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EC98-771 Farm*A*Syst Nebraska's System for Assessing Water Contamination Fact Sheet 8: Improving Household Wastewater Treatment

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Farm·A·Syst

FACT SHEET 8

Nebraska's System for Assessing Water Contamination Risk

Improving Household Wastewater Treatment

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. State and local codes specify how wastewater systems must be designed, installed, and maintained. For example, Title 124 regulates the design, operation, and maintenance of septic tank systems in Nebraska. In addition, federal and state regulations guide the stabilization and land application of wastewater septage.

At a minimum, follow the codes. But also consider whether the minimum requirement is sufficient for your site, pattern of use and type of wastewater generated. If your system is connected to a home-based business (e.g., beautician, furniture refinishing, musical instrument cleaning, photo processing, taxidermy, etc.) or commercial enterprise, special restrictions and management methods may apply. Look in the contacts and references section of this publication for agencies and organizations to contact if you are uncertain about your status.

Septic tank/soil absorption system

The most common form of on-site wastewater treatment is a septic tank/soil absorption system. In this system, wastewater flows from the household wastewater plumbing into an underground septic tank. There:

- The waste components separate—the heavier solids (sludge) settle to the bottom, and the grease and fatty solids (scum) float to the top.
- Bacteria partially decompose and liquify the solids.
- Baffles at tank inlets and outlets provide maximum retention of solids, prevent inlet and outlet plugging, and prevent rapid flow of wastewater through the tank.
- The liquid portion (effluent) flows through an outlet to the soil absorption field.
- The absorption field is usually a series of below-ground parallel trenches, each containing a distribution pipe or half-moon tile embedded in drainfield gravel or rock.
- The effluent seeps out through holes in the pipe or from the half-moon tile sections, then down through the drainfield gravel or rock and into the soil.
- The soil filters out remaining small solids and pathogens (disease-producing microorganisms), and water, carrying dissolved substances, slowly moves down to groundwater. The soil also completes the biological treatment of wastewater.

Figure 1 shows a typical household system for wastewater generation, collection, and treatment. The "leakage," "overflow," "infiltration," and "clearwater" components represent possible problems with the system. Unfortunately, these problems are often difficult to recognize since they are hidden underground. Overflow from systems may be noticed as wet spots, odors, and some changes in vegetative cover near the soil

