## Table of Contents

2  Introduction

What Does a Wastewater Treatment System Do?

3  Human Health and Safety Issues

3  Environmental Risks

4  Components of an On-site Wastewater Treatment System

Information on New Construction

4  What Options Are Available?

Which System Is Right for Me?

9  Things to Consider

Information on Existing Systems

18  How Do I Locate an Existing System?

19  How Do I Operate and Maintain My System?

19  Owner’s Responsibilities for Using a Septic Tank/Drainfield System

23  What Happens to Waste Pumped from the Septic Tank?

Troubleshooting On-site Wastewater Treatment Systems

24  Guide

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Residential On-site Wastewater Treatment: An Overview

Introduction
This publication will answer many questions that homeowners or potential homeowners, real estate agents and lenders may have about residential on-site wastewater treatment systems. Information is based on Iowa Administrative Code (IAC)567-Chapter 69, Private Sewage Disposal Systems of the Iowa Department of Natural Resources. This code requires that any home or building that generates wastewater have an on-site wastewater treatment system in accordance with those regulations, or be connected to a public wastewater treatment system. IAC567 - Chapter 69 applies to domestic wastewater from 4 homes or less or non-residential wastewater with a flow of less than 1,500 gallons per day. Industrial or commercial waste of any flow rate is not covered by these rules. See IAC 567 - Chapter 69 for more information.

Many Iowans 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, or other system specifically engineered for the site. Success or failure of a system depends on the site, design, installation, operation and maintenance.

In Iowa, domestic 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. Both blackwater and graywater must be collected and treated. Restaurant wastewater is considered domestic waste. 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.

The State of Iowa requires a homeowner to have a permit to construct — and in some counties to operate — an on-site wastewater treatment system. This permit is normally issued by the local county board of health or its agent. This agent is the county environmental health office or county sanitarian.

Every system must meet all provisions for design and separation distances required in Chapter 69. A site and soil evaluation or percolation test must be conducted to determine the capability of the soil to handle the treatment function. Information about the final system including the contractor/designer must be kept onsite for future reference. The primary goal is that onsite wastewater treatment systems must not endanger human health and must not cause environmental pollution.

Realistically, all wastewater treatment systems may cause some increase in pollutant concentrations in ground and surface water. The intent 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 disease 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, giardiasis, cryptosporidiosis 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, pharmaceuticals 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.

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.

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 (page 13) lists conditions

| Figure 1: | Typical composition of an on-site wastewater treatment system. |
| Figure 2: | Septic tank. |

or characteristics and gives maintenance requirements and drawbacks to each option.

Septic Tank (Primary Treatment)
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. In Iowa, a septic tank or primary treatment tank is required for all treatment systems. In addition, an effluent screen is required in the outlet of the tank to prevent solids from traveling into the treatment system.

Figure 3: Trench with pipe lateral.

Bacteria naturally occur in sewage entering the septic tank. They begin to break down and dissolve 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.

Secondary Treatment: Soil Drainfield
The most common type of secondary wastewater treatment system is a drainfield, also called the leach field, seepage bed or absorption field. When site conditions allow, this is often the most economical method available.

In a traditional gravel leachfield, wastewater from the septic tank, called effluent, travels through a pipe to the drainfield. The drainfield is a trench filled with gravel, surrounding a four-inch PVC perforated pipe, topped with soil (Figure 3). Effluent moves through spaces in the gravel and enters the soil, where millions of naturally occurring microorganisms consume the organic matter and kill some pathogens. The soil helps tie up viruses and some nutrients, such as phosphorus, 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.

Gravelless Systems
Although a traditional drainfield system has trenches filled with gravel, there are now several gravelless alternatives. In a gravelless system the trench may be held open by a fabric covered corrugated pipe (Figure 11, page 14), a plastic gravelless chamber (Figure 4), a mesh casing of Styrofoam packing “peanuts,” a bundle of four-inch corrugated plastic pipe or other material set in a trench and covered without the use of gravel. In the gravelless chamber system, effluent moves through piping from the septic tank through the distribution box into the chambers where it is free to travel along the earthen base of the trench until it is absorbed. In other gravelless systems the effluent may be conveyed along the trench through various diameter pipes and exits through holes or slots located in the pipe to enter the soil for treatment. In all cases, the effluent treatment takes place in the soil along the trench bottom and some of the sidewall. The purpose of the gravel or gravelless trench fill material is only to hold the
soils have appropriate percolation rates and are normally unsaturated, meaning spaces between soil particles are not all filled with water. Some areas of Iowa have clay soils with very slow percolation rates. Alternative wastewater treatment systems have been developed for these situations.

