and pathogens from the liquid.

At least four feet of suitable aerated soil beneath the bottom of a soil absorption system is needed to renovate wastewater before it reaches a limiting layer. A limiting layer may be bedrock, impervious soil (claypan, hardpan or fragipan), or seasonal high water table. Unsaturated soils allow movement of air, which helps keep the soil profile aerobic.

Disposal sites that are more distant and downslope from your well increase the isolation of your water supply from contaminated wastewater. A soil absorption system is required to be at least 50 feet from any water supply and 25 feet from the house and property lines. However, separation distances of greater than 200 feet to water supplies are highly recommended, and will provide greater protection to your drinking water supply.

Septic tank maintenance

Pumping the tank before it is more than one-third filled with scum and sludge improves functioning of the system. When the tank is filled beyond this point, sewage has less time to settle and solids can pass through to the absorption field causing premature failure. The tank is pumped through the access manhole. When the tank is pumped, have the baffles checked, check for tank leaks and make any needed repairs. An experience pumper is best qualified to perform septic tank maintenance.

The frequency of pumping depends on the capacity of the storage tank, the flow of wastewater (related to number of people in the household and water-use habits), and the volume of solids in the wastewater (more solids if garbage disposal is used).

The importance of safety around septic tanks should not be overlooked. The space within a septic tank contains gases which are toxic when inhaled. Because of this, never go into or lean into a septic tank. These gases are also explosive, so flames or electrical devices should not be used near tank openings. Fatalities have occurred during septic tank maintenance and repair.

Wastewater lagoons

In areas where soil has severe limitations for septic systems, lagoons are often the chosen method of household wastewater treatment (Figure 3). Construction cost for a lagoon is low, and minimal maintenance is needed to ensure proper operation. Odors from a properly designed, installed and maintained lagoon will be only slight.

A lagoon is simply a pond of uniform depth. Size is determined by the amount of sewage entering the lagoon, but water surface area should not be less than 900 square feet, and water depth at least three feet but not greater than five feet. Sewage is piped to the lagoon and released at the bottom near the lagoon center. Wastes in the sewage are broken down by microorganisms.

Bacteria and other organisms consume oxygen and give off carbon dioxide as they stabilize sewage. Algae, which give the lagoon its green color, produce part of the oxygen and consume the carbon dioxide. A lagoon should not be shaded since sunlight is essential for algae to produce oxygen. Another source of oxygen is from breezes blowing across the lagoon surface.

In Kansas, lagoons must be non-discharging. That is, during normal operation the lagoon should not overflow. Water must be lost through a combination of seepage and evaporation. The amount of water loss resulting from these two routes depends on the time of year and conditions at the site.

It is important to always maintain minimum water surface area and depth. Kansas has excessive evaporation nearly everywhere, every year. Additional water is often needed to maintain sufficient surface area for decomposition of wastes, and adequate depth to help prevent weed growth. Placing a post marked with water depths in the middle of the lagoon is recommended to help monitor water depth.

A lagoon should be located in a non-conspicuous area 100 feet or more from the house and property lines, and at least 200 feet from any water supply well or surface water body. A lagoon should be downslope from the house to allow gravity flow of sewage, with a sewer line slope of two percent. If the lagoon is placed above the house, sewage must be pumped.

For information on design and construction of a lagoon that suits your specific site conditions and situation, contact your local health department.

Lagoon maintenance

Properly sized and maintained lagoons usually have little or no odor. Odors may develop, however, during warmer periods following cloudy or cold weather or due to overloading. In a properly constructed lagoon, solids are distributed over such a large area that it will probably take many years before sludge removal is required.

Odors may be controlled by broadcasting sodium nitrate or ammonium nitrate fertilizer on the lagoon at a rate of two pounds per day until the lagoon turns green and the odor goes away.

Vegetation on the lagoon banks should be mowed often during the growing season to prevent shading of the lagoon. Any trees or brush shading the lagoon should also be removed. Mowing should extend to the water's edge to prevent tall vegetation from drooping into the lagoon where it provides mosquito breeding areas.

Fences around the lagoon area should be kept in good repair and any damage to the embankments should be repaired immediately.