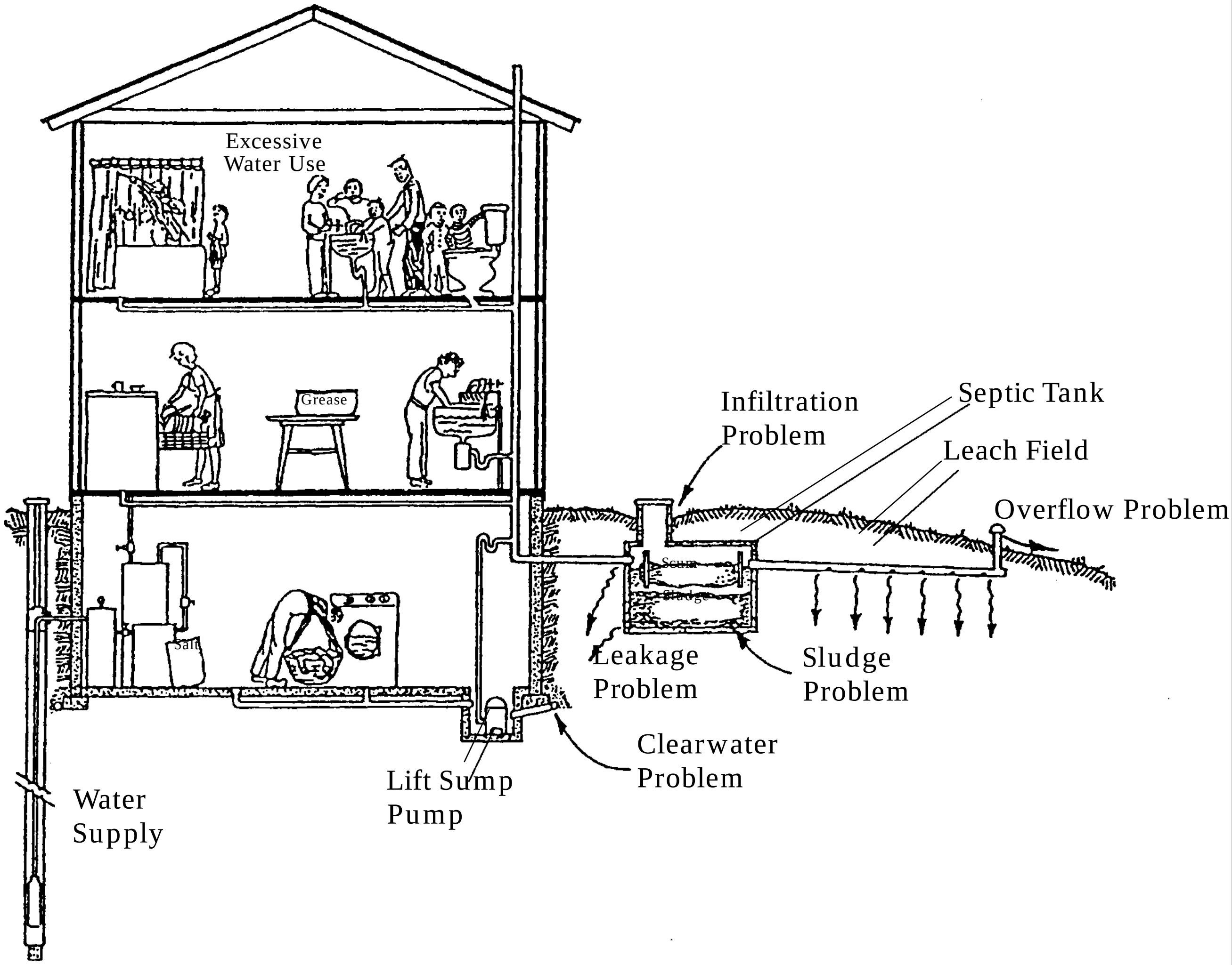

Figure 1: Typical household wastewater treatment system with problems.

absorption field. Water entry (infiltration and clear water) will be more difficult to detect, involving tracing where floor drains, roof drains, foundation drains, and sumps direct 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.

Wastewater quantity

Strategy: Minimize the volume of household wastewater.

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. For holding tanks, less volume reduces costs by reducing the number of times the tank has to be emptied.

The quantity of water used depends on the number of people using the dwelling, how water is used, and maintenance of the water supply system. The average water use in rural households is 50 to 100 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 the wastewater treatment system.

Reducing the volume of water entering the system will improve the treatment by increasing the time the waste spends in the system, thus providing more time for settling and treatment.

Consider the following ways to minimize water use:

- Eliminate nonessential 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 clearwater and infiltration into the system (see *Figure 1*). For example, divert roof drains 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 has plumbing codes that require 1.5-gallon-or-less toilets on all new construction. Composting toilets allow even greater reductions, but they can present other waste disposal challenges.

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

- For clothes washing, use an economy cycle and run full loads. Front-loading washers use much less water. When running small loads, be sure to use the reduced water level setting. Spread out the loads over the week to prevent system overload. Apply these same ideas to dishwashing also.

- Modern, efficient plumbing fixtures, including 0.5 to 1.5-gallons-per-flush toilets, 0.5 to 2.0 gallons-per-minute (gpm) showerheads, faucets of 1.5 gpm or less, and front-loading washing machines of 20 to 27 gallons per 10-12 pound dry load, offer the potential to substantially reduce residential water use and wastewater generation. These reductions have commonly amounted to between 30 and 70 percent of total in-house water use. (See *Table I*.)

- In hard water areas, the water softener may be a significant user of water. Proper adjustment and timing of the softener’s regeneration mechanism can reduce excessive water use. Some newer models use less water to regenerate, and regenerate as needed, thereby saving water.

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

Table I. Water use by conventional fixtures and water-saving fixtures and devices.

Conventional fixture	*Gallons used*	*Water-saving fixture/device**	*Gallons used*
Toilet	4-6 gallons/flush	Air-assisted toilet	0.5 gallons/flush
Shower head	4-6 gallons/minute	Low-flow shower	2.0 gallons/minute
Bathroom faucet	4-6 gallons/minute	Flow-control aerator	0.5 gallons/minute
Kitchen faucet	4-6 gallons/minute	Flow-control aerator	1.5 gallons/minute
Top-loading clothes washer	40-55 gallons/load	Front-loading clothes washer	22-33 gallons/load

*Installing all these water-saving devices could reduce water use by 35 percent. *Source*: Penn State Cooperative Extension Circular 302.

