Chapter II

WASTEWATER CHARACTERISTICS AND HEALTH CONCERNS

TABLES

INTRODUCTION

Many Kansas residents and rural businesses must rely on individual household wastewater treatment systems called onsite wastewater systems. Adequate household wastewater system standards provide for a safe and sanitary means of treating and dispersing household wastewater. When designed, installed, and maintained properly, many can function well for several decades. A well-functioning system is designed to treat and disperse the wastewater in a way which protects public health and the environment. Onsite wastewater systems must be used where public sewers are not available or feasible.

Wastewater must be managed in such a way that:

- Quality of water for beneficial uses is protected. Beneficial uses include drinking water, recreation, aquatic life support, irrigation and industry.
- A breeding place will not be created for insects, rodents, or other creatures which may come into contact with food and drinking water.
- Wastewater will not create a significant health hazard by being exposed on the ground surface where it is accessible to children or pets.
- State and federal laws and local regulations governing water pollution or wastewater disposal will be met.
- Nuisance conditions or obnoxious odors and unsightliness will be avoided.

This handbook applies to small wastewater systems which are not required to hold a Kansas Water Pollution Control Permit pursuant to State Statute K.S.A. 65-165. The principles contained here apply to year-round households, businesses, seasonal or temporary systems, and recreational area systems. Many of these principles are also applicable to larger wastewater flows. Specific standards and permit requirements for institutional, industrial, or municipal systems can be obtained from the Kansas Department of Health and Environment (KDHE).

WASTEWATER COMPOSITION

Wastewater may be divided into two categories: blackwater and greywater. Blackwater refers to toilet waste and greywater refers to the remaining wastewater from sinks, showers, laundry, and water treatment devices. Refer to Table II-1 for a comparison of the two wastes. Both blackwater and greywater may contain disease causing microbes, nutrients, and hazardous chemicals. The septic tank provides primary treatment for both types of wastewater by settling out the solids and providing space for floating scum to be retained. Relatively clear (but not clean) water is discharged from the septic tank to the absorption field. The soil provides for further treatment when the wastewater percolates through the soil profile.

Table II-1. A Comparison of Greywater with Blackwater

- Greywater is about 70% of the total household flow.
- Greywater is very similar to Blackwater or toilet discharges. There are slight differences; Greywater is stronger in organic matter but weaker in nitrogen and coliform bacteria. Although Greywater carries about 70% of the household phosphorous discharge, the phosphorous concentration is nearly the same.
- Greywater contains significant concentrations of coliform bacteria, therefore, it must be considered to have a potential to be pathogenic.
- Greywater must receive adequate treatment in the same fashion as Blackwater.

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Untreated or improperly treated wastewater contains biological contaminants known to cause disease. These contaminants are known as germs or pathogens. Pathogens fall into five main categories: bacteria, viruses, protozoans, fungi, and worms. Most of these pathogens use the fecal/oral route to spread disease. Fecal material, including human wastes, contains pathogens. The usual method of infection requires you to touch the fecal material with your hands and then transfer it to your mouth, either directly or through food and water or touching objects that other people have touched. Pathogens can contaminate water supplies when wastewater is allowed to reach the water table before adequate treatment occurs.

Bacteria

Bacteria are microscopic, single-celled organisms that are typically round (Cocci), rod-shaped (Bacillus), or spiral (Spirochestia). Bacteria may be associated in three different ways. Diplo means two bacteria attached together, strepto means a twisted chain of bacteria, and staphlo refers to a large clump of bacteria. Although a microscope must be used to see bacteria, the damage bacteria can do is very visible. Several diseases have been found to be transmitted primarily by contaminated water such as: Cholera, Typhoid, Salmonella, and Shigella. Cholera causes vomiting, diarrhea, dehydration, and may cause death. Typhoid causes fever, chills, and sometimes causes death. Salmonella causes fever, nausea, vomiting, bloody diarrhea, cramps, but rarely death. Shigella causes fever, nausea, vomiting, and diarrhea. Staphylococcus may cause skin and mucus membrane infections. However, almost any disease can be transmitted by water under the right circumstances.

