CHAPTER 12

Mechanical Wastewater Systems

In contrast to natural wastewater treatment processes, mechanical treatment processes utilize a natural biological sludge but depend on mechanical elements for mixing, aeration, and sludge handling. Mechanized treatment processes include suspended-media technologies such as activated sludge, extended-aeration activated sludge, contact stabilization, rotating biological contactors, and sequencing batch reactors as well as fixed-media technologies such as the trickling filter solids contact process. The suspended-growth, activated-sludge process is by far the most commonly used for the secondary treatment of wastewater. Most alternative mechanical treatment systems are variations of the conventional activated-sludge process.

The conventional suspended-growth, activated-sludge process begins with pretreated influent introduced into a aeration tank where aerobic bacteria are maintained in suspension. The aeration tank contents are referred to as "mixed liquor." In the aeration tank the bacteria convert the organic matter and other constituents in the wastewater to gases and cell tissues. Air is introduced into the mixed liquor through any one set of a variety of devices such as air diffusers or mechanical aeration devices. The wastewater then flows through a tank for additional settling and clarification. Some of the wastewater is then returned to the aeration tank to maintain proper bacterial conditions and the rest is sent as effluent for polishing or for disinfection prior to disposal.

Systems using mechanized treatment technologies generally have higher costs than centralized systems using natural or land-application processes due to higher energy costs and higher operator attention and skill levels.

Some small centralized systems using mechanical treatment technologies are considered cluster systems. Other such systems come in the form of "package" treatment plants, which are simply small, prefabricated wastewater treatment plants delivered as complete units to private businesses or clusters of houses in areas located too far from larger sewerage services.

When properly operated, package plants usually provide secondary treatment performance, as they perform activated-sludge processes. Package plants require the close attention of a qualified, licensed operator. Today, fewer package plants are being approved in North Carolina. Most package plants discharge into streams, a process which requires an NPDES permit. A complete evaluation of all nondischarge alternatives is required before a discharge permit will be issued for package plants.

Package plants should be selected by a trained sanitary engineer or appropriate consulting firm. Installation and operator training are usually provided by the manufacturer. Proper operation and maintenance must be provided by a licensed public or private management authority.

A package plant employing the conventional suspended-growth, activated-sludge process will usually contain the following basic components: a bar screen and comminutor, a primary settling chamber, an aeration chamber, an activated sludge return system, a secondary settling chamber, and a chlorination or other disinfection device. Fine-pore aeration equipment may help reduce the costs of activated-sludge systems.

The advantages of package plants include: relatively small area requirements; relative ease of installation; potential for sale or relocation; capability of modular expansion; and, potential to lease for interim needs.

Potential limitations of package plants include: possible operating problems in cold climates and due to corrosion; possible high total cost per unit capacity, especially for design flows of less than 10,000 gallons per day; the need for expert engineering design, selection, and installation of the unit best suited for the situation; the possibility of "burping" of sludge into the discharge effluent of small package plants; and, the need for expert operation and maintenance by a licensed operator.

Because package plants and small centralized systems using mechanical treatment technologies are especially

Mechanical treatment processes involve variations of either suspended media technologies or fixed-media technologies.

expensive for design flows of less than 10,000 gallons per day, they may not be the most cost effective option for small discharges. Rural schools, mobile home parks, small subdivisions, businesses, motels, and restaurants may be better served by alternative discharging systems such as sand filters, spray irrigation systems, or by alternative onsite systems.

Extended-Aeration Activated Sludge

The extended-aeration activated-sludge process is a widely used modification of the suspended-growth, activated-sludge process. The process uses low wastewater loading rates and the wastewater and solids are retained for long times. This process has been used since the 1950s and is fully developed as a technology. Extended-aeration systems are usually found as package plants.

An extended-aeration process typically consists of removing the largest solids by coarse screens or by cutting them in size (comminution), followed by activated-sludge aeration using coarse air diffusers or mechanical aerators for periods of 24 hours in long rectangular tanks, then secondary clarification using surface skimming and return sludge pumping, and finally chlorination and discharge. Solids are retained in the process for 20 to 40 days. In a well-operated extended-aeration facility, BOD and suspended solids removals can range from 85 to 95 percent.

Because they usually come in the form of a package plant and the site preparation and engineering costs are minimized, extended-aeration activated-sludge systems tend to be relatively economical. Some units are installed above ground on a concrete slab.

Advantages:

Extended-aeration activated sludge produces the least amount of sludge of any activated sludge process.

Steven J. Berkowitz

An aeration chamber of a small package wastewater treatment plant serving a small community.

The process produces a high quality effluent.