Wastewater quality

Strategy: Minimize the amount and complexity 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 "99.44 percent pure" 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 large enough to be removed by settling, or through filtration in the drainfield or soil. Many will die from the adverse conditions or aging in the system.
- **Suspended solids,** particles carried by the wastewater into the septic tank. Most can be separated from liquid waste by allowing enough time in a relatively calm tank. Particles which are more dense than water settle as sludge while those less dense form a floating scum layer. Grease and fats are a part of the suspended solids. Absorption systems can be clogged by wastewater high in suspended solids.
- **Oxygen demand.** The microorganisms that decompose organic wastes use oxygen. The amount of oxygen required to treat wastewater is typically measured as biochemical and chemical "oxygen demand." Wastes such as blood, milk residues, and garbage grindings have high oxygen demand. Aeration and digestion processes, in the presence of oxygen and organisms, produce treated, low-odor wastewater 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, thus adversely affecting ecosystems.
- **Organic solvents** from cleaning agents and fuels may be cancer-causing and are generally not degraded or removed through wastewater treatment. They can pass along with wastewater into groundwater or surface water supplies.
- **Nutrients.** Nitrogen from human wastes and phosphorus from some laundry and dishwasher detergents, and some chemical water conditioners are the most notable. Nitrate-nitrogen is a common groundwater contaminant. High levels of nitrate in drinking water can cause health problems, particularly in infants. Phosphorus can enter surface water and promote excessive algae and plant growth, thus creating an imbalance in the natural ecosystem.

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 down drains that may clog a septic tank or will not readily decompose in a lagoon (fats, grease, coffee grounds, paper towels, sanitary napkins, tampons, disposable diapers).
- Use toilet tissue recommended for septic systems. The same tissue is suitable for lagoons, and is generally white in color.
- Do not put toxic substances, such as solvents, degreasers, acids, oils, paints, disinfectants, and pesticides, in drains since these will most likely travel to your groundwater. This does not include normal use of household and laundry disinfectants, or washing clothes worn for pesticide application.
- Do not use chemicals to start, feed, or clean your system. They may interfere with the biological action in the tank, clog the absorption field by flushing sludge and scum into the field, or add toxic chemicals to groundwater.
- Add a supplementary lint screen to your washing machine drain hose.

Wastewater collection

Strategy: Collect all wastewater that needs treatment. Minimize loss of untreated wastewater. Collect only wastewater that needs treatment.

Leaking pipes, septic tanks, or lagoons can allow wastewater to return to the local water supply without adequate treatment. Infiltration of clear water overloads the system and dilutes the wastes. Don't allow water that doesn't need treatment (from basement floor drain sumps, foundation drains, infiltration of rain water, roof drainage) to add to your wastewater volume. Divert clear water, which doesn't require treatment, away from the house, well, and wastewater treatment system.

Treatment systems

Strategy: Make wastewater more suitable for further treatment or disposal.

Septic tanks retain most of the suspended solids from wastewater as sludge and scum. In the tank, bacteria digest and concentrate the sludge *(Figure 2)*. The partially treated effluent moves on for additional treatment (for example, in a soil absorption field).

The design and construction of septic tanks influence their water tightness and effectiveness of retaining sludge