Virus

Viruses use living cells to reproduce and cause infections. The virus penetrates the cell wall of the host and injects genetic material into the host cell so that the infected cell makes more virus. Viruses are generally smaller than bacteria but they can be more deadly. Diseases caused by viruses include Hepatitis A, a viral infection of the liver which causes nausea, vomiting, diarrhea, skin and urine discoloration, weakness, and sometimes liver damage. Acute gastroenteritis is a viral infection of the intestinal tract which causes fever, nausea, vomiting, diarrhea, and pain. Polio causes inflamation of motor neurons of the spinal cord and brainstem, leading to paralysis,

muscular atrophy, deformity, and can result in death.

Fungi

Fungi are non-phytosynthetic living organisms such as yeast and bread mold. They can be single-celled or long, multi-celled branching filaments. Disease caused by fungi include candidiasis which is transmitted by contact with feces or secretions from infected people.

Although they usually cause mild infections, occasionally they may cause ulcers in the intestinal tract or lesions in the kidneys, brain, or other organs.

Protozoans

Protozoans are large (compared to bacteria), single celled animals which may have the ability to move. Diseases caused by protozoa include amoebiasis, giardiasis, and cryptosporidiosis. Amoebiasis causes bloody diarrhea and sometimes death while giardiasis causes diarrhea and severe gas.

Perhaps the best known incidence of sickness caused by a protozoan is Cryptosporidiosis, which is caused by Cryptosporidium. The infection in humans can be divided into two distinctly different diseases depending on the patient's immune status. Both forms have an incubation period of fourteen days. In the immune competent host, the onset is sudden and characterized by watery diarrhea, cramping, abdominal pain, and flatulence. Nausea, vomiting, fever, anorexia, weight loss, myalgia, and malaise may also be present. Symptoms usually begin to subside in five to ten days. In immuno-compromised patients, (cancer, AIDS, elderly, previously diseased), the onset is more gradual, and the symptoms are more severe. Fluid loss may be excessive.

Weight loss may exceed 10 percent of the patient's original body weight. The duration of the illness is indefinite. The deaths are usually in the immuno-compromised host and are usually due to loss of water, loss of nutrition, and the inability of the patient to fight the disease. Few medications are available to fight this disease.

Worms

Worms such as the hook, round, pin, tape, and flatworm may be transmitted by water. In an ancylostomiasis infection, a hookworm penetrates the skin of the feet and travels to the gut where it attaches to the host. Ascariasis, a roundworm, lays eggs in soil contaminated by sewage and then it can be ingested by an individual with dirt on hands or root vegetables that are eaten raw. The worms develop in the intestinal tract, and may attack the lungs, liver, and other organs.

Nitrate

The primary health concern associated with nitrogen is the reduction of nitrate to nitrite in the digestive tract of infants by nitrate-reducing bacteria. Nitrite is readily absorbed into the bloodstream where it combines with the oxygen-carrying hemoglobin to form methomoglobin. Methemoglobin cannot carry oxygen and if the situation is not corrected, the disease can be life threatening. As methemoglobin levels increase, oxygen supply to tissues decreases and the affected individual becomes stressed; characterized as "failure to thrive". This condition may cause spontaneous abortions in women and livestock and low breeding conception. High enough levels will cause those affected to exhibit symptoms of suffocation. This condition is called

"methemaglobinemia" or blue baby syndrome in infants because of the blue color that develops around the eyes and mouth. Livestock may also develop this condition.

Infants are particularly susceptible to nitrate poisoning because bacteria capable of converting nitrate to nitrite are abundant in the digestive systems. Infants have little acid in the digestive tract, and depend on nitrate reducing bacteria to help digest food. Generally by six months of age, hydrochloric acid in the baby's stomach increases to a level at which the nitrate reducing bacteria cannot thrive.

When people ingest food and water containing nitrate, the nitrate is readily absorbed from the digestive tract. In older children and adults, nitrate that is ingested and absorbed is normally excreted in urine. The ingestion of nitrates by healthy adults is not known to cause any direct health affects, however, chronic exposure to nitrates is currently being researched.

Chemical Pollutants

Household cleaning products, pesticides, fertilizers, and other petroleum products are used in a variety of ways in homes and businesses. Table II-2 is a partial list of the types of chemicals which may be found in general household use. These chemicals may contain heavy metals or other poisons which may pass through the onsite wastewater system into the environment. Additionally, these chemicals may cause an onsite system to fail. Even a small amount of some chemicals can cause enormous contamination. Just one gallon of gasoline can contaminate one million gallons of drinking water. Chemical pollutants may cause long term health problems or may destroy the environment. Regulations on the use and disposal of many chemicals have become more stringent, however, the average homeowner may be unaware of the dangerous health hazards associated with improper disposal of common household chemicals.