**Pressure Dosing**

Iowa regulations strongly recommend pressure dosing for proper treatment of wastewater anytime more than 500 linear feet of drainfield is needed or in sand filters and mound systems. Pressure dosing is also recommended where elevation restrictions prohibit gravity distribution. 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.

**Mound System**

Mound systems (Figure 5) are helpful where the water table or bedrock is close to the soil surface, or percolation rates are too slow or too fast for adequate soil wastewater treatment.

In this system, the drainfield is located on top of a layer of sand covered by a mound above the natural soil surface. 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.

**Sand Filters**

The sand filter is an option for secondary treatment where the size of the site or the condition of the soils will not support a wastewater system that relies on the soil for treatment (Figure 6, page 6). Sand filters are often used as a replacement for a failed system or for “final” treatment following another type of alternative system.

The typical sand filter is an excavation, sometimes plastic lined, filled with clean, coarse sand and rock. The surface may be covered with soil (buried) for large sand filters or a removable cover for smaller free access sand filters.

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 or be discharged to the ground surface. If the water is surface discharged, the owner may need a National Pollution Discharge Elimination System (NPDES) permit and may have to provide disinfection. Discharging systems also require regular sampling to verify effluent quality.

**Media Filters**

Media filters are similar to sand filters in that they treat the wastewater as it filters through the media material. The media can be textile (Figure 8), peat (Figure 9) or foam cells. These units are usually manufactured package type devices that can be purchased and installed directly in the ground. All
of the necessary parts are sold with the package with the exception of the septic tank.

Wastewater flows from the house through the septic tank, where the solids settle out and primary treatment occurs. The effluent from the septic tank then travels into the media filter where secondary treatment further treats the wastewater. The wastewater can then travel to an effluent soil treatment system or be discharged to the ground surface. If the water is surface discharged, the owner may need a National Pollution Discharge Elimination System (NPDES) permit and may have to provide disinfection. Discharging systems may also require regular sampling to verify effluent quality.

**Aerobic Treatment Units**

These systems are sometimes called package treatment plants (Figure 7, page 7). 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 normally rapid and odor-free. In the aerobic unit, an 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 secondary treatment system. A perpetual maintenance contract is required by Chapter 69. After treatment in the aerobic unit, effluent flows to a reduced size drainfield, sand filter, mound system, subsurface drip tube irrigation system, or some other type of effluent treatment system for final treatment and release to the environment.

**Constructed Wetland**

A constructed wetland (Figure 10) 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. Wastewater travels from the house to the septic tank, and then to the constructed wetland. The wetland cell is filled with rock or gravel and may be lined with an impermeable material to prevent untreated wastewater from entering the soil. Plants, microbes and bacteria on the filter material treat the effluent. Water is collected from the constructed wetland through pipes and flows to a drainfield or sand filter. If the water is surface discharged, the owner may need a National Pollution Discharge Elimination System (NPDES) permit and may have to provide disinfection. Discharging systems may also require regular sampling to verify effluent quality. Discharging systems also require regular sampling. A continuously discharging lagoon requires further treatment.

**Waterless Toilets**

Portable and chemical 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. These systems are not intended for day-to-day household use. Most often, these toilets are used for campsites or remote locations. The waste pumped from these toilets should be disposed of at a permitted municipal wastewater treatment facility.

**Holding Tanks or Impervious Vault Toilets**

Holding tanks are used in Iowa for temporary or very low use situations. This may include public parks and recreation areas; riverside, lakeside cabins or hunting cabins; or until a proper system can be installed. Waste from holding tanks or impervious toilets must be pumped and transported to a public wastewater treatment plant.

**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 or installer. Iowa currently has no statewide certification system for these professionals, although some counties do. Training is available, but not required, except in counties with certification systems. 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.

**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 the system. Water moves very quickly through coarse, sandy soils, and water movement in some cases is too quick for the effluent to be treated. Clay soils hold water so that it moves too slowly for sufficient amounts to be treated. This may cause wastewater to build up and surface on top of the ground. 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 Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), Natural Resources
Soils are often disturbed during construction.

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. Topography is important in deciding what type of system to use, whether gravity distribution is feasible, and system layout. For example, sites with steep slopes may not be suitable for traditional septic tank/drainfield systems, although a drop box system may be more effective. Do not construct an on-site wastewater treatment system in natural drainageways, low spots where water might pond or other areas with a high groundwater table.

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. Iowa regulations require that the bottom of the drainfield system trench or bed must be at least three feet above the highest expected level of the groundwater. If there is less than three feet of unsaturated soil, the traditional drainfield may not be suitable, as wastewater will not receive adequate treatment. A more shallow installation may be necessary. 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.