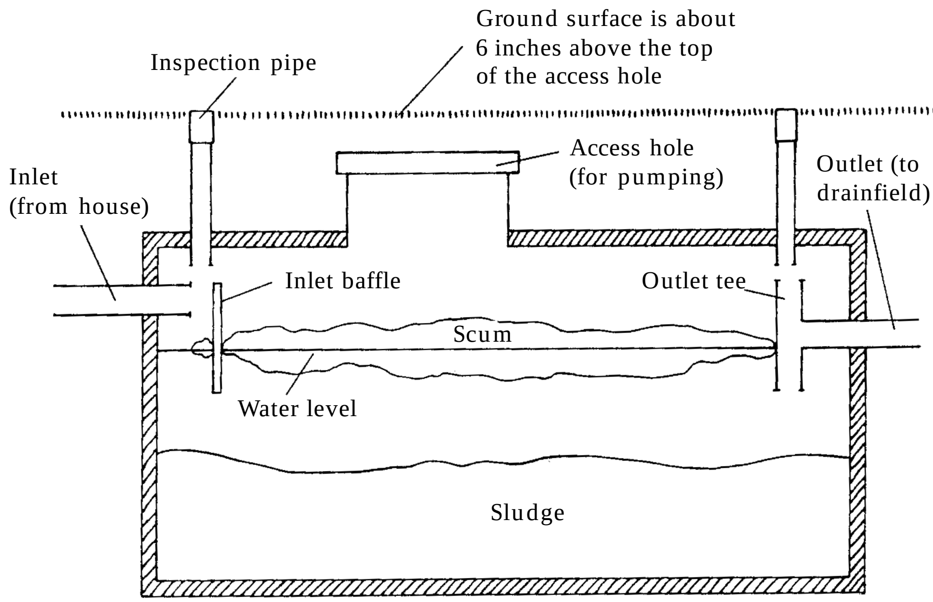

Figure 2. The parts of a septic tank.

and scum. Multiple-chambered tanks or tanks in series can improve the retention of sludge and scum. Filter screens help minimize solids carryover. Tanks should be sized to accommodate at least 24 hours of wastewater flow, while still allowing for sludge and scum retention. Infrequent pumping of septic tanks is one of the most common causes of system failure. Pumping the tank every three to five years, depending on the size of the tank and the volume and quality of wastewater generated is vital for the functioning of the system. A professional tank pumper can give you additional guidance on frequency for your system. When the tank is pumped, have the professional check the baffles for integrity and the tank for obvious cracks or holes.

Aerobic (oxygen-using) systems (packaged systems) provide more extensive treatment of wastewater, improved solids separation, and reduced sludge volume (see *Figure 3*) in contrast with the typical anaerobic (no oxygen) septic units. These systems, however, are more expensive to operate and maintain and are more subject to problems caused by changes in wastewater quality or environmental conditions.

Holding tanks collect and hold the entire wastewater flow. Disposal from holding tanks is generally 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. The tank should be large enough to accommodate wastewater and allow for disposal at convenient and appropriate times, especially for land spreading. When pumped, the tank should be checked for leaks.

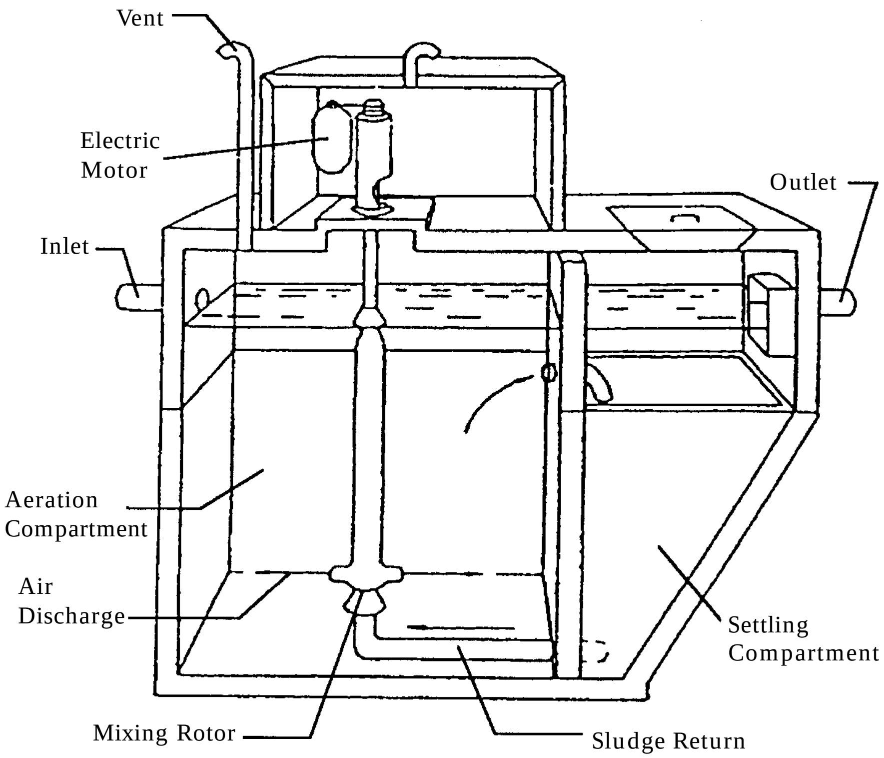

Figure 3. Aeration tank of a household aerobic treatment system.