Homeowners and small businesses which use an onsite wastewater system must be informed about chemical use and general maintenance of the system.

Table II-2. Common Household Chemicals

*Medications or **large amounts** of disinfectants and/or other chemicals can disrupt biological processes in septic tanks. Normal household use of cleaning compounds for laundry, dishes, and household fixtures, can be safely put in the septic tank. The use of disinfectants in all loads of laundry and for all household cleaning tasks in not a good idea and is discouraged for use with onsite wastewater system systems. **Leftover and unused portions of household hazardous waste, such as those listed here, should never be put into an onsite system.***

Rug and Upholstery Cleaners	Floor and Furniture Polish
Bleaching Cleaners	Mothballs
Pool Chemicals	Ammonia-based Cleaners
Abrasive Cleaners or Powders	Antifreeze
Transmission Fluids	Brake Fluids
Used Oils	Batteries
Household Batteries	Oven Cleaners
Toilet Cleaners	Photographic Chemicals
Disinfectants	Drain Cleaners
Arsenical Pesticides	Medications
Carbamate Pesticides	Chlorinated Hydrocarbons
Organophosphate Pesticides	Flea Collars and Sprays
Roach and Ant Killers	Rat and Mouse Poisons
Herbicides	Enamel or Oil Based Paints
Latex or Water Based Paints	Rust Paints
Paint Thinners and Turpentine	Furniture Strippers
Wood Preservatives	Wood Stains and Finishes
Plant Nutrients or Fertilizers	House Plant Insecticides
Fungicides	

ENVIRONMENTAL CONCERNS

Failing onsite wastewater systems may allow excess nutrients to reach nearby lakes and streams, promoting excess algae and aquatic weed growth. Algal blooms and abundant weeds make the lake unpleasant visually, interfere with for swimming and boating, and affect water quality for fish and wildlife habitat. As plants die and settle to the bottom to decompose, they use oxygen that fish need to survive. These nutrients can have a devastating affect on recreational uses of the surface waters such as lakes, rivers, and streams. Many of the sport fishes are very intolerant of

nutrient rich waters. In addition, when algae blooms occur the public drinking water supply may have severe taste and odor problems.

WATER USE AND CONSERVATION

The most critical aspects of onsite wastewater system operation are the total water use and the patterns of use. Water conservation can significantly reduce the amount of wastewater which must be treated, thereby increasing the useful life of the onsite system. Table II-3 shows basic water conservation options. Water conservation must be a part of any onsite wastewater system from the day of installation in order to protect and prolong the life of the system.

Table II-3. Basic Water Conservation Options

Bathroom	Kitchen	Laundry
• Install a low-flow toilet. New units give a complete flush with 1.6 gallons per flush. But in old toilet tanks, displacing water with bricks or bottles often gives less than a total flush. • Flush toilets less often. • Toilets can be used several times for liquid waste before flushing. • Do not use toilet bowl disinfectants that are placed in the tank or bowl. • Do not flush cigarette butts or unwanted medications down toilet. • Use moderate amounts of white toilet paper. Toilet paper should break down in water but some dyes are difficult for bacteria to decompose. • Take showers; showers use less water than baths. • Install low-flow shower heads, or hand held showers with pause, temperature balance valve controls. • Reduce use of drain cleaners by minimizing amount of waste that goes down the drain. • Turn off the water while brushing teeth or shaving. • Replace leaky faucets.	• Keep a pitcher of drinking water in the refrigerator instead of running the tap to get cool water. • Be conservative with the amount of soap used to get a job done. • Do not use a garbage disposal to dispose of food wastes; instead, use composting or throw them into the trash. • Repair leaky faucets. • Reduce use of drain cleaners by preventing grease and food from going down the drain. • When using drinking water treatment devices, be certain they have a shut-off valve to prevent the system from running continuously when the reservoir is full.	• Select a front-loading washing machine; this uses 40 percent less water. • Wash only full loads and adjust size settings for small loads. • Distribute wash loads evenly throughout the week to keep from overloading the system with large volumes of water. • Be certain washing machine has a filter to remove lint and clean this before each load. • Use liquid no-phosphate laundry detergents.