Distance to Surface Water

The closed portion (septic tanks, mechanical aeration tanks, impervious vault toilets, fully contained media filters) of the treatment system must be at least 50 feet from lakes and 25 feet from ponds, streams, rivers or other surface water. The open portion (absorption trenches, mounds, sand filters, wetlands) of the treatment system must be 100 feet from lakes and 25 feet from ponds, streams, rivers or other surface waters. These setback distance requirements reduce 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, and preferably have a 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.

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 an on-site system, unless grease traps are installed and maintained. On-site wastewater treatment systems are designed for residential waste only. Wastewater or chemicals from business or industrial activity cannot be disposed of in an on-site treatment system. Check with your county sanitarian or the Iowa DNR for more information about what to do with these types of waste.

**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 Iowa are septic tank/drainfield and sand filter systems. There are many other options, however. Table (page 13) summarizes the primary options and factors to help determine the system that will work best for a given situation.

**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 Chapter 69 regulations and local codes and approved by the county environmental health or sanitarian’s office. A permit is also required from your local county environmental health office. 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, although some counties do require certification. Get several bids and select the installer who can design and install a system based on state and local codes. Your county sanitarian can provide information and possibly a list of certified contractors.

**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

![Workers install a new septic system.](image)

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

<table>
<thead>
<tr>
<th>Type of System</th>
<th>Consider when:</th>
<th>Maintenance (<em>Depends on use</em>)</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel Drainfield</td>
<td>• Soil percolation rate: 5 to 60 min./in.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Excessive water use may overload the system.</td>
</tr>
<tr>
<td></td>
<td>• Bottom of trenches and beds at least 3 ft. above highest expected groundwater level.</td>
<td>• Prevent deep-rooted vegetation over drainfield.</td>
<td>Garbage disposal use increases pumping frequency.</td>
</tr>
<tr>
<td></td>
<td>• Slope of site is less than 15 percent.</td>
<td>• Prevent soil compaction over drainfield.</td>
<td></td>
</tr>
<tr>
<td>Pressure Dosing</td>
<td>• Drainfield is more than 500 linear ft. dosing is recommended, mound, sand filter.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flushing and cleaning of small diameter distribution pipe.</td>
<td></td>
</tr>
<tr>
<td>Mound System</td>
<td>• Soils with slow or fast percolation rates.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Costs are higher than conventional systems due to design costs and materials.</td>
</tr>
<tr>
<td></td>
<td>• Shallow soil cover over fractured or porous bedrock.</td>
<td>• Pumps and siphons must be maintained.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A high groundwater table.</td>
<td>• Flushing and cleaning of small diameter distribution pipe.</td>
<td></td>
</tr>
<tr>
<td>Gravelless Drainfield System</td>
<td>• Site is remote or difficult to reach.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Potential problems in sandy soils.</td>
</tr>
<tr>
<td></td>
<td>• Typical drainfield materials (gravel) not available or expensive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recirculating Filter</td>
<td>• No space for any other system.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Small treatment system easily abused.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand filter</td>
<td>• Repairing existing malfunctioning system.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Site is an environmentally sensitive area.</td>
<td>• Maintenance varies by design.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Soils with slow percolation.</td>
<td>• Dosing chamber pumps, controls and timer sequence must be checked.</td>
<td></td>
</tr>
<tr>
<td>Peat Filter</td>
<td>• Similar to sand filter.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Pump must be replaced every 8 years.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bake filter surface every year.</td>
<td></td>
</tr>
<tr>
<td>Aerobic Treatment Unit</td>
<td>• Soil characteristics are not appropriate for a traditional septic tank/drainfield system.</td>
<td>• Inspect and pump secondary settling chamber as needed (may be as frequent as 3-6 months)*.</td>
<td>Costs more to install than other systems.</td>
</tr>
<tr>
<td></td>
<td>• Groundwater table is high or shallow bedrock exists.</td>
<td>• Mechanical parts require periodic checks, maintenance and repair.</td>
<td>Problems with sudden heavy loads or neglect.</td>
</tr>
<tr>
<td></td>
<td>• A very small lot.</td>
<td></td>
<td>Electrical costs and associated maintenance.</td>
</tr>
<tr>
<td></td>
<td>• A traditional septic system has failed.</td>
<td></td>
<td>Requires final treatment in drainfield, sand filter, or other system.</td>
</tr>
<tr>
<td></td>
<td>• Desirable to extend the life of a drainfield.</td>
<td></td>
<td>Surface discharged water requires NPDES permit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>May require disinfection.</td>
</tr>
<tr>
<td>Constructed Wetland System</td>
<td>• Soil cannot treat wastewater before it percolates to groundwater, such as in clay soils.</td>
<td>• Pump septic tank every 2-3 yrs*.</td>
<td>Surface discharged water requires NPDES permit.</td>
</tr>
<tr>
<td></td>
<td>• Prevent trees from growing in wetland cell.</td>
<td>• Maintain wetland plants.</td>
<td>Costs are higher than conventional systems due to professional design costs and materials.</td>
</tr>
<tr>
<td></td>
<td>• Aesthetics are important.</td>
<td></td>
<td>Disinfection may be required.</td>
</tr>
<tr>
<td>Holding Tank</td>
<td>• There is no suitable efficient treatment area.</td>
<td>• More frequent pumping is required.</td>
<td>Restricted wastewater use.</td>
</tr>
<tr>
<td></td>
<td>• Temporary or seasonal use only.</td>
<td>• Alarm or visible float needed to indicate when tank is 90 percent full.</td>
<td>Pumping and disposal costs.</td>
</tr>
</tbody>
</table>
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 150 gallons per day for each bedroom. It assumes at least some water-using appliances such as a clothes washer and dishwasher will be operated in the home. A water softener, garbage disposal or large Jacuzzi-type bath may require increase in the size of the septic tank to allow ample settling time.