Lagoons are designed to contain all wastewater flows and rely on evaporation to keep from overflowing. The maximum allowable seepage rate is 1/8 inch per day after sealing and compaction.

Wastewater goes directly from the plumbing to a lagoon. Lagoons treat wastewater using both aerobic and anaerobic processes. Aerobic decomposition, requiring oxygen, occurs near the water surface. Anerobic decomposition occurs near the bottom of the lagoon, where there is little oxygen. Algae and bacteria work together to break down the waste.

For maximum performance and to be in compliance with state regulations, the lagoon must be maintained with a minimum of two feet of liquid depth. If necessary, additional water should be pumped into the lagoon to offset evaporation during hot weather. The water depth should not exceed five feet and the water level should not be closer than one foot to the top of the lagoon.

Because they shade algae and interfere with wind flow, no trees, brush, or weeds, should extend above the top of the lagoon dike within a fifty foot radius. The dike should be planted to grass and should be kept mowed to six inches or less.

Subsurface constructed wetlands are man-made marsh-like areas that treat wastewater using natural processes. In this system, effluent flows through a bed of rock or gravel that is placed on an impermeable membrane or clay surface, with the water level remaining below the surface of the gravel bed. Suitable vegetation is grown on the surface. Besides being low in cost and low in energy use, subsurface constructed wetlands can be a reliable means of treating wastewater for single-family residences. Among their advantages are the lack of odors and insect vectors, and little risk of public exposure and contact with the water in the system. A relatively new concept, constructed wetlands are not recommended for systems where very high levels of nitrogen are a concern or in very cold climates. Although freezing can be a concern, mulching the surface and keeping a continual flow can reduce the threat of freezing. Additional information on constructed wetlands can be found in some of the references provided at the end of this fact sheet. This system may require an NPDES permit from the Nebraska Department of Environmental Quality (NDEQ) Permits and Compliance Division.

Subsurface treatment and disposal using soil absorption (trenches, beds, mounds, at-grade and gravelless) is the common practice for household wastewater after primary treatment in a septic tank or aerobic system. Deep, well-drained, well-developed, medium-textured soils (such as silt loam and loam) are desirable soil absorption sites. There are, however, sites where soil absorption systems are not acceptable because of high or low soil permeability, or shallow depth to bedrock or the saturated zone, or other factors.

Enhanced treatment

Strategy: Reduce concentration and amount of contaminants in the wastewater to expand options for appropriate 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 after septic tank primary treatment. Effective treatment involves aerobic biochemical activity as well as physical filtration. Filters consist of 2 to 5 feet of sand (or other media) in a bed equipped with a distribution and collection system. Wastewater is pumped in doses, and 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 design of the system (see *Figure 4*).

Maintenance includes resting, occasional raking, removal of clogged and crusted surface media, filter media replacement, and attention to dosing equipment.

Dry systems generally involve composting and may find applications in seasonal use housing such as weekend vacation properties.