Simply repairing leaks from a sink or toilet has a significant impact on the total water volume used. Table II-4 shows the volume of water produced by leaking plumbing. Remember that leaks occur 24 hours a day, seven days a week. A steady stream of leaking water becomes quite large in just one day. Table II-5 lists some common, easy to do ways to detect water fixture leaks. Sometimes it makes sense to upgrade the fixture rather than make expensive repairs. Table II-6 shows the flow reduction that is provided by replacing existing fixtures with low volume fixtures. Leaks should be fixed immediately to keep the onsite wastewater system functioning properly.

The homeowner must understand that not only the volume of water used but the pattern of use is important for onsite wastewater system operation. For complete treatment of wastes, the onsite wastewater system needs time to work. If a large volume of water is used in a short period of time, the system may become hydraulically overloaded. Hydraulic overload can cause turbulence and washout of solids, sludge or scum, from the septic tank. If solids enter the drainfield, the life expectancy of the soil absorption system is greatly diminished. Homeowners should modify their water use pattern to achieve a uniform flow, avoid large water use in a short time. From a practical viewpoint, homeowners must learn to stagger dishwashing and loads of laundry to times during the day when other water uses (such as showers) are low.

Table II-4. Common Water Leak Volumes and Repairs

	Faucets	**Toilets**
Problem or Symptom	A slow drip is 15 to 20 gallons per day. A 1/16th inch stream is about 100 gallons per day	Water level too high in the tank causes a continuous trickle down the overflow tube. Water leaks past the flush valve and periodically comes on to refill the tank. Either can lose as much as several hundred gallons per day.
Repair	Replace worn washers or eroded valve seat.	Bend float arm for cutoff at least a half inch below top of the overflow pipe or replace the flapper valve.

Table II-5. Leak Detection

Overall	Shut off all water use and observe water meter 15 to 30 minutes
Toilet Tank	Dye or food coloring in tank should not get to bowl without flushing
Reconciling winter water use by meter or bill records	> 75 gallons per capita day (GPCD) probable leak > 100 GPCD sure leak or wasteful habits

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Table II-6. Household Wastewater Flow Generation and Reduction

A reduction of 10 Gallons per Capita Day (GPCD) is readily available. This is about 20 percent of the total sewage generation from a household.	
Toilets	**Conventional Type** 4.6 gallons average flush 3.5 uses per person per day 16 GPCD typical generation **Tank Inserts** 4 gallons average flush 14 GPCD typical generation **Water Saving Type** 1.6 gallons average flush 5.6 GPCD typical generation **Reduction** Total toilet reduction 2 to 10 GPCD or up to 20 percent of daily flow
Showers	**Conventional Head** 25 gallons used every 2.5 days 10 GPCD typical generation **Low Flow Showerhead** 15 gallons used every 2.5 days 6 GPCD typical generation **Reduction** Total shower reduction 4 GPCD or about 8% of daily flow
Laundry	**Top Loader** 37 gallons/load, 10 GPCD **Front Loader** 23 gallons/load, 6 GPCD **Reduction** Total laundry reduction 4 GPCD or about 8% of daily flow
Total Reduction from All Sources up to 18 GPCD or about a third of daily flows	

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FAILURE OF ONSITE WASTEWATER SYSTEMS

Two conditions are by far the largest contributors to onsite system failure:

1) excess wastewater flow.

2) inadequate septic tank maintenance resulting in solids carried into the soil absorption system.

In the soil absorption portion of an onsite wastewater system, bacteria and viruses are filtered out by the soil and microscopic organisms that occur naturally in the soil. Nutrients are absorbed by the soil particles or taken up by plants. These processes only work in unsaturated soil that has enough oxygen to keep the aerobic microorganisms active. Soil conditions may be saturated near lakes, streams and wetlands, in areas with seasonal or perched high water tables and poorly drained soils. In these cases, biological breakdown will be incomplete and nutrients will move much greater distances. Ironically, numerous unsewered communities exist around lakes, where saturated conditions are likely to exist. Originally intended as part-time vacation homes, residents may now occupy the homes year round. Full-time use may cause many of these onsite wastewater systems to fail.

As discussed above, water conservation is an important tool for keeping onsite wastewater systems in operation. High water use will disrupt the physical, chemical, and biological processes which are needed to keep an onsite system functioning properly. Public education of homeowners who use onsite wastewater systems is critical to prevent the failure of these systems.

