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EC798 Residential On-site Wastewater Treatment: An Overview

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Residential On-site Wastewater Treatment

An overview

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Residential On-site Wastewater Treatment: An Overview

Introduction

This publication will answer many questions that homeowners or potential homeowners, realtors and lenders may have about residential on-site wastewater treatment systems. Information is based on *Title 124: Rules and Regulations for the Design, Operation and Maintenance of On-site Wastewater Treatment Systems* of the Nebraska Department of Environmental Quality (NDEQ), which requires that a dwelling or establishment that generates wastewater have an on-site wastewater treatment system in accordance with those regulations, or be connected to a public wastewater treatment system. An establishment is a house, building, structure, or place that generates more than 1,000 gallons of wastewater per day, generates non-domestic wastewater, or serves as a restaurant or food preparation facility. Different regulations, which are **not** covered in this publication, may apply to an establishment. See NDEQ *Title 124* for more information.

Be sure to contact the local health, environmental, zoning, or planning department prior to constructing an on-site wastewater treatment system, to see if a local permit is required. Local regulations may be the same as or more strict than those issued by the state, but never will be more lenient.

Many Nebraskans live in homes that do not have access to public wastewater treatment systems. Instead, they must rely on their own on-site wastewater system, whether it is a traditional septic tank and drainfield, a lagoon, or another system specifically engineered for the site. Success or failure of a system depends on the site, design, installation, operation and maintenance.

In Nebraska, wastewater is defined as the liquid and waterborne wastes that result from ordinary living processes. It consists of blackwater, which are wastes carried off by toilets, urinals, and kitchen drains; and graywater, from baths, lavatories, laundries, and sinks, except kitchen sinks. Both blackwater and graywater must be collected and treated. Water from roof and footing drainages and swimming pools does not require treatment, and should not be directed to an on-site wastewater treatment system.

With a few exceptions, the State of Nebraska currently does not require a homeowner to have a permit to construct and operate an on-site wastewater treatment system. If the home has 10 bedrooms or more, generates over 1,000 gallons of wastewater per day, or generates any non-domestic wastewater, a permit is required. Also, a permit is required for specially engineered on-site wastewater treatment systems, such as mound or aerated (package) systems.

Every system must meet all provisions for design, setback distances and reserve area as found in *Title 124*. Information about the system including the contractor/designer must be kept on-site, and a soil percolation test must be conducted to determine the rate that water travels through the soil. *Title 124* also states that an on-site wastewater treatment system must not endanger human health and must not cause pollution. Realistically, all on-site wastewater treatment systems may cause some increase in pollutant concentrations in ground and surface water. The goal is to minimize pollution and the risk associated with it as much as humanly and technologically possible.

What Does a Wastewater Treatment System Do?

A properly designed, sized, installed and maintained on-site wastewater treatment system should safely remove and treat wastewater from a home. Untreated or improperly treated wastewater is a risk to people through direct contact with sewage, or animals (flies, dogs, cats, etc.) that have been in direct contact with sewage. Also, untreated or improperly treated wastewater is a threat to human health and the environment when it pollutes surface water or groundwater.

Human Health and Safety Issues

There are direct health hazards associated with untreated or improperly treated wastewater. Untreated or improperly treated wastewater contains pathogens – organisms that can cause diseases. These organisms may enter groundwater and contaminate drinking water supplies. Untreated or improperly treated wastewater also can introduce pathogens to surface water. Ponds, rivers, or lakes containing these organisms may not be safe for recreation. Also, flies and mosquitoes may spread diseases; they may be attracted to and breed in wet areas where wastewater reaches the surface. Dogs and other animals that have been in contact with wastewater also can be carriers of disease organisms.

Diseases which may be transmitted through contact with improperly treated wastewater include, but are not limited to, cholera, dysentery, Hepatitis A, polio, salmonella and typhoid. Parasites also can be transmitted by improperly treated wastewater, including, but not limited to, hookworm, pinworm, roundworm and tapeworm.

High concentrations of nitrate can cause methemoglobinemia, or blue baby syndrome, in infants by interfering with the blood's ability to carry oxygen. Although most wastewater treatment systems do not remove nitrate, proper system siting and design will reduce the risk of contaminating groundwater, the source of drinking water for many rural dwellers.

Environmental Risks

Poorly functioning on-site wastewater treatment systems also can affect the surrounding environment. On-site systems can release nitrogen from human waste into groundwater and surface water. They also can release phosphorous, found in some household detergents and water conditioners, as well as human waste, into surface water. These nutrients promote algae and weed growth in lakes and streams. These plants eventually die and settle to the bottom where they decompose. This decomposition process depletes oxygen that fish and other aquatic animals need to survive, which may result in the death of fish and other aquatic organisms.

Cleaning products and other chemicals dumped down the household drain also enter the wastewater treatment system. Some of these materials can be dangerous to humans, pets and wildlife. If allowed to enter a system, many of these chemicals will pass through without degrading and may contaminate groundwater, surface water and/or soil.

What Are the Components of an On-site Wastewater Treatment System?

All on-site wastewater treatment systems must perform the same basic functions. They must collect wastewater from the home and treat it to break down organic material, destroy pathogens and absorb nutrients. A typical system consists of plumbing in the home to collect wastewater and send it to a septic tank, where treatment begins. From there, the partially treated wastewater, called effluent, travels to an effluent treatment system. Further treatment occurs and the wastewater is released to the environment (Figure 1). More information on different options and how treatment occurs are given in the following section.

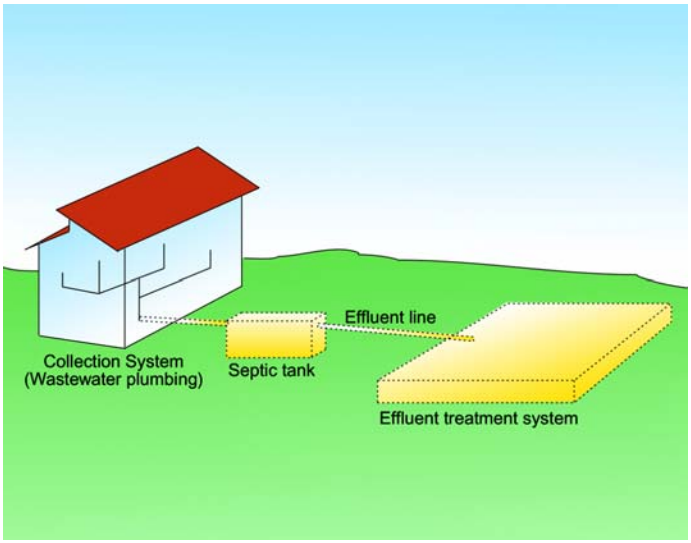

Figure1. Typical components of an on-site wastewater treatment system.

Information on New Construction

What Options Are Available?

In most situations, there are a number of different options available for residential on-site wastewater treatment. This section lists various options and explains how treatment occurs. It may be of special interest to those planning new construction or replacing an existing system. At the end of the section, Table 1 lists conditions or characteristics and gives maintenance requirements and drawbacks to each option.

Septic Tank/Drainfield

The most common type of on-site wastewater treatment system is a septic tank and drainfield, also called the leach field, seepage bed, or absorption field. When site conditions allow, this is often the most economical method available.

Wastewater flows through the plumbing from the home into a watertight septic tank (Figure 2), which acts as a settling area for the wastewater. Heavy materials settle to the bottom of the tank as sludge. Water, other liquids and suspended solids are found above the sludge. Soaps and grease form a floating scum layer. This physical separation of sludge, liquids with suspended solids, and scum, is called primary treatment.

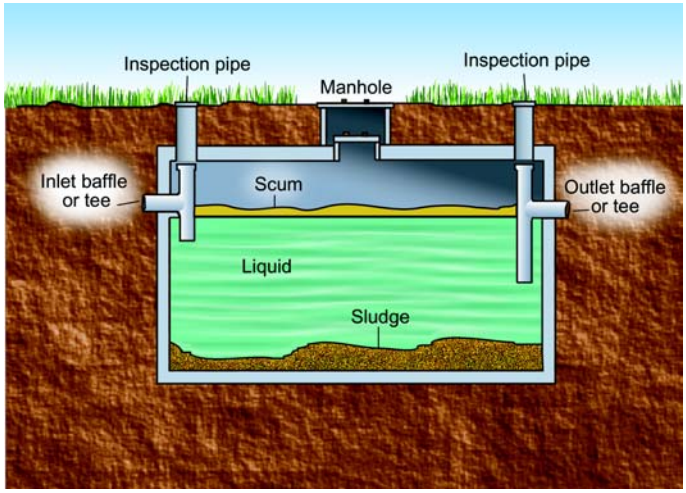

Figure 2. Septic tank.

Bacteria naturally occur in sewage entering the septic tank. They begin to break down organic materials in the wastewater under anaerobic conditions (without oxygen). The settling and bacterial breakdown that occur in the tank prepare wastewater for final treatment in the soil.

Wastewater from the septic tank, called effluent, travels through a pipe to the drainfield. The drainfield is a trench often filled with gravel, topped with soil. Effluent moves through spaces in the gravel and enters the soil, where millions of naturally occurring microorganisms kill some pathogens. The soil helps tie up viruses and some nutrients, such as phosphorous, before the effluent reaches groundwater. Nitrate, another nutrient found in effluent, is water soluble; effluent and precipitation movement will carry some through the soil. The type and condition of the soil are important factors for a properly functioning drainfield. Drainfield size is determined by the amount of wastewater generated and soil characteristics. In many traditional septic tank/drainfield systems, gravity moves wastewater through the system. In some situations, a pump may be needed to move wastewater through the system. See Extension publications *Residential On-site Wastewater Treatment: Septic Tank Design and Installation* (due Spring 2002) and *Residential On-site Wastewater Treatment: Septic System and Drainfield Maintenance* (G01-1424A) for more information.

Alternative Systems

In Nebraska, more development is occurring in rural areas where on-site systems must be used for wastewater treatment. In some areas, the conventional septic tank/drainfield will not properly treat wastewater. This may be due to a high groundwater table, or soil types that allow water to percolate or travel through the soil too quickly or too slowly for proper treatment. Alternative wastewater treatment systems have been developed for these situations.

Of the following options, Systems 1 through 6 use a traditional septic tank, with an effluent treatment system that is an alternative to the traditional drainfield. Systems 7 through 9 use alternatives to the septic tank.

1. Septic Tank/Pressure Dosing

Nebraska regulations require pressure dosing anytime more than 500 linear feet of drainfield is needed for proper treatment of wastewater. The quantity of wastewater generated and the soil characteristics, especially the percolation rate (the rate at which water travels through the soil), are used to determine the size of pump and drainfield needed. Effluent is pumped out of the dosing chamber following the septic tank at regular intervals, in doses. This forces the wastewater along the entire line so that the drainfield is used evenly, increasing the probability of uniform distribution.