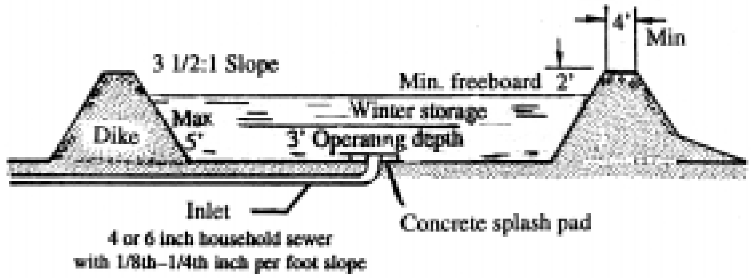

Figure 3: Cross section of wastewater lagoon. A fence at least four feet in height should surround the lagoon. The inlet pipe should have capped cleanouts to allow unplugging the line if needed. *Adapted from an illustration in Onsite Wastewater Treatment and Disposal Systems Design Manual.*

Other treatment systems

Aerobic (oxygen-using) biological systems (packaged systems) provide more extensive treatment of wastewater than the typical anaerobic (no oxygen) septic units by improving solids separation, releasing volatile chemicals and reducing sludge volume. These systems are, however, more expensive to operate and maintain and are more subject to problems caused by changes in wastewater quality or environmental conditions. KDHE does not permit surface discharge from aerobic systems. Thus, soil absorption or a non-discharging lagoon must follow the system for use in Kansas (see the above discussions of these disposal methods).

Holding tanks collect and hold the entire wastewater flow. Disposal should be done by a licensed contractor who spreads the waste on the land at an approved site or hauls it to a municipal waste treatment facility (see the section on septage disposal). Tank size should allow for ample capacity to accommodate pumping and disposal at convenient and appropriate times, especially for land spreading. When the tank is pumped, it should also be checked for leaks. Use of holding tanks is not recommended as a standard practice for a year-round household.

4. Additional treatment

Strategy: Reduce concentration and amount of contaminants in the wastewater prior to disposal.

Aerobic systems, described in the previous section, may be used for additional treatment of septic tank effluent, yielding a better quality effluent suitable for more disposal options.

Sand filters improve the quality of wastewater following septic tank pretreatment. Effective treatment involves aerobic biochemical activity as well as physical filtration. Filters consist of two to five feet of sand (or other media) in a bed equipped with a distribution and collection system. Wastewater is applied by dosing, and it may be recirculated to improve treatment. Wastewater treated in such systems is generally lower in bacteria, nitrogen, phosphorus, oxygen demand, suspended solids and organic matter. The amount of reduction depends on the design of the system. Maintenance includes resting, occasional raking, removal of clogged and crusted surface media, filter media replacement and attention to dosing equipment.

Nitrogen removal can be achieved through denitrification (conversion of nitrate to nitrogen gas) or ion exchange. These processes are not used extensively at this time, as they are quite expensive to install, operate and maintain.

Disinfection systems kill disease-causing microorganisms in wastewater and are used where discharge to surface water is allowed. Discharge to surface water in Kansas is not allowed without a permit from KDHE. Chlorine, iodine, ozone and ultraviolet light systems are available for treatment of good quality effluents, such as those from properly functioning aerobic units and sand filters.

Disinfection of holding tank waste and septage prior to land spreading has been studied, but it is not in common use. Treatment with lime is feasible, and provides some disinfection.

5. Septage disposal

Regular pumping of septic tanks is essential to ensure proper functioning of a septic system (see section on septic tank maintenance). Wastes pumped from the tank are known as septage. Septage should be removed and disposed of only by septage haulers approved by your county. Homeowners are responsible for the proper disposal of septage and local ordinances should be followed in all instances.

The most desirable method of septage disposal is at a municipal wastewater treatment plant. Land application of septage is also an acceptable method of disposal. Land application of septage should be done in such a manner as to prevent runoff to surface water, nuisances and human contact. Incorporation of septage into surface soils is necessary to reduce the chance of runoff. Site characteristics, such as soils, land use and depth to groundwater, should be considered when selecting a site for septage applications. Land application of septage should only be done on sites approved by your county.

Septage should not be applied to frozen, snow covered or saturated soil. Planning is required to ensure this condition is met. Application rates should be less than 30,000 gallons of septage per acre per year. There should be at least 200 feet of separation between application sites and any water well or surface water body.

All septage should be tested for levels of nutrients and contaminants prior to land application. Septage should not be applied to recreational areas or to land used for production of edible plants. There should be a signed agreement between the land-owner and the septage hauler establishing these requirements befor any land application occurs.

6. Assistance with failing systems or new designs

If you suspect your household wastewater treatment system is backing up, your distribution system is clogged, or your lagoon is leaking, first contact your plumber or treatment system installer who may have suggestions for extending the life of your system. Your county health department is the agency to see for permits to repair or replace your wastewater treatment system.