When approved, preengineered package plants can be relatively quickly installed with minimal site preparation.

With sufficient operator attention the process is quite reliable.

Nitrification is likely at wastewater temperatures above 15 degrees Celsius.

There are relatively minimal land requirements.

The initial costs are relatively low.

The process can handle moderate shock hydraulic loadings with minimal problems.

Potential Limitations:

There is a high power consumption and energy cost compared with land-based or natural systems.

Operation and maintenance requirements are high compared to land-based or natural systems and operators must be skilled due to the general mechanical complexity of the components.

Because of high variations in the influent flow and operator inattention these systems are susceptible to "excursions" or undesirable levels of suspended solids and associated BOD in the effluent.

In cold climates there are potential freezing problems.

Some of the wastewater solids may not settle efficiently due to formation of "pinpoint floc."

There is the potential for rising sludge due to denitrification in the final clarifier in warmer months.

There is the potential for sludge handling odor and blower noise.

Preengineered plants may require additional components or modification to meet specified effluent limitations.

Trickling Filter

A trickling filter is a bed of rock or plastic materials through which wastewater is filtered. Trickling filter processes provide a simple and easy-to-operate wastewater treatment method that may achieve a secondary level of treatment for communities where large tracts of land are not available for a treatment system. Trickling filter processes have been used in the United States since the 1930s.

Wastewater is periodically distributed over the bed of materials and trickles down through the rock or plastic. A layer of organisms contained in slime that

Centralized mechanical treatment systems are generally designed for wastewater flows of more than 10,000 gallons per day.

forms in the bed treats the wastewater.

A conventional trickling filter process consists of screening, grit removal, primary clarification, biological treatment with the trickling filter, secondary clarification, and disinfection. A separating tank is required to remove the parts of the slime layer that come off of the bed when the wastewater passes through.

In North Carolina, wastewater systems with trickling filters do not usually receive approval for meeting secondary discharge standards. Strict discharge standards on systems with trickling filters will require additional treatment. Conventional trickling filter facilities are no longer being built, though there are many still in operation, having been upgraded.

Modifications to the conventional standard rate of trickling have been developed to overcome the performance limitations of the original process. These include "high rate" processes and the trickling filter-solids contact (TFSC) process. Trickling filters can also be coupled with an activated sludge to remove ammonia (that is, for nitrification) if needed.

In the TFSC process, discharge from the trickling filter is "contacted" with secondary return sludge in an aerated, short-detention-time tank. This reduces the levels of suspended solids and improves the BOD removal in the final clarifier. The TFSC process is appropriate as a mechanical wastewater system for small, sewered communities, both for new systems and as a retrofit to existing trickling filter plants.

In general, new TFSC processes are more costly than either custom-designed extended-aeration plants or package plants. This is attributable mainly to the additional costs associated with primary clarification and sludge handling. However, use of the TFSC process is probably the most economical means of upgrading an existing trickling filter plant to meet secondary standards. Relatively high costs are likely to be associated with sludge treatment.

Advantages:

The TFSC process is applicable for new facilities or upgrading existing trickling filter plants.

TFSC is a relatively easy process. Conventional trickling filter systems can be upgraded to a TFSC system for relatively low cost and high reliability.

TFSC systems can be designed to provide nitrification.

Potential Limitations:

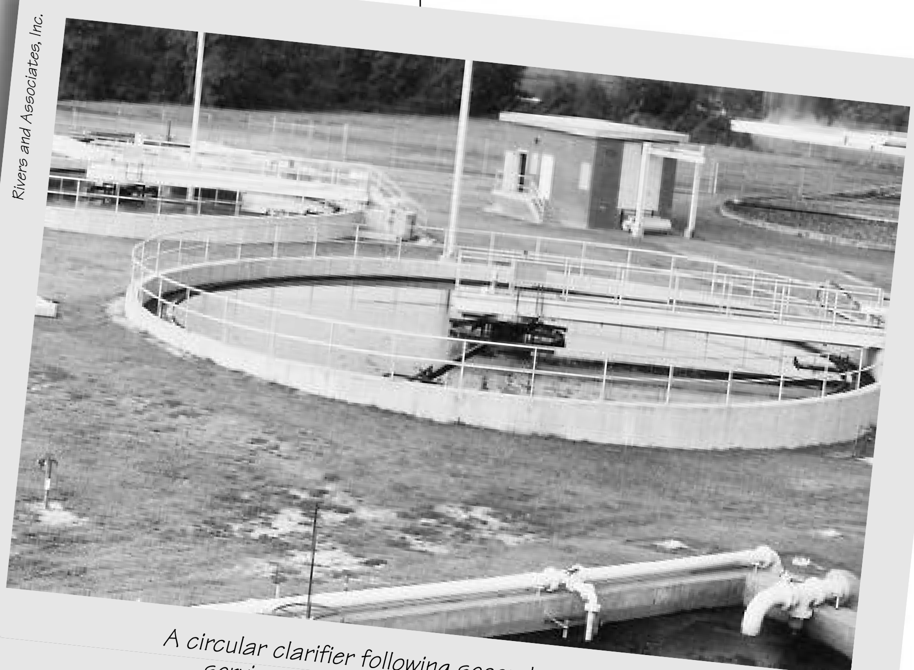
Primary clarification is required.