2. Septic Tank/Mound System

Mound systems (Figure 3) are helpful where the water table is close to the soil surface, or percolation rates are too slow or too fast for adequate wastewater treatment. In this system, the drainfield is located in a mound above the natural soil surface. The mound is made of materials that will provide proper treatment. Effluent is pumped from the septic tank to the mound. There, effluent trickles through gravel beds or trenches, through a bed of sand fill, and then flows into the natural ground surface. NDEQ requires a permit for a mound system. For more information, see Extension publication *Residential On-site Wastewater Treatment: Mound Systems* (due Spring 2002).

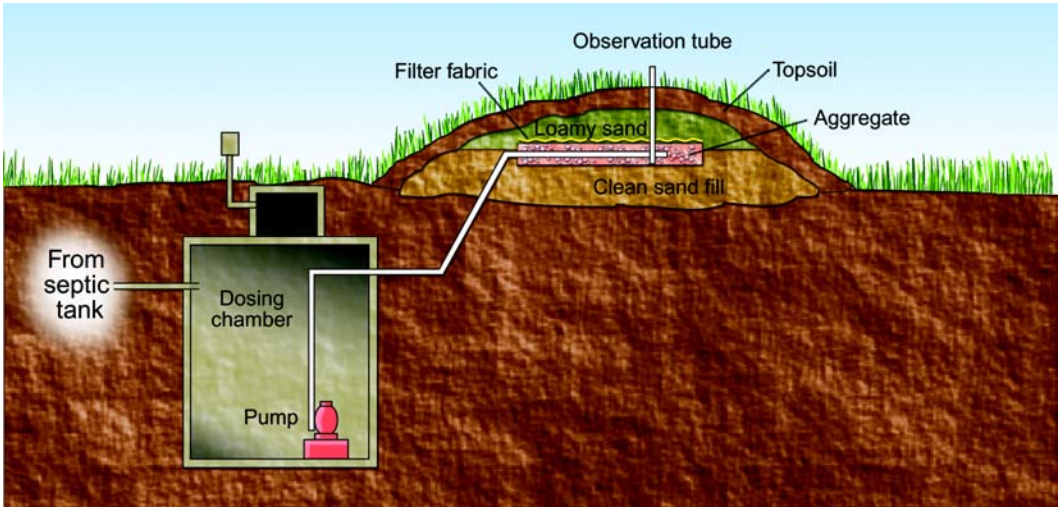

Figure 3. Mound system.

3. Septic Tank/Gravelless System

In a traditional septic tank/drainfield system, the trenches in the drainfield are filled with gravel. In a gravelless system, a fabric-covered corrugated pipe or a plastic chamber is set in the trench, and no gravel is used. In the gravelless pipe system (Figure 4), effluent travels from a septic tank or aerated tank (see System 7) to the drainfield, where it travels through a corrugated pipe surrounded by a synthetic fiber. Effluent is treated in the soil below the pipe. In the gravelless chamber system (Figure 5), effluent passes from the septic tank or aerated tank to the drainfield, where it travels through a chamber made out of a material that will not degrade, typically plastic. The effluent is treated in the soil along the sides as well as below the chamber.

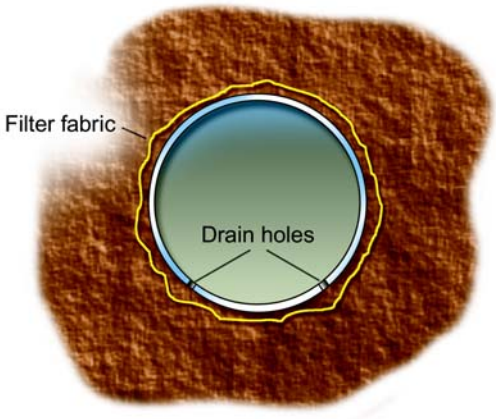

Figure 4. Gravelless pipe system for effluent treatment.

Gravelless systems are easier to install. The lightweight components can be carried to remote or difficult-to-reach sites. Gravelless systems have greater storage capacity than traditional drainfields because there is no gravel to occupy the space that water could occupy. Chambers in both gravelless and gravel systems have an advantage over perforated pipe because of greater storage capacity. Also, treatment can occur as wastewater enters the soil through slits along the sidewalls of the chamber. NDEQ does not require a permit for a gravelless system; however, some counties may not allow gravelless systems, so contact local permitting agencies. See Extension publication *Residential On-site Wastewater Treatment: Traditional and Gravelless Drainfield Systems for Septic Tank Effluent* (due Spring 2002) for more information.

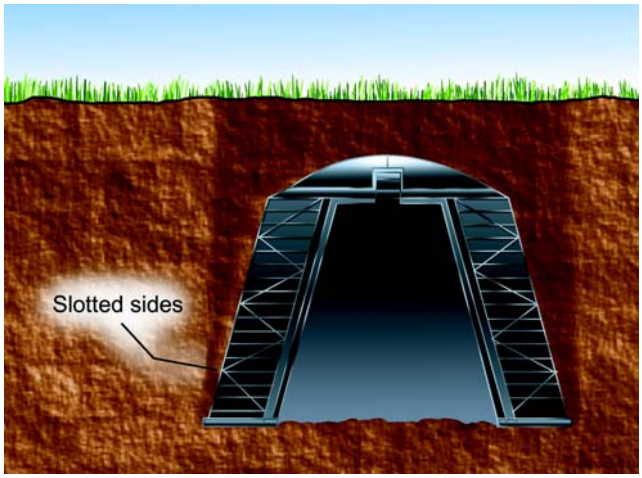

Figure 5. Gravelless chamber for effluent treatment.

4. Septic Tank/Constructed Wetland

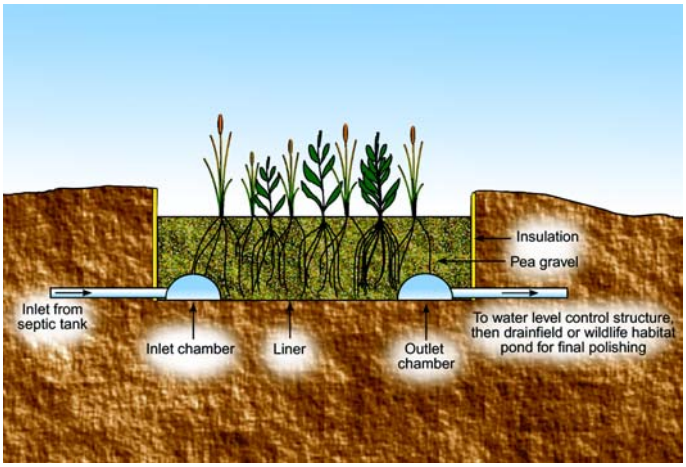

Figure 6. Constructed wetland cell.

A constructed wetland (Figure 6) mimics a natural wetland to treat wastewater. Cattails, reeds and other aquatic plants in the constructed wetlands remove or take up some nutrients and other contaminants. This system can be attractive, since it resembles a small natural wetland. Wastewater travels from the house to the septic tank, and then to the constructed wetland. The wetland cell may be lined with an impermeable material to prevent untreated wastewater from entering the soil and filled with rock, gravel, sand and/or soil. Plants, microbes, and fill material treat the effluent. Water is collected from the constructed wetland through pipes and flows to a drainfield or polishing pond where continued treatment and evaporation can occur. If the water is surface discharged, the owner needs a National Pollution Discharge Elimination System (NPDES) permit and may have to provide disinfection. NDEQ requires a permit for a constructed wetland system. For more information, see Extension publication *Residential On-site Wastewater Treatment: Constructed Wetlands* (due Spring 2002).

5. Septic Tank/Evapo-Transpiration System

This system uses evaporation from the soil and transpiration of water through plants to treat wastewater. Plants use water and release it through their leaves to the atmosphere. The evapo-transpiration or ET system (Figure 7) is used where the soil cannot treat wastewater before it percolates to the groundwater such as in rocky soils, or in clay soils where water percolates too slowly. This system can be used in dry climates; it does not work well in wet climates where precipitation exceeds evaporation and transpiration rates. Conditions in eastern Nebraska are marginal for ET systems.

Solid materials from the wastewater settle out in the septic tank. Effluent flows to the ET bed that consists of perforated pipes in a crushed stone bed. The surface of the bed is covered with a shallow layer of topsoil that can be planted to water-tolerant vegetation. Final treatment and disposal of the effluent occurs as water evaporates from the soil, plants use nutrients, and moisture is released through transpiration. Viral populations are reduced in the bed. As the water evaporates, salts, minerals and solids from the wastewater accumulate in the bed. During very wet periods when ET rates are low, the bed stores water until drier periods, when it evaporates and is transpired. NDEQ requires a permit for an ET system. NDEQ allows them in marginal areas only if the lot is at least three acres in size and a lagoon can be constructed if the system fails.

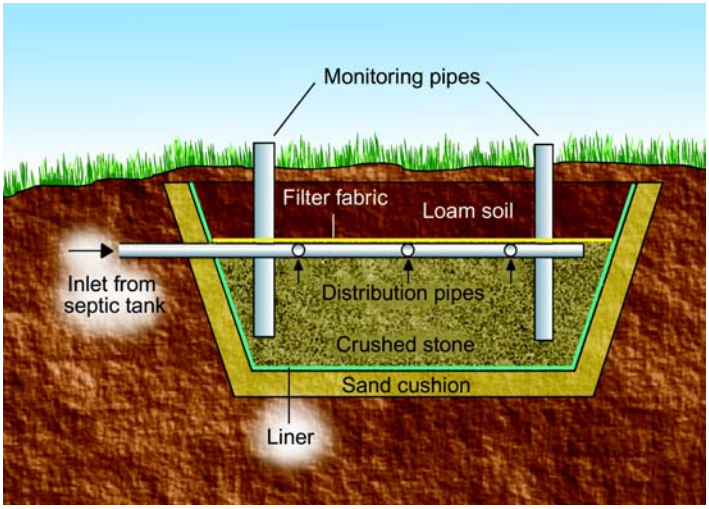

Figure 7. Evapo-transpiration system.

6. Septic Tank/Sand Filter

Sand filters (Figure 8) usually are used as the second step in on-site wastewater treatment after primary treatment in a septic tank or aerobic unit (see System 7). The sand filter is a good option for additional on-site treatment where a septic tank/drainfield system has failed or is restricted due to high groundwater, shallow bedrock, soils that wouldn't adequately treat wastewater, or other site conditions.

The typical sand filter is a watertight box, generally concrete or plastic lined, and filled with a specific sand material. The filter may be above ground, partially above ground, or below ground, and the filter surface may be covered or uncovered.

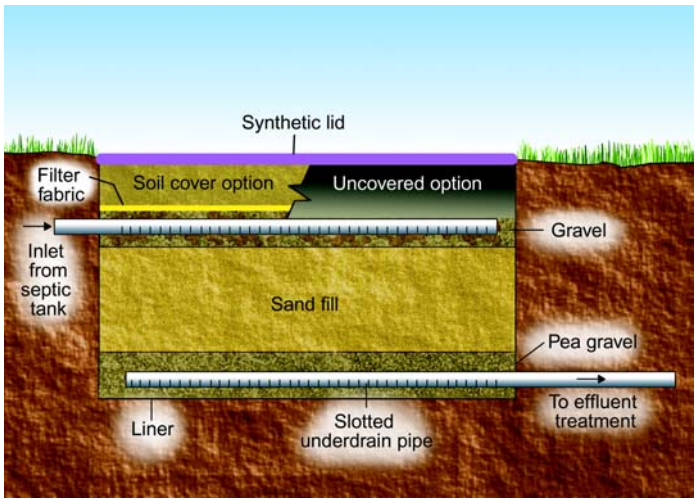

Figure 8. Sand filter.