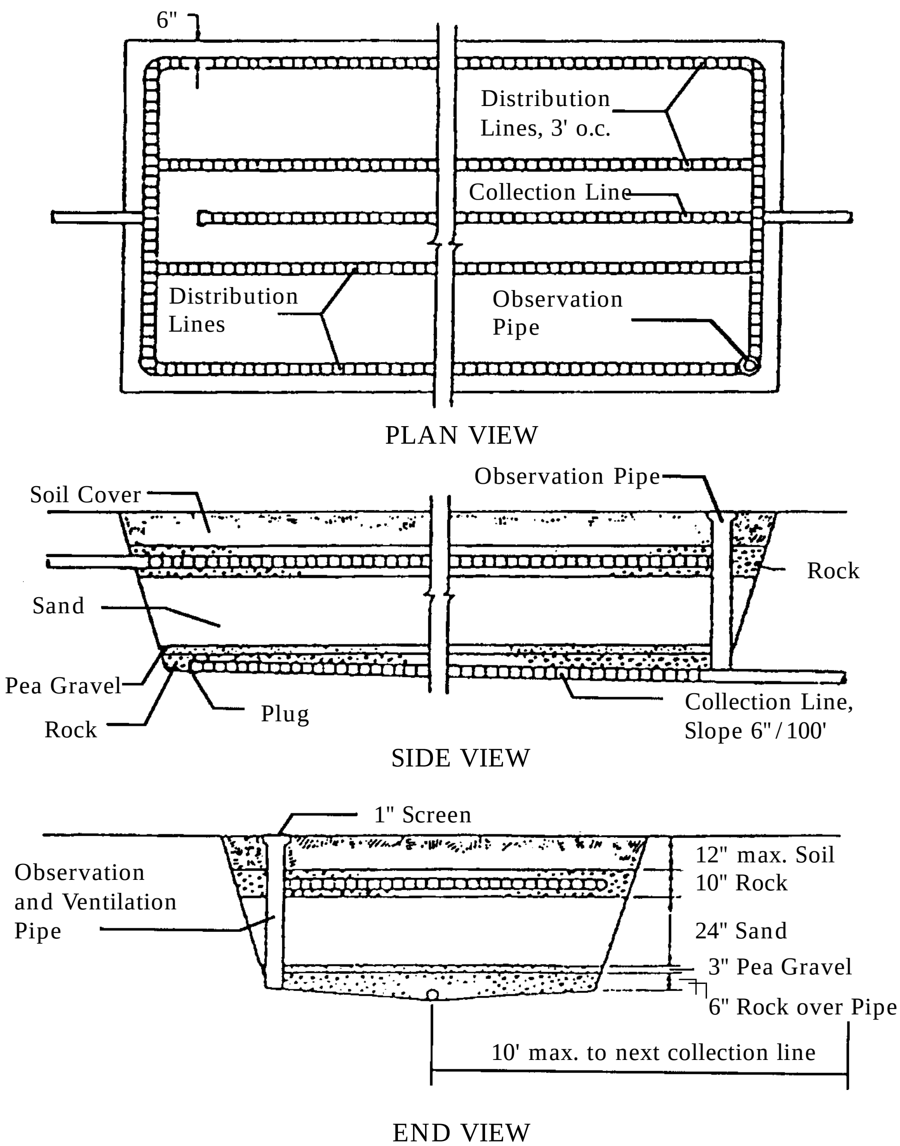

Figure 4. Buried sand filter.

Disposal of septage

Strategy: Disperse wastes, take advantage of additional treatment afforded by contact with soils, and minimize opportunity for wastewater to contaminate water supplies.

Proper off-site disposal of septage, by hauling to a municipal treatment facility or well managed land spreading, can help protect the local water supply as well as all water resources. Discharging treated wastes to surface water from private systems is not permitted in Nebraska. Improper waste management off-site can endanger the health of others and, if done on adjacent property, may eventually contribute to poor water quality at your well.

Applying septage to the soil surface provides an opportunity to recycle nutrients and to further reduce the contaminant content of wastewater in a safe manner. The application time should be chosen so that there will be little runoff, maximum use of nutrients by plants, and additional reduction in microorganisms. A professional should consider site characteristics such as soil, land use, depth to groundwater, weather, climate, and hydrogeology when selecting a site. *This practice requires an NPDES permit obtainable through the NDEQ, Permits and Compliance Division.*

Incorporation of septage into surface soils is most desirable because the chance of runoff is reduced. While septage applications are often controlled by the amount that will infiltrate, the rate of application should be calculated to match the nutrient uptake by vegetation harvested from the site. This minimizes loss of nutrients to the surface water and groundwater. Contact your local Cooperative Extension Educator or private crop consultant for assistance in developing a septage use plan.

Soil characteristics and separation from the water supply are important factors. Unsaturated soils allow movement of air, helping keep the wastewater aerobic. A minimum depth of 4 feet of unsaturated soils is recommended for removing bacteria. Finer-textured soils (clay loams and clay) retain water better, allowing plant roots to take up wastewater and nutrients, and allowing increased die-off of microorganisms. Coarse, sandy soils allow effluent to flow quickly down to groundwater, providing inadequate time and soil structure for filtering solids and pathogens from the liquid. Disposal sites that are more distant and downslope from the well increase the isolation of your water supply from the contaminated septage.