If you have a septic tank-soil absorption system, do not wait for the system to fail before pumping the septic tank. Once a system fails, it is too late to pump the tank and salvage the absorption field. Also avoid using septic tank cleaners that contain degreasing solvents like TCE. They can contaminate groundwater. If wastewater is surfacing near or above your soil absorption field, don’t cover it with more soil. This does not fix the system, and it will soon surface again.

For lagoons which have developed leaks, the bottom and sides can be sealed with bentonite clay or a membrane lining of plastic or rubber. Recommendations on using these materials can be obtained from your county Extension or Soil Conservation Service office.

If your wastewater treatment system is leaking or showing signs of failure, seek help to correct the problem. Do not just pipe the sewage to the road ditch, storm sewer, stream or farm drain tile—this pollutes the water, creates a health hazard and is illegal. Also avoid running the sewage into a sinkhole or drainage well—this pollutes groundwater.

A properly designed, constructed and maintained system can effectively treat wastewater for many years. For more information on septic systems and wastewater lagoons—or for advice on alternative wastewater systems—contact your local health department or county Extension office.

CONTACTS AND REFERENCES

Who to call about...

Household wastewater treatment and regulations

Your local health department or county Extension office; the Kansas Department of Health and Environment (KDHE) or the KDHE district office for your area:

Southwest District (Dodge City): (316) 225-0596
South Central District (Wichita): (316) 838-1071
Southeast District (Chanute): (316) 431-2390
Northeast District (Lawrence): (913) 842-4600
North Central District (Salina): (913) 827-9639
Northwest District (Hays): (913) 625-5664

What to read about...

Publications are available from sources listed at the end of the reference section. (Refer to number in parentheses after each publication.)

Groundwater contamination, protection and testing

Groundwater and Well Contamination. MF-932. (1)
Managing the Farmstead to Minimize Groundwater and Well Contamination. MF-948. (1)
Nitrates and Groundwater. MF-857. (1)
Safe Domestic Wells. MF-970. (1)
Ensuring Safe Drinking Water. MF-952. (1)
Suggested Water Tests for Private Systems. MF-871. (1)
Taking a Water Sample. MF-963. (1)
Testing to Help Ensure Safety of Drinking Water. MF-951. (1)
Commercial Laboratories Certified for Water Quality Tests. MF-872. (1)
Understanding Your Water Test Report. MF-912. (1)

Design, installation, use and maintenance of onsite sewage systems

Septic Tank-Soil Absorption Systems. MF-944. (1)
Soil Evaluation for Home Septic Systems. MF-945. (1)
Why Do Septic Systems Fail? MF-946. (1)
Septic Tank Maintenance. MF-947. (1)
Wastewater Lagoons for Private Homes. MF-1044. (1)
A Manual of Recommended Standards for Locating, Constructing and Operating Septic Tank Systems for Rural Homes or its replacement. KDHE bulletin 4-2. (3)
Onsite Domestic Sewage Disposal Handbook. First Edition. 1982. MWPS-24. (2) Includes information on septic tanks, soil absorption systems, site selection, distribution systems and such other systems as aerobic treatment and holding tanks.
Design Manual: Onsite Wastewater Treatment and Disposal Systems. 1980. U.S. Environmental Protection Agency. EPA Technology Transfer 625/1-80-012. (4) Contains information on site evaluation procedures, wastewater characteristics, onsite treatment and disposal methods, and management of onsite systems.

Water-saving toilets and showerheads

"How To Save Water," *Consumer Reports*, July 1990, pages 465-473.

Publications available from...

1. Your county Extension office, local health department, or directly from Extension Distribution Center, Umberger Hall, Kansas State University, Manhattan, Kansas 66506, (913) 532-5830. There may be charges for publications, postage and sales tax.

2. Your county Extension office or Extension Agricultural Engineering, 237 Seaton Hall, KSU, Manhattan, Kansas 66506, (913) 532-5813. There may be charges for publications, postage and sales tax.

3. Kansas Department of Health and Environment, Forbes Field, Building 740, Topeka, Kansas 66620, (913) 296-5565, or the KDHE district office for your area.

4. U.S. Environmental Protection Agency, 401 M Street S.W., Washington, D.C. 20460.

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The Farmstead Assessment System is a cooperative project of the Cooperative Extension Service, Kansas State University, and the Kansas Department of Health and Environment.

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Publications from Kansas State University are available on the World Wide Web at: http://www.oznet.ksu.edu

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