Wastewater from the house flows to the septic tank or aerobic unit where solids settle out and a scum layer forms. The effluent may be further treated with screens or filters to ensure that no solids carry over to the sand filter bed. Then effluent is distributed evenly in the bed by pumping controlled doses through a network of small diameter pipes. Wastewater leaves the pipes, trickles down through the gravel and is treated as it filters through the sand. There it is collected and can travel to an effluent treatment system. If the water is surface discharged, the owner needs a National Pollution Discharge Elimination System (NPDES) permit and may have to provide disinfection. NDEQ requires a permit for the sand filter system.

7. Aerobic Unit or Aerated Tank

These systems are sometimes called package treatment plants (Figure 9). All of these use aerobic digestion – breaking down wastes in the presence of oxygen. Aerobic bacteria, those that need oxygen, break down the organic portions of the wastewater into simpler compounds. This aerobic treatment is rapid, odor-free and reduces solids more than anaerobic treatment, which occurs in the traditional septic tank. In the aerobic unit, an external air compressor bubbles air through the wastewater, or a pump or stirring device incorporates air. Because this type of system uses mechanical parts and energy, it is more costly and requires more maintenance than the traditional septic tank. After treatment in the aerobic unit, effluent flows to a drainfield, mound system, subsurface drip tube irrigation system, or some other type of effluent treatment system for final treatment and release to the environment. NDEQ requires a permit for an aerobic unit.

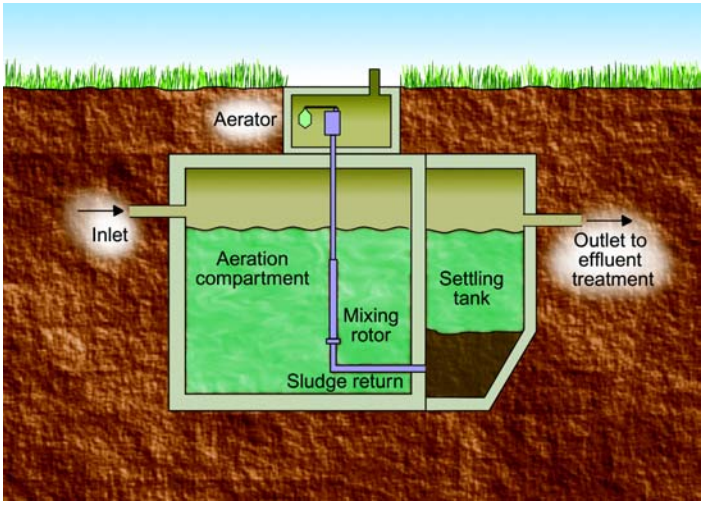

Figure 9. Aerobic unit or aerated tank.

8. Lagoon System or Waste Stabilization Pond

Properly functioning drainfields require that soils have appropriate percolation rates and are normally unsaturated, meaning spaces between soil particles are not all filled with water. Some areas of Nebraska have clay soils with very slow percolation rates. In these situations, consider a lagoon system for treating wastewater (Figure 16, pg. 21). Lagoons use both aerobic and anaerobic processes. Aerobic decomposition, requiring oxygen, occurs near the water surface. Anaerobic decomposition occurs near the bottom of the lagoon, where there is little oxygen. Nebraska regulations require that a property be at least 3 acres in size for a lagoon system to be used. Lagoons can be cost effective to design and construct.

Wastewater goes directly from the household plumbing to the lagoon, where algae and bacteria work together to break down the waste. There is typically no septic tank. The heavy solids settle to the bottom of the lagoon where they are broken down by bacteria. Also, bacteria floating in the water decompose the lighter, suspended material while giving off carbon dioxide. Algae use the dissolved nutrients, such as phosphorous and nitrogen, as well as the carbon dioxide. In turn, the algae give off oxygen, providing air for bacteria. Water returns to the environment through evaporation, and NDEQ allows up to 1/8 inches per day of seepage through the artificial or clay liner. NDEQ does not require a permit to construct a lagoon. See Extension publications *Residential On-site Wastewater Treatment: Lagoon Design and Construction (G01-1441)* and *Residential On-site Wastewater Treatment: Lagoon Maintenance (G01-1423A)* for more information.

Systems 8 and 9 are alternatives to tank-effluent treatment types of systems. System 10 consists of a different type of toilet, but does not eliminate the need for some type of wastewater treatment system for other domestic wastewater.

9. Holding Tank

Some homes are on small lots with no suitable soil or space for an effluent treatment system, and no access to a municipal wastewater treatment system. Wastewater from the home is discharged to a holding tank, which must be pumped periodically. The tank contents, called septage, must be transported to a treatment and disposal system or, if local regulations allow, may be land applied as described in the Code of Federal Regulations Part 503 *Standards for Use or Disposal of Sewage Sludge*. Nebraskans may use holding tanks with a minimum capacity of 1,000 gallons for one or two bedroom homes. Each additional bedroom requires an additional 300 gallons of tank space. Average daily water usage in a fully plumbed home is about 75 gallons per person. This means a home with four people generating 300 gallons per day with a 1,000-gallon holding tank may need pumping about every 3 to 4 days! Holding tanks must have an alarm or visible float that indicates when the tank is 90% full so pumping can be arranged.

10. Waterless Toilets

Composting and incinerator toilets are two types of waterless toilets. These systems may be useful where water is in short supply, or one wants to reduce the quantity and improve the quality of wastewater that requires treatment. Most waterless toilets will handle feces, urine, toilet tissues and some other biodegradable materials. A separate system must handle other wastewater from the home.

Some composting toilets may handle kitchen wastes in addition to toilet wastes. Heat produced by bacterial activity drives off excess moisture, and reduces the waste to about 5-10% of its original volume. A fan or roof vent carries away odor, gases and moisture. Composting destroys harmful organisms and

produces a residue that can be disposed of in the trash bin or garden if permitted by the local health department. Some models need a heater to aid composting.

Incinerator toilets use oil, gas, or electricity to burn waste, reducing it to a sterile ash. The ash box must be emptied periodically. These units consume varying amounts of energy and release some odors and gases into the atmosphere, depending on the type and model.

Which System Is Right for Me?

Selecting the most appropriate on-site wastewater treatment system depends on the residential site and water usage. Choosing a good site and appropriate system can save time, money and problems in the future. The right site and system also will protect human health and the environment.

One of the first things to do is hire a professional designer/contractor/installer. Nebraska currently has no certification system for these professionals, although some counties may. Training is available, but not required. When contacting potential designers/contractors, ask about their experience, if they attend on-site wastewater treatment training sessions or receive professional publications to keep informed of new technology, and references for systems they have installed. The local health or zoning department may have a list of professionals who have attended training sessions. Hiring an untrained, inexperienced person with a backhoe to install a system may save money on installation, but most likely will cost more later when the poorly designed or poorly installed system doesn't function properly and requires costly repairs or replacement. In addition, a malfunctioning system may endanger human health and the environment.

A designer/contractor can help select the appropriate type of system. To make the right decision, they'll need information on:

- **Type of soils, including percolation test**
- **Lay of the land (topography)**
- **Depth to groundwater**
- **Distance to surface water**
- **Lot size and configuration**
- **Water usage and wastewater quality**

These factors are described below.

Type of Soils

Soil characteristics are very important in determining the type of on-site wastewater treatment system that will work for a home. The type of soil determines how fast the water will move through it. Water moves very quickly through sandy soils, in some cases too quickly for the effluent to be treated. Clay soils hold water so that it moves too slowly for sufficient amounts to be treated. County soil survey reports provide a wealth of information about soils in an area. These reports are usually available from the Natural Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), Natural Resources Districts (NRDs), University of Nebraska Cooperative Extension offices, and the Conservation and Survey Division at the University of Nebraska-Lincoln. See the Extension publication *Residential On-site Wastewater Treatment: The Role of Soil* (due Spring 2002) for more information.

There can be great variation in soils from site to site as well as at different depths at the same site.

The soil percolation (or perc) test, required by Nebraska *Title 124*, will tell how quickly water moves through the soil. The perco-

lation rate is measured in the number of minutes it takes ponded water in a test hole to drop one inch in elevation in undisturbed soil. It is a good indicator of whether a traditional drainfield is feasible and, if so, the proper size required for a given loading rate. Although *Title 124* does not specify qualifications for individuals conducting percolation tests, it is important to know and be familiar with the correct procedure. Some counties require percolation tests to be conducted by a certified professional. The percolation test must be conducted on undisturbed, unfrozen ground, in the area and the depth where the drainfield will be installed. Results of the test must be kept on-site. See the Extension publication *Residential On-site Wastewater Treatment: Conducting a Percolation Test* (due Spring 2002) for information on how to conduct a percolation test.

Ideally, drainfields should be installed in natural soils, not in fill soils. Fill soils are those that have been moved from their site of geologic formation and deposited in a new location. When soils with textures other than clean sand are moved to a new location, soil structure is destroyed, and settling may occur. This affects pore space, causes silt and clay particles to migrate when water is added and ultimately results in percolation problems in the soil. Soil percolation tests on loamy fill can range from 7 to over 200 minutes per inch, making it difficult if not impossible to accurately size the drainfield. Often during construction, however, soils are disturbed and compacted.

Topography

The topography of a site influences the retention and movement of water, rate and amount of runoff, potential for erosion and ease with which machinery can be used to install a system. Slope is important in deciding what type of system to use, whether gravity distribution is feasible, and system layout. For example, sites with steep slopes usually are not suitable for traditional septic tank/drainfield systems, although a drop box system may be used. Do not construct an on-site wastewater treatment system in natural drainageways, low spots where water might pond, or 10-year floodplains.

Soils often are disturbed during construction.

Depth to Groundwater

Bacteria and other microorganisms in the soil that perform the final treatment of wastewater require oxygen. If soil is saturated, meaning all air spaces are filled with water, aerobic microorganisms will not be able to work. Nebraska regulations require that the bottom of the drainfield system trench or bed must be at least four feet above the highest expected level of the groundwater. If there is less than four feet of unsaturated soil, the traditional drainfield cannot be used, as wastewater will not receive adequate treatment. Soil color is a good indicator of whether a soil is or has been saturated. Alternate saturation and drying of the soil results in discoloration or staining, called mottling, which is not part of the dominant soil color. Mottled soils may have streaks or spots of various shades of gray, brown, and/or reddish brown. This is used as an indicator of seasonal high groundwater; for example, the ground may be dry in summer, but saturated in spring. Mottling shows that groundwater had, at some point in time, risen up to this particular elevation, and remained long enough to cause a chemical reaction. Because groundwater had risen that high at some point in the past, the potential exists for a recurrence. The

groundwater elevation is assumed to be the elevation at which the mottling is observed regardless of whether water is present at the time of the percolation test or site evaluation. Soil boring or excavation may be needed to determine the seasonal high water table. More information can be found in the NebGuides *Residential On-site Wastewater Treatment: The Role of Soil,* and *Residential On-site Wastewater Treatment: Site Evaluation* (due Spring 2002).