Pumping is required to douse the trickling filter.

There is the potential for nuisance odors from primary clarifiers, the trickling filter, and sludge handling processes.

A skilled operator is necessary and there are moderate operation and maintenance requirements.

Trickling filters may need to be covered in cold climates.



Rivers and Associates, Inc.

A circular clarifier following secondary treatment serving a town in eastern North Carolina.

Rivers and Associates, Inc.

An oxidation ditch in eastern North Carolina.
As an emerging technology, oxidation ditches offer small communities flexibility in meeting stringent discharge limits.

Oxidation Ditches

The oxidation ditch process is a variation of the extended-aeration, activated-sludge process. Oxidation ditches are moderately complex systems appropriate where strict discharge standards apply and where limited land is available. They are the most stable of the mechanical treatment systems in all climates and are suitable for relatively small wastewater flows associated with small communities or subdivisions.

Wastewater flows through a looped channel where it is mixed and aerated and where sludge is formed. Wastewater is retained for 18 to 30 hours and solids for 10 to 33 days.

Oxidation ditches have been shown to produce a very high quality effluent. Average annual effluent quality from oxidation ditches tends to be 15 milligrams per liter of BOD and suspended solids.

The basic components of an oxidation ditch process include coarse screening, grit removal, one or more closed-loop aerated channels, secondary clarification, and disinfection. Most oxidation ditch systems need a separate clarifier to remove sludge, which must be treated and disposed of.

Costs of oxidation ditch plants are competitive with other smaller activated sludge processes and appear to be particularly cost-effective in the larger-size ranges. However, local factors can have a major impact on relative construction costs.

Advantages:

The oxidation ditch process produces little sludge if properly operated.

The process has an excellent performance record.

It is highly reliable.

Substantial nitrogen and phosphorous removal is likely.

There is a relatively low initial cost with the system.

The system can be designed for biological phosphorous and nitrogen removal.

Potential Limitations:

Protection from aerator freezing problems is needed in cold climates. The aerators require relatively high maintenance.

There is the potential for rising sludge due to denitrification in the final clarifier.

These systems require good operating skills and routine monitoring.

Sequencing Batch Reactors

A sequencing batch reactor is wastewater treatment system that uses a form of the activated-sludge process in which aeration, sedimentation, and other functions are combined in a single reactor. SBRs allow wastewater treatment systems to be flexible for a variety of treatment goals to be met. SBRs are appropriate for communities with strict discharge standards and where limited land is available.

A tank is filled with a batch of wastewater and that batch is completely treated. Separate secondary sedimentation tanks are not used. Instead, several tanks are provided so that while one batch is being treated, the flow can be directed to another tank. Sludge forms on the bottom of the tanks, and some of it must be removed at the end of the cycle. Some is left in the tanks to help treat the next batch of wastewater. The sludge that is removed must be treated and disposed of. Programmable logic controllers are used to control all these processes.

A typical SBR process consists of screening, grit removal, SBR cycling, and disinfection. Critical components of an SBR system include the aeration-mixing system, the decant system which allows the treated wastewater to be draw off for discharge, the control system, and disinfection.

SBRs are likely to be cost competitive with other mechanical wastewater treatment systems over a wide range of flows. As with other mechanical systems, capital costs may be affected by site conditions such as climate, geology, and surrounding aesthetics. Costs for sludge stabilization and dewatering may account for a significant percentage of construction costs.

Advantages:

SBR systems are simple, reliable, and less costly than continuous-flow activated-sludge systems.

They are ideally suited for wide flow variations.

They can handle extremely low organic loads.

They are capable of very high and consistent effluent quality due to inactive batch settling.

While requiring skilled operators, SBR systems require less operator attention than most other mechanical systems.

The systems provide high operational flexibility, allowing capability for nutrient removal and filaments growth control.

SBRs can often be retrofitted into existing aeration basins or clarifiers.

Less land is required for installation than continuous-flow systems.