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.

Setback Distances

When determining where to place an on-site wastewater treatment system, adhere to all required setback distances. Iowa regulations require that septic tanks, effluent treatment systems (traditional drainfields, sand filters, mound systems, etc.) must be a minimum distance from surface water, wells and buildings. These distances are listed in Table 2 (page 15).

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 to place 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.

Table 2. Minimum Setback Distances in Feet

<table>
<thead>
<tr>
<th>Minimum distance in feet from:</th>
<th>Closed portion of treatment system</th>
<th>Open portion of treatment system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private water supply well</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Public water supply well</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Ground water heat pump borehole</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Lake or reservoir</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Stream or pond</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Edge of drainage ditch</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Dwelling or other structure</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Property lines (unless a mutual easement is signed and recorded)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Other type subsurface treatment system</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Water lines continually under pressure</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Suction water lines</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Foundation drains or subsurface titles</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

(1) Includes septic tanks, aerobic treatment units, fully contained media filters and impervious vault toilets.

(2) Includes subsurface absorption systems, mound systems, intermittent sand filters or constructed wetlands.

Permits

No on-site wastewater treatment and disposal system shall be installed or altered until an application has been submitted and a permit has been issued by the county environmental health office. Alteration includes any changes that affect the treatment or disposal of the waste. Repair of existing components that does not change the treatment or disposal would be exempt. Examples of exempt repairs may include repairing an inlet pipe, baffle or a mechanical device such as a pump or blower. Contact your county sanitarian for more information about permitting.

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 Iowa, 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 in an improper manner and to prevent groundwater from entering the septic tank and hydraulically overloaded the treatment system.

The number of bedrooms in the house will determine the size of the tank. Ideally, the septic tank will hold wastewater long enough (two days) 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 residential dwelling is 1,250 gallons.

Baffles or tees are important components of a septic tank (Figure 2, page 4). 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 are often buried below ground level. The septic tank should have inspection lids if the inlet and outlet do not have manholes over both of them. More shallow depths are preferred because there is more oxygen closer to the surface. The drainfield relies on bacteria that require oxygen to break down the wastewater. The maximum depth from soil surface to the bottom of the trench is 36 inches. In addition, the bottom of the trench or bed must be at least three feet above the groundwater table, to prevent the scum layer from moving with gravel or other filter material.

A typical drainfield will require 18 to 36 inches of vertical depth, from the soil surface to the bottom of the bed or trench, depending upon soil characteristics and materials (Figure 3, page 5). More shallow depths are preferred because there is more oxygen closer to the surface. The drainfield relies on bacteria that require oxygen to break down the wastewater. The maximum depth from soil surface to the bottom of the trench is 36 inches. In addition, the bottom of the trench or bed must be at least three feet above the groundwater table, to prevent the scum layer from moving with gravel or other filter material.

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. The installer should backfill immediately after inspection of the tank to reduce the possibility of accidents.

The installer should backfill immediately after excavation to install septic tanks and sewer lines by using supports to prevent sidewalls from collapsing. People have been seriously injured and 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 backfill immediately after inspection of the tank to reduce the possibility of accidents.