Distance to Surface Water

Septic tanks, effluent treatment systems, and lagoons must be at least 50 feet from lakes, ponds, streams, rivers, or other surface water. This 50-foot setback distance requirement reduces the risk of contaminating surface water with pathogens or excess nutrients from wastewater. More information on setback distance is given in the section on design and installation.

Lot Size and Configuration

For new construction, a lot must be large enough, and have soils suitable to support an on-site wastewater treatment system, as well as reserve space for a replacement system. The reserve space cannot be built on or developed. Both the on-site system and the reserve system must meet all state regulations, including setback distances such as distance to groundwater, surface water, property lines, and wells. Lots must be at least three acres in size for a lagoon system to be installed.

Water Usage and Wastewater Quality

Besides the site and its characteristics, consider the quantity and quality of wastewater the home will generate when selecting a type of on-site wastewater treatment system. Some types of systems cannot handle extreme fluctuations in volumes that might occur at a seasonal dwelling.

The quality of wastewater also affects which type of system to select. Home-based businesses or hobbies such as beauty salons, taxidermy shops, or autobody repair shops introduce chemicals into the wastewater that an on-site system may not be able to handle effectively. Restaurants generate grease, which can cause failure of on an on-site system, unless grease traps are installed and maintained. A state permit is required for on-site wastewater treatment systems for any type of home-based business if wastewater quality or quantity is different from typical residential wastewater. See NDEQ *Title 124* for more information.

Summary for Selecting an On-site Wastewater Treatment System

There are many factors to consider when selecting an on-site wastewater treatment system for new residential construction. The most common systems in Nebraska are septic tank/drainfield and lagoon systems. There are many other options, however. Table 1 summarizes the primary options and factors to help determine the system that will work best for a given situation.

Table 1. Primary considerations for selecting type of on-site wastewater system.

Type of system	Consider when:	Maintenance (* Depends on use)	Drawbacks
Septic tank/ Drainfield	-Soil percolation rate: 5 to 60 min./in. -Bottom of trenches & beds at least 4 ft. above highest expected groundwater level. -Slope of site is less than 15%.	-Pump septic tank every 2-3 yrs*. -Prevent deep-rooted vegetation over drainfield. -Prevent soil compaction over drainfield.	-Excessive water use may overload the system. -Garbage disposal use increases pumping frequency.
Septic Tank/ Pressure Dosing	-Drainfield is more than 500 linear ft.	-Pump septic tank every 2-3 yrs*.	-Cost of pump and energy to run pump.
Septic Tank/ Mound System	-Soils with slow or fast percolation rates. -Shallow soil cover over fractured or porous bedrock. -A high groundwater table.	-Pump septic tank every 2-3 yrs*. -Pumps and siphons must be maintained.	-Costs are higher than conventional systems due to design costs (must be designed by a professional engineer), & materials.
Septic Tank/ Gravelless Drainfield System	-Site is remote or difficult to reach. -Chambers require less area than in traditional drainfield. -Typical drainfield materials (gravel) not available.	-Pump septic tank every 2-3 yrs*.	-Potential problems in sandy soils.
Septic Tank/ Constructed Wetland System	-Soil cannot treat wastewater before it percolates to groundwater, such as in clay soils. -Aesthetics are important.	-Pump septic tank every 2-3 yrs*. -Prevent trees from growing in wetland cell.	-Costs are higher than conventional systems due to professional design costs, & materials. -Surface discharged water requires NPDES permit -Disinfection may be necessary.
Septic Tank/ Evapo-transpiration Bed	-Soil cannot treat wastewater before it percolates to groundwater, such as in clay soils.	-Pump septic tank every 2-3 yrs*. -Trim vegetation.	-Not effective in wet or humid climates where precipitation exceeds evaporation & transpiration rates. -Costs are higher than conventional systems due to professional design costs, & materials.
Septic tank/ Sand filter	-Repairing existing malfunctioning system. -Site is an environmentally sensitive area.	-Pump septic tank every 2-3 yrs* -Maintenance varies by design. -Dosing chamber pumps, controls, & timer sequence must be checked.	-Cost is high where media is expensive or must be transported long distances. -Pumps require electricity. -Requires final treatment such as drainfield or ET bed. -Surface discharged water requires NPDES permit.
Aerobic Tank/ Drainfield	-Soil characteristics are not appropriate for a traditional septic tank/drainfield system. -Groundwater table is high or shallow bedrock exists. -A higher level of wastewater treatment is required. -A traditional septic system has failed. -Desirable to extend the life of a drainfield.	-Inspect and pump secondary settling chamber as needed (may be as frequent as 3-6 months)*. -Mechanical parts require periodic checks, maintenance, & repair.	-Costs more to install than other systems. -Problems with sudden heavy loads or neglect. -May release excess nitrate to groundwater. -Electrical costs & associated maintenance. -Requires final treatment in drainfield, sand filter, or ET bed. -Surface discharged water requires NPDES permit. -May require disinfection.
Lagoon System	-Lot is at least 3 acres. -Lagoon bottom will be at least 2 ft. above highest expected groundwater level or fractured bedrock. -Soil percolation rate too slow for traditional septic/ drainfield. -May be used where soils are too permeable if proper liner is used.	-Requires fencing with sign. -Maintain water depth at 2-5 ft. -Keep dike mowed. -Keep vegetation cleared for proper air flow. -Prevent dike from eroding.	-May have short periods of spring & fall odor. -Install liner if seepage is greater than 1/8" per day. -Aesthetic concerns.
Holding Tank	-There is no suitable effluent treatment area. -Lot size is less than 3 acres, so lagoon is prohibited.	-More frequent pumping is required. -Alarm or visible float needed to indicate when tank is 90% full.	-Restricted water use. -Pumping & disposal costs.
Waterless Toilets	-Water is in very limited supply. -Desirable to reduce the quantity and pathogen/ nutrient load of wastewater.	-May require maintenance to prevent odors. -Remove and dispose of ash/compost regularly.	-Incinerator toilets use high energy & may release odors. -Composting toilets may require energy for heat.

How Do I Have a System Designed and Installed?

A professional installer will help explore options and help select the best system for each situation. System design must be based on Nebraska *Title 124* regulations and local codes. A knowledgeable contractor/designer also will know what permits are needed. More information appears in the Permit section. Use a reputable business since industry professionals are not regulated or certified by the state at this time. Get several bids and select the installer who can design and install a system based on state and local codes. NDEQ has a list of installers who have voluntarily attended training sessions.

Site Evaluation

A completed site evaluation will include the type, size, location and elevation of the proposed system as well as the reserve area for a replacement system. Most of the information collected to determine which system to select also will be used in designing a system. If the lot is large enough to allow a choice, the site evaluation will help you choose between different potential system locations. A designer/contractor should conduct a site evaluation and use the information that was collected to develop a scaled drawing that includes:

- the legal description of the property
- property lines
- buildings
- water supply wells
- buried water pipes and utility lines
- the high water mark of lakes, rivers and streams
- the type of water supply wells within 1,000 feet of the proposed system
- depth to groundwater
- depth to confining layer (rock, clay layer) if it is shallower than depth to groundwater
- direction of groundwater flow
- soil conditions, properties and permeability
- proposed area for the system
- proposed reserve area for a replacement system
- slope

See the Extension NebGuide *Residential On-site Wastewater Treatment: Site Evaluation* (due Spring 2002) for more information.

Wastewater Flow

Wastewater treatment systems are designed and sized according to the number of bedrooms and water-using appliances in the home. They are not based on the number of residents because ownership and family size often change.

Wastewater design flow is 200 gallons per day for the first bedroom plus 100 gallons per day for each additional bedroom. It assumes at least some water-using appliances such as a clothes washer, dishwasher, or water softener will be operated in the home. Any on-site wastewater treatment system connected to a residential garage floor drain must be sized 75 gallons per day larger in capacity (see Floor Drain section). A septic tank will need more frequent pumping if a garbage disposal is used, because more solids will be in the wastewater.

Consider family water habits. If family members take long showers, have heavy use of a garbage disposal, or wash a number of loads of laundry in a given day, tell the designer/contractor so the system can be sized accordingly. Since high water use is a common cause of system failure, it is a good idea to be conservative in water use. This is covered in more detail in the section on operating and maintaining a system.

Once the designer knows the site characteristics and estimated wastewater flow, the size of the drainfield, mound, constructed wetland, or other effluent treatment system can be calculated. The estimated wastewater flow is also important in sizing a lagoon or holding tank.

Setback Distances

When determining where to place an on-site wastewater treatment system, adhere to all required setback distances. Nebraska regulations require that septic tanks, effluent treatment systems (traditional drainfields, ET beds, mound systems, etc.) and lagoon systems must be a minimum distance from surface water, wells, and buildings. These distances are listed in Table 2.

Table 2. Minimum Setback Distances in Feet

Item	Septic Tanks	Effluent Treatment Systems	Lagoons
Surface water	50 ft	50 ft	50 ft
Private drinking water wells	50 ft	100 ft	100 ft
Public drinking water wells:			
Non-community system	50 ft	100 ft	100 ft
Community system	500 ft	500 ft*	500 ft
**Wastewater treatment systems handling more than 1,000 gpd must be evaluated for impact on the well by a professional engineer if less than 1,000 feet from a community system.*			
Water lines:			
Pressure-main	10 ft	25 ft	25 ft
Pressure service connection	10 ft	25 ft	25 ft
Suction lines	50 ft	100 ft	100 ft
Trees	No setback	No setback	50 ft
Property Lines	5 ft	5 ft	50 ft
Foundations			
Class 1	15 ft	30 ft	100 ft
Class 2	10 ft	20 ft	100 ft
Class 3	7 ft	10 ft	50 ft
Neighbors' foundations			
Class 1	25 ft	40 ft	200 ft
Class 2	20 ft	30 ft	200 ft
Class 3	15 ft	20 ft	100 ft

Class 1 foundations: Full basements or non-basement footing foundations and slab on grade for living quarters that are lower in elevation than the on-site wastewater treatment system.

Class 2 foundations: Non-basement footing foundations, trailer houses and slab on grade living quarters that are higher in elevation than the on-site wastewater treatment system.

Class 3 foundations: Structures using slab on grade construction and are not used as living quarters.

These setback distances are important to reduce the possibility of contaminating drinking water and other groundwater and surface water. Also, a drainfield should be far enough away from buildings so that rainwater from the roof and other drainage sources do not overload it.

How Should I Protect the Selected Site?