Assistance with failing systems or new designs

If you suspect your household wastewater treatment system is backing up or your soil absorption field is clogged, first contact your plumber or septic system installer, who may have suggestions for extending the life of your system. Contact your county code administrator for permits to repair or replace your wastewater treatment system.

- Do not wait for the system to fail before pumping the septic tank. Once a system fails, it is difficult to repair a clogged soil absorption system.
- Do not use septic tank cleaners, especially those that contain degreasing solvents like TCE. They can contaminate groundwater.
- Do not place more soil over a soggy soil absorption field; this does not fix the system, and the problem will reappear.
- Do not just pipe wastewater to the road ditch, storm sewer, stream or drain tile; this pollutes the water and creates a health hazard.
- Do not run wastewater into a sink hole or drainage well; this pollutes the groundwater.

A properly designed, constructed, and maintained wastewater treatment system can effectively treat wastewater for many years. For more information, contact your local Cooperative Extension Educator or local health department.

If you need advice on alternative wastewater treatment systems, such as mounds, at-grades, gravelless systems, sand filters, and aerobic units, or if you would like to explore experimental systems such as constructed wetlands, contact the University of Nebraska-Lincoln Cooperative Extension office in your county.

CONTACTS AND REFERENCES

Who to call about...

Household wastewater treatment and local regulations:
County health departments, or local city and county zoning administrators.

Statewide regulation of private sewage systems:
Nebraska Health and Human Services System Environmental Health, 301 Centennial Mall South, Lincoln, NE 68509, (402) 471-2541.
Nebraska Department of Environmental Quality, Suite 400, The Atrium, 1200 "N" Street, P.O. Box 98922, Lincoln, NE 68509-8922, (402) 471-2186.

Requirements for land application:
Your local University of Nebraska Cooperative Extension Educator, or NRCS office.

Small and alternative wastewater treatment technologies:
National Small Flows Clearinghouse, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064, or call (800) 624-8301.
University of Nebraska-Lincoln Cooperative Extension at (402) 472-8656.

What to read about...

Publications are available from the sources listed at the end of the reference section. The number in parentheses after each publication refers to its distributor.

Design, installation, use and maintenance of on-site sewage systems:
Design Manual: On-site Wastewater Treatment and Disposal System. 1980. EPA Technology Transfer 625/1-80-012. 391 pages. Contains information on site evaluation procedures, wastewater characteristics, on-site treatment and disposal methods, and management of on-site systems. (2)

Nebraska Department of Environmental Quality Title 124—Rules and Regulations for the Design, Operation, and Maintenance of Septic Tanks, 1999. (3)

A Septic Tank System for Sewage Treatment. 1979. NebGuide G79-448. Description of septic tank system for home sewage treatment. (1)

Home Sewage Treatment Systems. 1980. NebGuide G80-512. Descriptions of several alternative home sewage treatment systems. (1)

Soils, Absorption Fields and Percolation Test for Home Sewage Treatment. 1980. NebGuide G80-514. A guide to help place the absorption field keeping soil characteristics and water table in mind. (1)

Mound Sewage Waste Treatment Systems. 1981. NebGuide G81-559. (1)

General Design, Construction, and Operation Guidelines: Constructed Wetlands for Wastewater Treatment Systems for Small Users Including Residences: TVA Water Management Library, Haney Building 2C, 1101 Market Street, Chattanooga, TN 37402-2801. Item # WWPCDM65. (4)

Natural systems for Wastewater Treatment in Cold Climates. Brochure contains information about constructed wetlands and other natural systems. Item # WWBRGN19. (4)

Water-saving toilets and showerheads:
"How to Save Water," *Consumer Reports*, July 1990, pages 465-473.

Publications available from...

1. Your University of Nebraska Cooperative Extension office or directly from IANR Communications and Information Technology, 105 Ag Communications Building, University of Nebraska-Lincoln, P.O. Box 830918, Lincoln, NE 68583-0918, (402) 472-9712.

2. U.S. Environmental Protection Agency, 401 M Street S.W., Washington, DC 20460.

3. Nebraska Department of Environmental Quality, Suite 400, The Atrium, 1200 "N" Street, P.O. Box 98922, Lincoln, NE 68509-8922, (402) 471-2186.

4. National Small Flows Clearinghouse. West Virginia University, Box 6064, Morgantown, WV, 86506-6064, (800) 624-8301.

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