Operation of an onsite wastewater system refers to the daily use of the system. All owners of onsite wastewater systems should practice water conservation. Table II-3 has some practical guidelines to help avoid excess water flow. The homeowner has some control over the quality, quantity, and use patterns of the wastewater.

In more complex systems, operations may include maintaining an uninterrupted power supply and response to an alarm system. Maintenance is the periodic work which must be done to keep the system operating properly. Maintenance includes the repair, replacement, cleaning, and lubrication of all mechanical parts of the system.

The onsite treatment system must be maintained by the homeowner or a qualified service provider. Even a simple septic tank and absorption field must have maintenance. In the past, these systems were buried and forgotten until problems began to surface. Homeowners must understand that the system must be pumped to remove solids, drain lines must be cleaned to prevent clogging, and the absorption field must be protected from damage and root intrusion.

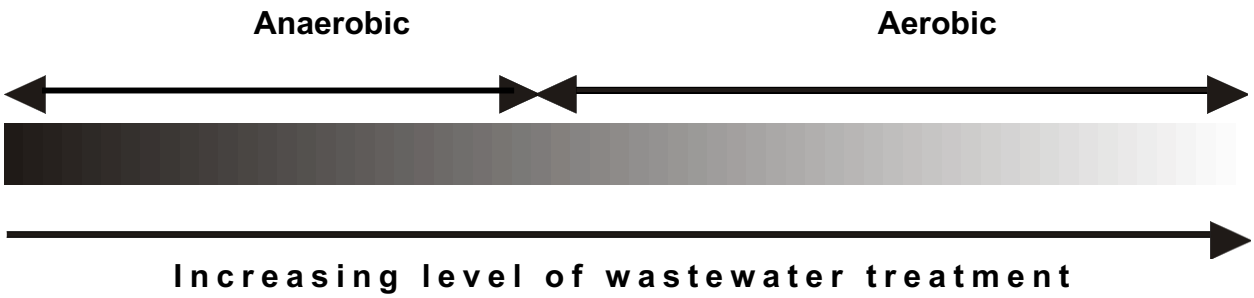
Lack of simple maintenance is the most common reason for the failure of an onsite system.

MANAGEMENT FOR ONSITE WASTEWATER TREATMENT SYSTEMS

The sections which follow discuss the treatment processes and components which are available to treat wastewater in onsite wastewater systems. These systems may be combined in different ways as indicated by Table II-7. In the past five years, the technology for onsite wastewater

systems has exhibited remarkable growth. New technologies and new applications for existing technologies are being developed at a rapid rate. This handbook is designed to provide as much information about the processes and components of an onsite wastewater system as possible, with the understanding that newer equipment and processes will become available. As new technology develops, the operational principles contained in this handbook may be applied to understanding and properly using these newer techniques.

Table II-7. Onsite Wastewater System Combinations and Treatment



Septic Tank	Soil Distribution [1]	
Septic Tank	Enhanced Treatment [2]	Soil [1]
Aeration System with septic tank [3]		Soil [1]
Septic Tank	Mound Including Soil Beneath	
Lagoon		Percolates Through Soil

[1] Soil profile. Site and soil conditions determine what methods of soil distribution will be most effective for a location. In many cases, any of the soil distribution methods may be used for any of the septic tank or septic tank plus enhanced treatment options, including aeration. The mound provides dosed distribution over the soil covered by the mound. At this time, using an aeration system, sand filter, or one of the other media filter enhanced treatment systems, with drip irrigation is recommended. Research is not conclusive about using septic tank or rock-plant filter effluent with drip irrigation.

[2] Enhanced treatment systems include sand filters, other media (peat, foam, textile), rock-plant filters, and aeration systems that use a separate septic tank.

[3] Aeration Systems are of many different designs, some are installed in a septic tank, some have specially designed tanks, and some may not require a tank for physical separation of the sewage. Follow local codes and manufacturer's recommendations.

As the technology for onsite wastewater treatment becomes more complex, the need for management of these onsite wastewater systems becomes more critical. Management includes the operation, maintenance, and monitoring of an onsite wastewater system. For a septic tank and gravity drainfield, the required management may be as simple as practicing water conservation, removing septic tank sludge as needed (usually every 3-5 years), and replacing broken pipes, risers, and caps as needed. However, when an onsite wastewater treatment system components include complex mechanical and/or electrical components such as: pumps, filters, small diameter

orifices, or aerators, then the management of the system must be more intensive, frequent, and extensive. Service contracts are highly recommended for these systems.