After determining where the on-site wastewater treatment system and reserve area will be located, mark and fence that area so it will not be disturbed during construction. This is especially important for an effluent treatment system such as a drainfield or mound, since compaction can seriously impair the soil's ability to treat wastewater. It is wise to determine where to place the on-site wastewater treatment system, as well as the future replacement system prior to building a home. New developments already may have designated areas for the system and reserve system.

Permits

The owner of a home with fewer than 10 bedrooms that generates less than 1,000 gallons per day of domestic wastewater can construct and operate an on-site wastewater treatment system without obtaining a state permit provided the system meets all design, setback distance and reserve area provisions covered in NDEQ *Title 124*. The owner must keep a copy of pertinent information on-site, including the names, addresses and phone numbers of the owner, contractor and designer; the legal location of the system; and the number of bedrooms and/or gallons of wastewater generated per day. The owner also must keep a scaled drawing of the system that includes its location on the property, setbacks, capacity, materials and construction details. Soil percolation test results also should be kept on file. Although the state may not require a permit, local (county and/or city) planning, zoning, or health departments may have a permitting requirement.

If the home has 10 bedrooms or more, generates over 1,000 gallons of wastewater per day, or generates any non-domestic wastewater from business operations or hobbies within the home, the owner must obtain a construction permit from NDEQ before construction. A professional engineer, licensed in Nebraska, must prepare documents for obtaining a construction permit.

An owner can have a wastewater treatment system repaired without upgrading to the requirements of *Title 124* if the system is functioning properly, and if the repair is to fix a structural component, such as a baffle or a pipe, or a mechanical device such as a pump or blower. Replacing a tank or drainfield, or extending a trench or bed in a drainfield is considered more than a repair, and must meet state regulations.

Floor Drains

A floor drain may be installed in a garage for a private residence provided oil, paint, engine cleaners, or other hazardous materials are not washed into the system. These drains are designed to handle snow and ice melt and wastewater from occasional (external) vehicle washing. Although residential garage floor drains are allowed through Nebraska *Title 124* regulations, some counties and cities do not allow them. Contact the local health or zoning department to find out what is allowed in your area.

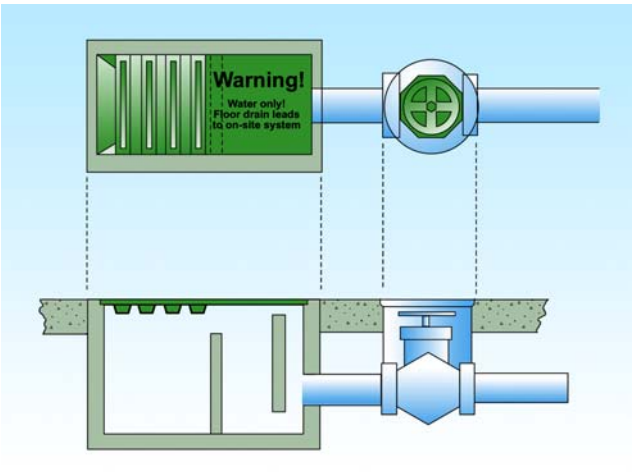

Figure 10. Floor drain for residential garage.

Residential floor drains must have a mud trap, an oil separator and valve located immediately following the drain (Figure 10). Keep this valve in the closed position until the floor drain will be used to collect snowmelt or washwater. After use, close the valve again and clean out settled material. Any on-site wastewater treatment system connected to this drain must be sized 75 gallons per day larger in capacity. As a reminder, place a permanent sign within view of the drain that states **"Warning! This floor drain leads to an on-site system. Disposing of fluids other than water may lead to groundwater contamination."** Although not required, this will help protect the on-site wastewater system, as well as human health and the environment.

Septic Tank/Drainfield Sizing and Installation

Since the septic tank/drainfield is the most common type of on-site wastewater treatment, more specific information on its sizing and installation is provided here. Septic tanks are made of concrete, plastic, or fiberglass. In Nebraska, coated metal tanks no longer can be installed because of the potential to rust. Septic tanks must be watertight to prevent untreated wastewater from entering the soil. The number of bedrooms and water-using appliances in the house will determine the size of the tank. Ideally, the septic tank will hold wastewater long enough for primary treatment to occur — the solids to settle as sludge and the lighter materials to float and form a scum layer. Excessive water use or an undersized tank will force wastewater to the drainfield before primary treatment is completed, and may clog the drainfield system. The minimum size septic tank for a dwelling is 1,000 gallons.

Baffles or tees are important components of a septic tank (Figure 2, pg. 5). The tank should have an inlet baffle or tee to force entering wastewater down into the tank. This ensures mixing, which encourages bacterial break down of organic materials. The inlet baffle also prevents the scum layer from floating back and clogging the inlet pipe. Each tank also needs an outlet baffle or tee, to prevent the scum layer from moving into the drainfield or other type of effluent treatment system and clogging it.

The tank must have one or more access manholes for cleaning. These often are buried below ground level. The septic tank should have inspection pipes if the inlet and outlet do not have manholes over both of them**.** See the Extension publication *Residential On-site Wastewater Treatment: Septic Tank Design and Installation* (due Spring 2002) for more information.

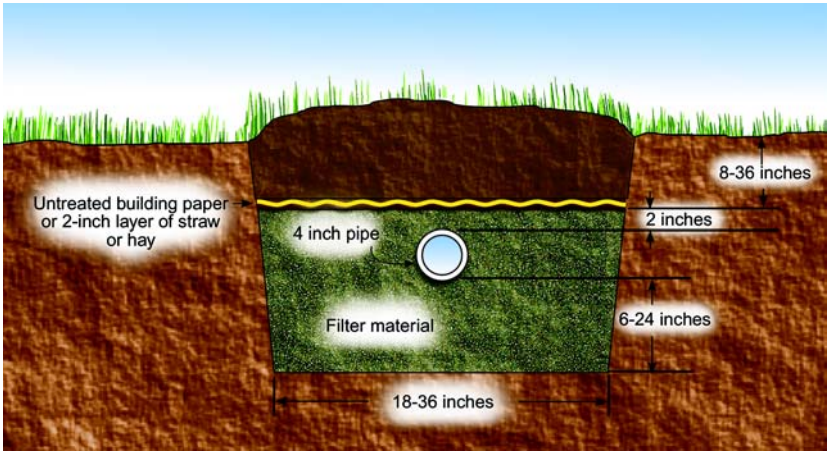

Figure 11. Trench with pipe lateral.

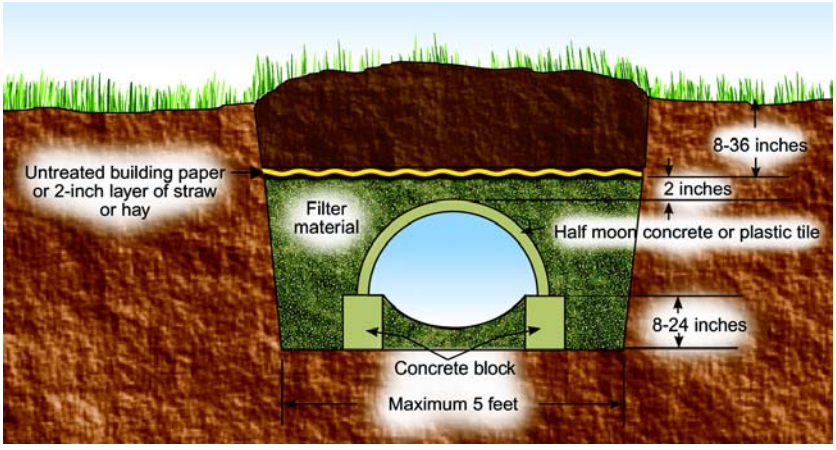

Figure 12. Trench with traditional chamber.

Effluent from the septic tank travels through a pipe to a treatment system, often a drainfield, where final treatment occurs. The drainfield is composed of trenches or beds, the most economical and preferred method for treating the effluent. Trenches are between 18 and 36 inches wide for pipe laterals (Figure 11) and no more than five feet wide for chambers (Figure 12). Beds are over 36 inches wide for pipe laterals and over five feet wide for chambers. Beds have a slower filtration rate than trenches. Traditional trenches and beds are filled with gravel or other filter material. A typical drainfield will require 20 to 66 inches of vertical depth, from the soil surface to the bottom of the bed or trench, depending upon soil characteristics and materials (Figures 11 and 12). The maximum depth from soil surface to the top of the distribution pipe is 38 inches. In addition, the bottom of the trench or bed must be at least four feet above the groundwater table, bedrock, or other barrier so that there is enough soil for the effluent to be properly treated. The specific size of the trench or bed depends upon the percolation rate for the site, and the amount of water that will be treated each day. See NDEQ *Title 124* or Extension publication *On-site Wastewater Treatment: Traditional and Gravelless Drainfield Systems for Septic Tank Effluent Treatment* for design specifics.

It is desirable, but not necessary, to have gravity flow throughout the wastewater treatment system to avoid the need for a pump. The depth of the septic tank depends on the house wastewater plumbing and whether gravity flow from a basement sewer drain or toilet to the tank is feasible.

For homes with a basement sewer drain or toilet, try to build the house high enough relative to the septic tank for gravity flow from the basement plumbing to the tank, if possible. Tanks are typically designed to handle 2 to 3 feet of soil cover. Refer to technical information regarding your specific tank when deciding the depth, as deeper placement may void the warranty, since there is a risk of the tank collapsing due to the weight of the soil. The system may need a pump to lift septic tank effluent from a pumping chamber, connected to the septic tank, up to higher drainfield lines. If it is not possible to build the house high enough for gravity flow from the basement plumbing to the tank, install a grinder pump or sewage ejector pump to lift wastewater out of the basement to an elevation suitable for drainage to a septic tank. In this situation, both solids and liquids must be pumped. In the first scenario, only the septic tank effluent, liquid with larger solids removed, must be pumped. Your system installer/designer will help you select the type and size of pump, and frequency of pump operation to provide the desired application of wastewater to the drainfield area.

A good installer will not construct the soil treatment system when the soil is extremely wet, such as after heavy rainfalls. Heavy equipment will compact wet soils and may result in a poorly functioning system. Before any excavation, call the Diggers' Hotline (800-331-5666) to locate underground utilities. During construction, the installer should take proper safety precautions when excavating to install septic tanks and sewer lines by using supports to prevent sidewalls from collapsing. People have been seriously injured and even killed when sidewalls have caved in. Also, cover holes that could be dangerous for children, adults, or animals with boards that cannot be readily removed, and surround with fencing. The installer should back-fill immediately after setting a tank in position to reduce the possibility of accidents.

Drop Boxes and Distribution Boxes

Septic tank effluent may be spread or distributed between trenches of a drainfield with a distribution box or a drop box. The distribution box may be built as part of the tank or may be a separate unit. As with septic tanks, a distribution box must be watertight and non-corrosive. The distribution box must have an opening at least 12 inches in diameter for inspection, cleaning, leveling, and maintenance.