Potential Limitations:

Some problems have been reported with decant systems.

Improvements to hardware and software continue to be made as the technology develops.

Other Mechanical Treatment Systems

There are a variety of other mechanical treatment systems and technologies that are used as modifications of the conventional suspended-growth, activated-sludge process. Other modifications that may be appropriate for small community systems include contact stabilization and rotating biological contactors (RBCs). Contact stabilization is used for package plants with larger, more constant flows held for 20 to 40 minutes in order to reduce the volume of the aeration tank as compared to the extended-aeration process. Rotating biological contactors contain covered plastic rotating discs mounted on horizontal shafts. RBCs are used for treatment of pretreated wastewater by rotating the discs to sustain a biological film that forms on them and removes organic material.

Sequencing batch reactors are ideally suited for wide flow variations.

Steven J. Berkowitz

Rotating biological contactors under construction to be used for secondary treatment at a small centralized facility.

CHAPTER 13

Disinfection of Treated Wastewater

Disinfection is used to destroy potential disease-causing organisms in the wastewater stream. Since disposal of wastewater to surface water may result in potential contacts between individuals and the wastewater, disinfection processes to reduce the risk of infection will always be required by local or state health departments depending on the type of system used.

Disinfection is not a substitute for other forms of wastewater treatment, and generally requires the addition of special equipment at the end of the treatment process. The most common method of disinfection is chlorination. Ozone and ultraviolet light systems also disinfect wastewaters and destroy or remove harmful organisms.

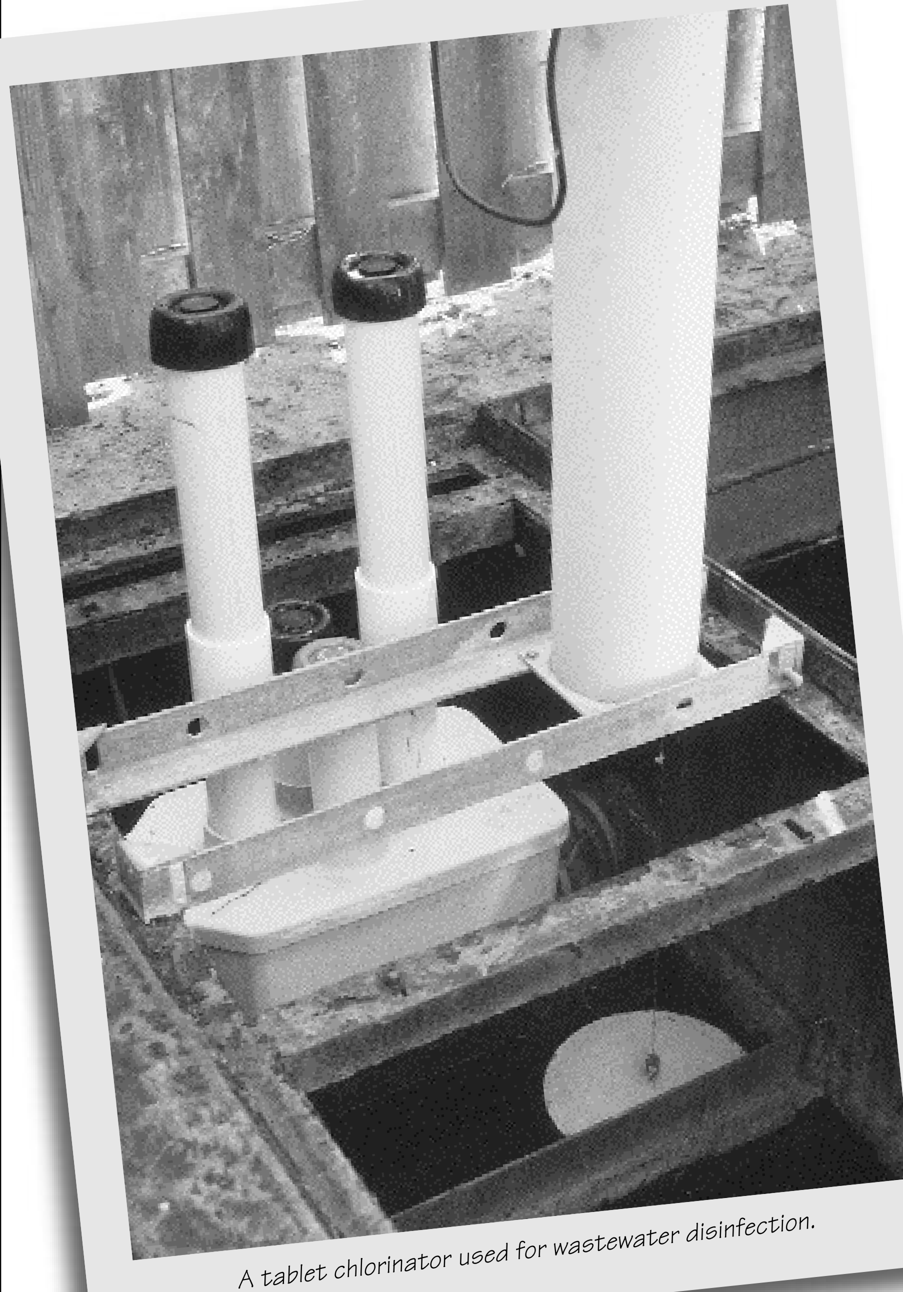
Disinfection does not always remove all of the harmful organisms in the water. For example, chlorination may not remove the eggs or cysts of the organism that causes amoebic dysentery; hence, other forms of disinfection may be required.