**Figure 12:** Distribution box.

**Figure 13:** Serial distribution with drop boxes on slope.

**Figure 14:** On-site wastewater treatment system on the contour, using drop boxes.

**Figure 15:** Pumping station (Figure 12, page 16). As with septic tanks, a distribution box must be watertight and noncorrosive. The distribution box must have an opening of adequate size to allow for inspection, cleaning, leveling and maintenance.

Septic tank effluent must be spread or distributed between trenches of a drainfield with a distribution box or drop boxes. The distribution box is a separate unit installed after the septic tank (Figure 12, page 16). With septic tanks, a distribution box must be watertight and noncorrosive. The distribution box must have an opening of adequate size to allow for inspection, cleaning, leveling and maintenance.

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 Iowa One Call 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 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 backfill immediately after inspection of the tank to reduce the possibility of accidents.
For hillside installations, a pressurized distribution system or drop box may be used. A drop box is a different way to distribute water through a drainfield installed on a slope (Figure 14, page 17). Drop boxes must be watertight and noncorrosive. 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, page 16). 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.

Drop boxes work well on slopes. They eliminate the problem of poor distribution among trenches and potential of one trench (especially the lowest one) receiving most of the flow. A series of trenches is dug parallel to the slope so that each trench is higher/lower than the next. Starting with the highest, each trench fills with wastewater completely, then overflows through a series of drop boxes to each succeeding trench. Each trench must be level from end to end and follow the contour. 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.

**Information on Existing Systems:**

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

Counties may have information about existing on-site wastewater treatment systems. The location of alternative systems such as media filters or aerobic systems 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.

**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.**

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. Existing systems with septic tanks that discharge to a ditch, the ground surface, surface water or a field tile are illegal and are not “grandfathered.” A proper, permitted system must be installed.

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.

**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 shower heads) 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 six 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 two to three 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 15, page 19). 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.

A licensed 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 Iowa Administrative Code (567)-Chapter 68 “Commercial Septic Tank Cleaners,” or local regulations if they are more stringent.

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 diversion landscaping 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:
• Do not compact soil in 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:
• Avoid using toilet bowl cleaners that automatically dispense chemicals with each flush.
• Use household cleaners and drain cleaner 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.

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 groundwater.

What you can do:
• Avoid using toilet bowl cleaners that automatically dispense chemicals with each flush.
• Use household cleaners and drain cleaner 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.

What Happens to Waste Pumped from the Septic Tank?
In Iowa, septic may be taken to a public wastewater treatment system for disposal, or land applied following Iowa Administrative Code (567)-Chapter 68 “Commercial Septic Tank Cleaners.” Local regulations may be more stringent.

OSWAP helps replace outdated and failing septic systems in Iowa
The DNR’s Onsite Wastewater Systems Assistance Program (OSWAP) helps rural Iowans replace inadequate or failing septic systems in an effort to help clean up polluted waterways statewide. Since beginning in 2002, the program has helped finance the replacement of more than 700 septic systems, totalling $4,000,000, at an average cost of $5,400 per loan. OSWAP offers low-interest loans to homeowners at 3 percent, for amounts beginning at $2,000, for a maximum repayment period of 10 years. Loan applicants must be creditworthy and apply for a loan through participating lenders. The program limits eligibility to owners of existing homes only, in unincorporated areas not served by a public sewer.

Homeowners wanting to apply for an OSWAP loan must first obtain a septic construction permit from their county sanitarian and complete an OSWAP approval form. Next, they apply for a loan through a participating lender. If their loan is approved, the final step is to hire a septic contractor to complete the approved project. OSWAP is funded through the state revolving loan fund.

FOR MORE INFORMATION
Visit the DNR’s septic website at: www.iowadnr.gov/water/septic/
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.

Sluggish or no drainage from fixtures, or backup 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
- Effluent filter may need cleaning.

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 backup 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 backup 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
- 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

Additional Resources

On the Web
Iowa Administrative Code 567-Chapter 69
http://www.legis.state.ia.us/aspx/ACODOCS/DOCS/567.69.pdf
Iowa Administrative Code 567-Chapter 68
http://www.legis.state.ia.us/aspx/ACODOCS/DOCS/567.68.pdf
Iowa Department of Natural Resources, Septics Information
www.iowadnr.gov/water/septic/

U.S. EPA
http://cfpub.epa.gov/owm/septic/home.cfm

National Onsite Wastewater Recycling Association
www.nowra.org

National Small Flows Clearinghouse
www.nesc.wvu.edu/nscf/nsfc_index.htm

County Soil Survey Maps are available from your local National Resources Conservation Service (NRCS), formerly known as Soil Conservation Service (SCS) office or from Iowa State Extension offices.