The distribution box must be level and arranged so that effluent is evenly distributed to each trench or bed. Each trench or bed must have its own connection to the box. All of these outlets must be the

same elevation. The installer will level the box, but when covered with soil, or due to settling over time, the distribution box often will no longer be level. It will not perform its function of spreading effluent evenly throughout all trenches. For this reason, distribution boxes are not the most desirable option for distributing effluent. A better alternative, a drop box, is described later.

A distribution box may not be used on slopes greater than 3%. Wastewater could potentially continuously flow to only one trench if the distribution box settles, is bumped, or not set properly, rather than allow equal use of all the trenches. For slopes greater than 3%, a pressurized distribution system or drop box must be used.

Because of the difficulty in maintaining a level distribution box and the slope restrictions, a drop box is a more favorable way to distribute water through the drainfield. Drop boxes must be watertight and non-corrosive. The bottom of the inlet pipe must be at least one inch higher than the bottom of outlet pipe to the next trench (Figure 13). The outlet pipe to the next trench must be at least two inches higher than the outlet pipe of the trench in which the box is located. The drop box must have a removable cover either flush with or above finished grade, or covered by more than six inches of soil.

Drop boxes work well on slopes (Figure 14). They allow all of the trenches or beds to be used, instead of having wastewater constantly flow to only one trench. A series of trenches is dug parallel to the slope so that each trench is higher/lower than the next (Figure 15). Starting with the highest, each trench fills with wastewater completely, then overflows through a series of drop boxes. Running trenches perpendicular to the slope is not an option, as all water would run to the end of the trench, not allowing full use of the entire trench area, and usually resulting in system failure.

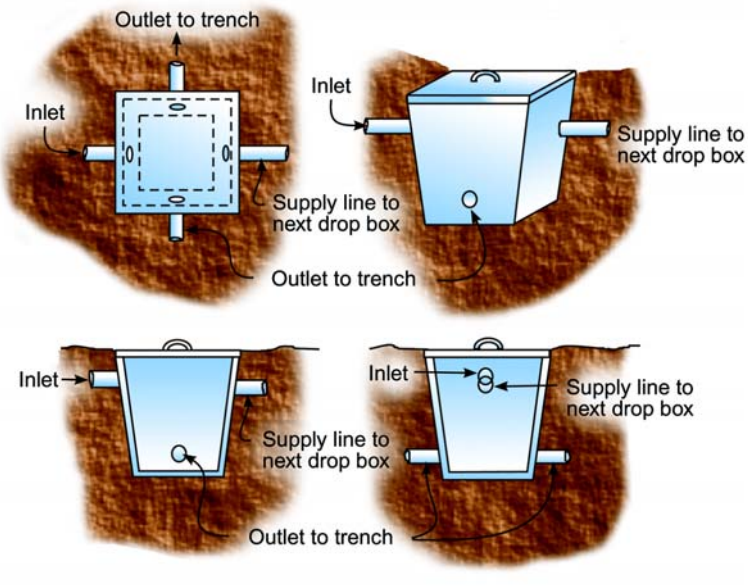

Figure 13. Drop box.

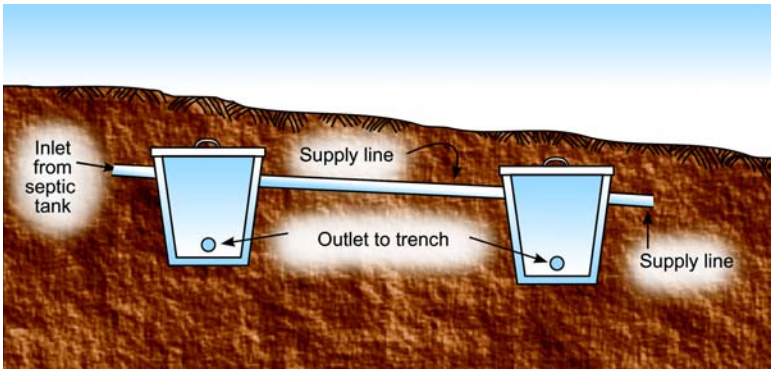

Figure 14. Serial distribution with drop boxes on slope.

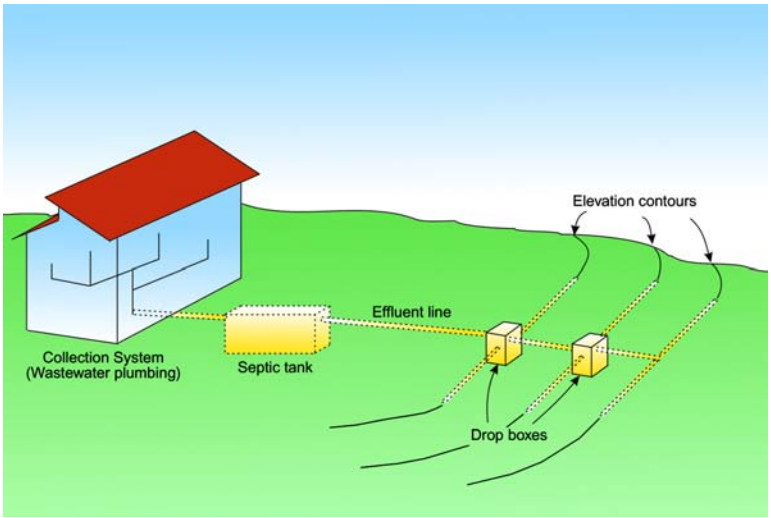

Figure 15. On-site wastewater treatment system on the contour, using drop boxes.

Lagoon Design and Installation

The lagoon system is an effective method of residential on-site wastewater treatment and is well suited for lots with at least three acres, where soils have very slow percolation drainage rates. Lagoons are constructed and lined with material such as clay or an artificial liner that will allow no more than 1/8 inch seepage per day to the groundwater below.

Every lagoon system must be individually planned to fit its specific site and use. Designs are based on factors including soil characteristics, amount of land area available, climate, amount of sunlight and wind in the area, and type and amount of wastewater to be treated. Nebraska *Title 124* has standard designs for a typical residential application. Although a lagoon is a relatively simple system to design and construct, consider having an experienced, qualified professional design it.

Ideally, a lagoon should be constructed in an area with clay or other soils that won't allow the wastewater to quickly percolate down through the lagoon bottom to the groundwater. If the natural soil allows more than 1/8 inch seepage of water per day, Nebraska regulations require that the lagoon must be artificially lined with soda ash, bentonite, or a synthetic liner to prevent groundwater pollution. These liners usually increase system costs.

The bottom of the lagoon must be at least two feet above the highest expected level of groundwater, and at least two feet above fractured bedrock. Setback distances to property lines, wells and other property features are listed in Table 2 (pg. 16). Also, a lagoon should be located downgrade and downwind from the home it serves, when possible, to avoid the extra cost of pumping the wastewater uphill and to prevent occasional odors from becoming a nuisance.

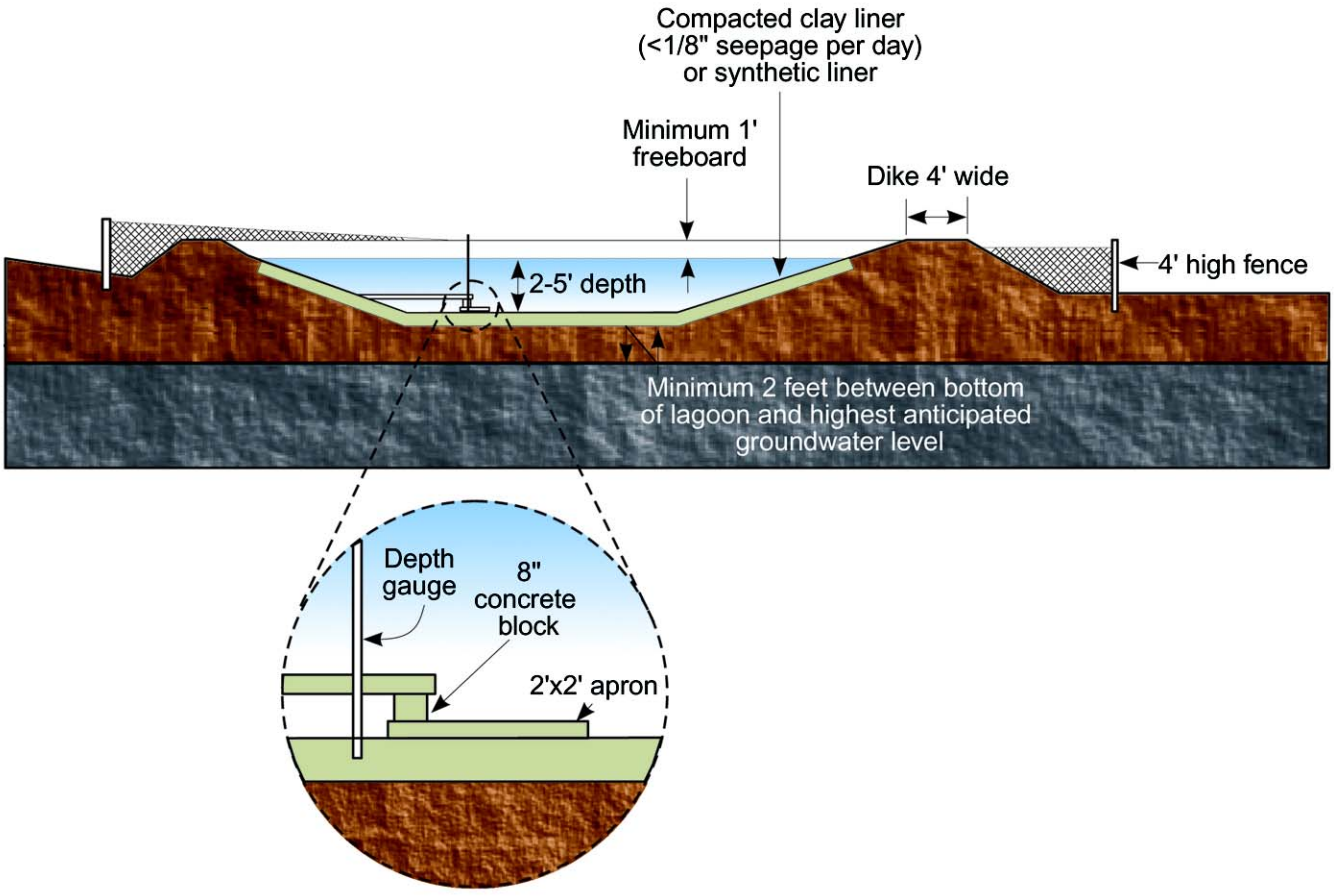

Figure 16. Wastewater lagoon showing dike, fence, and inlet pipe.

The average velocity and predominant direction of wind at the site is another important factor that helps to determine the lagoon's exact position. Any obstruction to wind or sunlight, such as trees or surrounding hillsides, must be considered. Sometimes trees and tree stumps need to be removed. Weed growth around lagoons should be controlled for the same reasons.

The exact dimensions of a lagoon vary depending on the amount of wastewater that needs treatment, the climate and whether other types of treatment also are being used. The size and shape of a lagoon is designed to maximize wastewater treatment. A lagoon can be round, square, or rectangular with rounded corners. The top of the dike should be at least four feet wide for ease in mowing, and provide at least a foot of freeboard. This is the distance from the top of the five-foot water level to the top of the dike (Figure 16).

The bottom of the lagoon should be as flat and level as possible to allow continuous circulation of wastewater in the lagoon. The wastewater in the lagoon must be two to five feet deep, so there is enough surface area to support the algae growth needed, but also enough depth to maintain anaerobic conditions at the bottom. Water depth in a lagoon will vary throughout the year, but the minimum two-foot level will prevent the bottom from drying out, and reduce the chance of odors. Also, this range of depth allows algae to use sunlight most effectively, and ensures that there is a large surface area exposed to the air for water to evaporate more readily. There should be no vegetation taller than the top of the dike within 50 feet of the dike. The vegetation could interfere with wind flow, or potentially shade the lagoon. In addition, water from surface drainage or storm runoff should be kept out of lagoons. Sometimes it is necessary to install diversion terraces or drains at the site to accomplish this.

A properly designed lagoon will not have an odor problem, although there may be odors during a few weeks of spring and fall due to water turnover caused by temperature changes. Lagoons can be a breeding area for mosquitoes and other insects. Freezing in winter months should not be a problem if the lagoon is in normal use and the minimum two-foot water depth maintained. If a lagoon is allowed to dry, cracks may form in the clay liner. The seal must be reestablished before filling with wastewater, by disking or raking to rough up the clay liner, and recompacting it.

A lagoon can attract children, pets and unsuspecting adults who may think it looks like a good place to play and even swim. Nebraska regulations require that a four-foot high fence with a locking gate surround each lagoon. The fence may be woven wire, welded wire, or seven strands of barbed wire with the lowest wire three inches from the ground. The fence should be at the top of the dike, or four feet outside the toe of the dike. Each gate must have a warning sign which reads **"NO TRESPASSING – WASTEWATER LAGOON."** Although lagoons usually are not very deep, people have drowned in them. Lagoon bottoms can be both very slick and sticky in places from linings, slime, clay and sludge, which make it difficult for anyone who has entered a lagoon to get out. See Extension publication *Residential On-site Wastewater Treatment: Lagoon System Design and Installation* (G01-1441) for more information.

Information on Existing Systems:

How Do I Locate the Main Parts of an Existing System?

Counties with inspection and permit programs may have information about existing on-site wastewater treatment systems. It should be fairly easy to find a lagoon or constructed wetland system. As the owner of an older home or potential new owner of a home that has no records, it is important to find the system to confirm that one is in place, that it is functioning properly, and that wastewater is not illegally being discharged to surface water, groundwater, or land. Also, distance to water wells and other setbacks can be determined. An owner should know where the system is located for pumping and maintenance, as well as for any future remodeling or construction. Before purchasing property, have the tank pumped and the system inspected by a competent professional.

Look for an access manhole or inspection pipe at ground level to locate the septic tank. Unfortunately, these are often buried several inches to several feet below ground. In this case, you may want to contact a professional to investigate your system. Older tanks may be metal, and concrete tanks may have metal reinforcing rods, so a metal detector may be helpful. Another option is to have a septic tank maintenance person flush a small transmitter down the toilet and use a receiver to locate the tank.

To find the drainfield, look around the yard in the general direction where the sewer pipe left the house for an area where the grass grows differently. The drainfield releases water and nutrients to the soil, which may give clues as to its location. In summer the grass may be greener. In winter the snow may melt more quickly. There may be a slight depression or mound. The area may be soggy when the rest of the yard is dry, which is not a good sign. It means the wastewater is surfacing instead of draining down into the soil for treatment.

If the owner is unable to find the drainfield, a pumper or designer usually has the tools to find it. If no one can find the drainfield, there simply may not be one. The wastewater may be going to a ditch, surface water, or just into the ground. This doesn't treat wastewater to remove pollutants such as pathogens and nutrients and is not legal.

Once the septic tank and drainfield have been located, sketch a map to keep with other wastewater treatment system records. This will be important when the system is inspected and pumped, or when the property is sold.

How Do I Operate and Maintain My System?

Homeowners should know what to expect from a properly functioning on-site system and be able to tell when a system is malfunctioning. Besides overuse of water, homeowner neglect is one of the most common factors contributing to system failure. An on-site wastewater treatment system is not as forgiving as a municipal system in terms of water usage and materials that go down the drain.

An on-site wastewater treatment system may fail in two ways. The system may fail to accept all of the wastes discharged into it, and/or the system may fail to properly treat the wastewater. Both of these may be due to faulty design, faulty installation, or homeowner neglect/abuse.

Owner's Responsibilities for Using a Septic Tank/Drainfield System

Practice sound water conservation measures.

Excessive water use places a strain on the septic system. For best performance, an on-site system needs enough time to treat the wastewater. Every time wastewater enters the septic tank, an equal amount leaves it and enters the drainfield. Large amounts of wastewater entering the septic tank over a short period of time may stir up the scum and sludge, and resuspend solids in the liquids. These solids could be carried into the drainfield and eventually clog it, causing the system to fail.

What you can do:

- Use low volume water appliances (toilets and showerheads) when possible. Newer toilets use as little as 1.5 gallons of water or less per flush, compared to older models which use up to 6 gallons. Low volume toilets are required in new construction.
- Try to distribute wastewater loads over a number of days. Don't wash five loads of laundry in one day. Instead, wash one or two loads per day.
- Fix leaky faucets and toilets.
- Take short showers.
- Shut off water while shaving or brushing teeth.
- Fill the basin to wash hands or dishes instead of washing under running water.
- Wash only full loads of dishes or laundry.
- Route roof drains and basement drainage tile water outside of the septic system and away from the drainfield (see *"Never apply large amounts of water to the drainfield,"* in this section).

Have the septic tank pumped regularly. This is one of the few but vital tasks a homeowner faces. If sludge and/or scum enter the drainfield, they could cause expensive and possibly irreparable damage. How often you should have your tank pumped depends upon the size of the tank, the volume and quality of wastewater generated, and the number of water-using appliances in the home. Garbage disposals and newer dishwashers that have garbage grinders built into them can greatly increase the load to the septic system. Many experts recommend a tank be pumped every 2-3 years.

What you can do:
Have the tank inspected annually until it is determined that pumping is required. The tank should be pumped when the bottom of the scum layer is within three inches of the bottom of the outlet baffle, the top of the scum layer is within one inch of the top of the outlet baffle, or the top of the sludge layer is within 12 inches of the bottom of the outlet baffle (Figure 17). Once the pumping interval is established, follow it until there is a change in your water-use patterns that would require the tank to be pumped more or less frequently.

Warning: Only a qualified service person using proper safety precautions should enter a septic or dosing tank. Lack of oxygen or the presence of dangerous gases could be fatal. Do not allow anyone to smoke in the vicinity because volatile gases may be present. Make certain septic tank lids are secured to keep out children and animals.

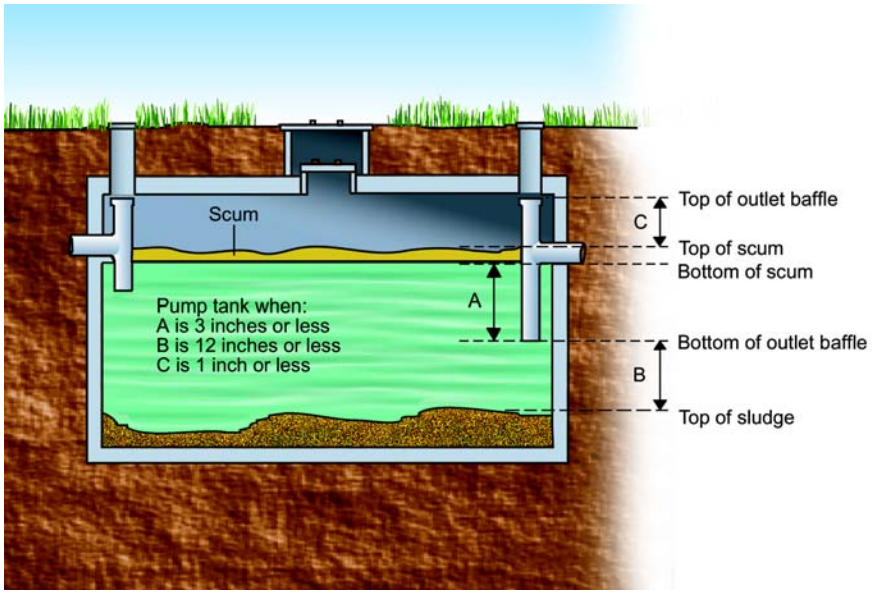

Figure 17. Measurements to determine if a septic tank should be pumped.

A professional should pump and inspect a tank, as this involves more than just removing the septage, or wastewater from the septic tank. A septic tank cannot be adequately cleaned or inspected using the inspection pipe, typically only four inches in diameter. If the inspection pipe is used, the scum layer could plug the outlet baffle when liquid again fills the tank. To properly pump the tank, use the manhole.

Some of the liquid should be pumped out, and then injected back into the tank under pressure to agitate the sludge into suspension. If the scum layer is hard, the septage should be agitated in the tank with air or a long-handled shovel through the manhole to break up the scum layer.

When all of the solids have been broken up and are suspended in the liquid, the septage should be pumped out of the septic tank into the truck. Unless the manhole is open, it is impossible to tell if all of the solids have been removed. Also, when the manhole is open, the condition, length and submergence of the inlet and outlet baffles should be checked and replaced if they are the wrong length or in poor condition. Septage should be disposed of according to Federal 40 CFR 503 regulations, or local regulations if they are more stringent. The homeowner is liable/responsible if septage is illegally disposed of (see *"What happens to waste pumped from the septic tank?"* for information on proper disposal).

It is not necessary to leave solids in the septic tank as "seed." Incoming wastewater contains enough microorganisms to repopulate the system. Do not wash, scrub, or disinfect the tank. Because microbial action is necessary, you do not want a clean, sterile environment.

Never apply large amounts of water to the drainfield. Do not allow water from roofs, driveways, patios and other areas to drain over any part of the on-site wastewater treatment system.

What you can do:

- Divert runoff water from roofs, concrete patios, driveways, or other impervious surfaces away from the system.
- Do not install an underground lawn sprinkler system that would discharge water over any part of the drainfield.
- If a slight amount of watering is required on a mound system or a lawn to maintain the grass cover, use a manually operated sprinkler, and measure the amount supplied. Do not overwater the drainfield.

Do not place additional soil fill over the drainfield other than to fill slight depressions due to settling. However, a slight mounding will ensure runoff of surface water. Microbial breakdown occurs in the drainfield, and these organisms need air, which is more readily available closer to the soil surface.

What you can do:

- If any surface water ponds over the system, add adequate fill and landscape to eliminate ponding.
- Do not add large amounts of soil to any portion of the system; only add enough to maintain the original grade, not change the grade.

Maintain vegetation over the drainfield. Establish grass or natural vegetation over the drainfield unit, as this cover helps the system remove some water and prevents erosion.

What you can do:

- For drainfields and mound systems, establish grass vegetation.
- Mow frequently to encourage vegetative growth.
- Keep rodents out of the drainfield area.
- Do not plant trees or other plants with deep invasive roots within five feet of the drainfield.

Don't compact soil in the drainfield. Driving vehicles on the mound system or drainfield before, during, or after construction can damage it. Soil treatment depends on undisturbed, uncompacted soils to treat wastes. In winter, a vehicle's weight can drive frost deep into the soil and prevent treatment from occurring.

What you can do:

- Avoid unnecessary foot traffic and any vehicular traffic over the drainfield.
- Do not allow traffic of any type in the winter that would compact accumulated snow over the drainfield.
- Do not tie or confine livestock or pets over the drainfield at any time.

Do not use additives. Additives fall under three major categories:

- Starters to get bacterial action going in the septic tank;
- Feeders to supplement and/or feed bacterial populations; and
- Cleaners to clean the tank.

Current research indicates that additives do **not** improve the performance of a septic tank, and may actually increase the chance for clogging a drainfield. Some additives, especially "cleaners," allow solids to remain in suspension, instead of settling into the sludge layer. Then, they may be carried to the drainfield and clog it.

What you can do:

- Do not use additives. Millions of bacteria enter the septic system through normal use. There is no need to add more, nor is there a need to feed them.
- Do not wash or disinfect the tank.

Avoid disposing of potentially hazardous materials in the septic system. Remember that any chemicals such as antifreeze, bleach, ammonia, or other products that are poured down the drain flow to the septic tank and drainfield. Overloading the system with these products may reduce the ability of bacteria and other microorganisms to break down waste. Chemicals that are not broken down in the septic tank or drainfield may enter the groundwater.

What you can do:

- Avoid using toilet bowl cleaners that automatically dispense chemicals with each flush.
- Use household cleaners and drain cleaners sparingly. Careful use of chemicals should not harm the system.
- Unused and unwanted chemicals should not be disposed of in toilets or drains. They should be properly handled through a household hazardous waste collection program.
- Do not dump unwanted pesticides such as herbicides, fungicides, or insecticides down the drain.
- Do not dump paints, thinners, or solvents down the drain.
- Do not dump excess medications down the drain.

Don't expect the septic system to handle all household wastes. Do not use the toilet as a garbage can. Cigarettes, facial tissues and sanitary products will clog the plumbing or increase the scum or sludge in your tank. Discarding food through a garbage disposal uses a lot of water and adds significant amounts of scum and sludge to the septic tank, which will require more frequent pumping, and may contribute to premature drainfield failure.

What you can do:

- Manage these as solid waste rather than with wastewater.
- Compost vegetable scraps if possible.
- Have effluent filter/screen installed at septic tank effluent tee to further protect drainfield.

See the Extension publication *Residential On-site Wastewater Treatment: Septic System and Drainfield Maintenance* (G01-1424A) for more information.

What Happens to Waste Pumped from the Septic Tank?

Homeowners and owners of establishments with on-site wastewater treatment systems are responsible for what the pumper/hauler does with septage. In Nebraska, septage may be taken to a public wastewater treatment system for disposal, or land applied following Federal 40 CFR 503 regulations-*Standards for the Use or Disposal of Sewage Sludge*. Local regulations may be more stringent.

Septage provides valuable nutrients and some organic matter to the soil. To protect public health, septage that is land applied must be either injected immediately, or plowed or disked into the soil within six hours of application. Another option requires that the septage be stabilized with lime to decrease odors, decrease the levels of pathogens, and provide further breakdown of the waste. Then it can be applied to the land without injection or incorporation. There are restrictions as to what crops may be grown, or what the land can be used for if septage has been applied.

Contact NDEQ or your local health department to learn if there are more stringent local regulations.

Owner's Responsibilities for Using a Lagoon System

One of the advantages of a lagoon is that it requires minimal maintenance to perform well. However, this doesn't mean it should be neglected.

Establish grass or natural vegetation on the dike. The vegetative cover protects soil from eroding.

What you can do:

- Establish and maintain grass vegetation on the dike.
- Mow frequently to encourage vegetative growth. Never let vegetation grow above 6 inches.
- Keep rodents and other burrowing animals out of the dike.
- Do not allow trees or other vegetation taller than the height of the dike within 50 feet of the dike, as they reduce wind flow and may shade the surface, reducing evaporation.
- Do not plant trees or other plants with deep invasive roots near the dike.

When performing maintenance tasks, always minimize exposure to wastewater by wearing protective and waterproof gloves. After completing the tasks, thoroughly wash hands or shower, and disinfect any breaks in the skin.

Control weeds in the lagoon. Weeds take up valuable space that should be occupied by algae, and they can stop sunlight and wind from reaching the wastewater.

What you can do:

- Control weeds. Physically remove duckweed and hyacinth using a boat and a rake.
- Pick up trash, leaves, and branches that blow around the lagoon.

Maintain the fence, gate, and warning sign. These are important safety features.

What you can do:

- Check for holes or gaps at the bottom of the fence monthly.
- Repair sags or holes that would allow children and animals to enter the lagoon area.
- Make sure the gate closes and locks.
- Make sure the sign is visible.

See the Extension publication *Residential On-site Wastewater Treatment: Lagoon Maintenance* (G01-1423A) for more information.

Troubleshooting On-site Wastewater Treatment Systems

Some of the problems that occur include sluggish drainage, contaminated drinking water, wastewater surfacing in the yard, odors, pipes freezing, or lagoons overflowing. If any of these occur, the following list may help narrow down the cause of the problem. The first section covers problems and solutions for wastewater treatment systems in general. The next section covers problems and solutions for septic tank/drainfield systems, followed by a section with problems and solutions specific to lagoon systems.

Troubleshooting - General

Sluggish or no drainage from fixtures, or back-up of wastewater into the house may be caused by:

- Improperly designed and/or installed system
- Improper plumbing in the house
- Blockage in house plumbing
- Improper appliance operation
- Excess water entering system
- Blockage in sewer line between house and wastewater treatment system
- Improper elevations in wastewater system
- Pump failure or improper operation if system is not a gravity flow

Contaminated drinking or surface water may be caused by:

- Inappropriate or improperly installed wastewater treatment system
- Wastewater treatment system too close to well
- Direct flow of wastewater to surface or groundwater
- Improper water supply well construction or damaged water supply well
- Broken water supply pipe
- Broken wastewater lines
- A source other than owner's system

Sewage odors indoors may be due to:

- Improper plumbing and venting in house
- Traps not filled with water
- Wastewater back-up into house

Sewage odors outdoors may be due to:

- Wastewater surfacing in yard
- Improper plumbing and venting in house
- Pump station vent or an inspection pipe located too close to house
- Inspection pipe caps damaged or removed
- Wastewater back-up into house
- Source other than owner's sewage system

Troubleshooting Septic Tank/Drainfield Systems

Sluggish or no drainage from fixtures, or back-up of wastewater into the house may be caused by:

- Improperly designed and/or installed system
- Improper plumbing in the house
- Blockage in house plumbing
- Improper appliance operation
- Excess water entering the system
- Improper elevations in wastewater system
- Pump failure or improper operation if system is not a gravity flow
- Blockage in wastewater line between house and septic tank
- Blockage in septic tank
- Blockage in line from septic tank to drainfield
- Blockage in distribution box, drop box, or pipe
- Blockage at the drainfield/soil treatment interface, where wastewater enters soil

Contaminated drinking or surface water may be caused by:

- Inappropriate or improperly designed and/or installed wastewater treatment system
- Wastewater treatment system too close to water supply well
- Direct flow of wastewater to surface or groundwater
- Improper water supply well construction or damaged water supply well
- Broken water supply pipe
- Broken wastewater lines
- Leaking septic tank
- A source other than owner's system

Sewage odors indoors may be due to:

- Improper plumbing and venting in house
- Traps not filled with water
- Wastewater back-up into house
- Wastewater surfacing in yard
- Unsealed wastewater ejector sump pump

Sewage odors outdoors may be due to:

- Wastewater surfacing in yard
- Improper plumbing and venting in house
- Pump station vent or an inspection pipe located too close to house
- Inspection pipe caps damaged or removed
- Wastewater back-up into house
- Unsealed wastewater ejector sump pit
- Source other than owner's wastewater treatment system

Wastewater surfacing in yard may be caused by:

- Excess water entering system
- Blockage at the drainfield/soil treatment interface where wastewater enters soil
- Blockage in distribution pipe
- Improper elevation for drainfield
- Restricted or impaired flow through the distribution box, drop box, or drainfield
- Undersized drainfield due to design or construction
- Pump failure or improper operation
- Inappropriate or improperly designed and/or installed system

Distribution pipes and/or drainfield freezes in winter may be due to:

- Improper construction
- Check valve in pump to lift wastewater to tank or effluent to drainfield not working
- Traffic over subsurface pipes (drainfield, pipe to drainfield, etc.)
- Low wastewater flow rate
- Lack of use

Troubleshooting Lagoon Systems

Lagoon depth falls below 2-foot minimum, due to:

- Not contain enough clay in natural soil liner or not compacted
- Leak in artificial liner
- Clogged inlet pipe
- Low flow rate into lagoon
- Holes in dike from plant roots or burrowing animals

Lagoon flows over the dike and banks. This may be caused by:

- Improper sizing
- Excessive water use
- Excess precipitation
- Surface water from site is draining into lagoon

Lagoon has persistent odor. This may be due to:

- Algae bloom blocking sunlight
- Anaerobic conditions
- Insufficient air flow – blocked by trees, shrubs, or other vegetation
- Improper sizing and/or overloading

Lagoon has high numbers of flies and mosquitoes:

- Long grass and weeds may be blocking the wind and providing breeding areas for flies, mosquitoes, and other insects.

Additional Resources

Extension publications, available from County Cooperative Extension Offices or Publications Distribution, UNL Cooperative Extension, Lincoln, NE 68583-0927:

Residential On-site Wastewater Treatment: An Overview
*Residential On-site Wastewater Treatment: Constructed Wetlands
Residential On-site Wastewater Treatment: Lagoon Design and Construction
Residential On-site Wastewater Treatment: Lagoon Maintenance
*Residential On-site Wastewater Treatment: Mound Systems
Residential On-site Wastewater Treatment: Septic System and Drainfield Maintenance
*Residential On-site Wastewater Treatment: Septic Tank Design and Installation
*Residential On-site Wastewater Treatment: Soils
*Residential On-site Wastewater Treatment: Site Evaluations, and Percolation Tests
*Residential On-site Wastewater Treatment: Traditional and Gravelless Drainfield Systems for Septic Tank Effluent Treatment.

*Anticipated publication Spring 2002.

NDEQ publications, available from 1200 N Street, Lincoln, NE 68508:
Title 124: Rules and Regulations for the Design, Operation and Maintenance of On-site Wastewater Treatment Systems

County Soil Survey Maps are available from UNL Conservation and Survey Division, 113 Nebraska Hall, Lincoln, NE 68517.

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