Routine maintenance and water testing are needed when using disinfection.

Chlorine

Chlorination is the most cost effective and most widely used means of disinfecting small wastewater discharges in the United States. The application of chlorine is a method that deactivates or kills many of the microorganisms present in wastewater.

Chlorine can be applied in gas or tablet form, or as a liquid solution of hypochlorite salt. The use of solid or liquid chlorine is much more practical for small systems than is chlorine gas.



Steven J. Berkowitz

A tablet chlorinator used for wastewater disinfection.

Chlorine is also often used for disinfection prior to land application of wastewater.

When used in wastewater disinfection, a chlorinator should be selected, installed, and adjusted by an expert in disinfection processes. It is important that enough chlorine is added for proper disinfection, but not so much as to threaten downstream aquatic life. Proper chlorine dosage depends on chemical characteristics (such as BOD and COD) of the wastewater, and requires the judgment of an expert. Effluent should be tested routinely for proper chlorine levels.

The process of dechlorination using sulfur dioxide has come into increased use due to rising concerns over chlorine toxicity and protection of fish and wildlife in sensitive waters. Dechlorination removes all or part of the chlorine residual remaining after chlorination, and reduces or eliminates chlorine toxicity harmful to aquatic life in receiving waters.

Chlorinators suitable for small wastewater flows are available for about $250 to $600.

Advantages:

Chlorine is low cost when compared to other disinfectants.

Chlorine is reliable as a disinfectant in proper dosages.

A variety of chlorination devices are readily available.

Potential Limitations:

Chlorine is toxic to aquatic, estuarine, and marine organisms, so careful, measured dosing is required. An additional hazard is the cancer-causing potential of chlorine after it reacts with decomposing organic material, a combination known as trihalomethanes. Other harmful residual chemicals such as chloroform may be produced and would persist downstream of the discharge. Chlorine gas is potentially toxic when inhaled and chlorine transport is a risk.

Chlorination requires conscientious maintenance, including periodic testing of water for proper chlorine concentration.

A. Robert Rubin

A small ozone generator used on an experimental basis for wastewater disinfection.

Ozone

Ozone has been used as a disinfectant for over a century. A pale blue gas with a pungent odor, ozone is a more potent disinfectant than chlorine and reacts quickly. As an unstable form of oxygen (O3), ozone is produced by the passage of an electric current through a stream of air. Disinfection is achieved by bubbling ozone through wastewater in an appropriate contact chamber. As a high-technology process, ozonation requires expert installation and maintenance.

Small ozone generators cost more than $2,000. Operating expenses are moderate due to the large amount of electrical energy required.

Advantages:

Ozonation is a safe, effective means of disinfection. Ozone does not have a residual and byproducts are considered minimal and far less detrimental than those generated through chlorination.

Ozonation can be economically attractive for treatment plants where oxygen-activated sludge is used since a source of pure oxygen is already available.

Ozone poses no threat to downstream aquatic life.

Potential Limitations:

Ozonation is energy and capital intensive, and generally requires a high quality effluent to be effective. It is not typically considered effective for secondary-level effluents.

As a high-technology process, ozonation requires expert maintenance.

Because of its instability, ozone must be generated onsite using commercially available equipment.

Ultraviolet Light

Ultraviolet rays comprise the shortest wavelength and highest energy band of the visible light spectrum. It is the component of sunlight which produces sunburn.

Disinfection by ultraviolet light is a physical process relying on the transference of electromagnetic energy from a source (a lamp) to an organism's genetic material. The lethal effects of this energy result in the irradiated cell being unable to replicate. In order to properly disinfect wastewater, the water must be relatively free of suspended solids which would otherwise screen the microorganisms from UV light.

The basic components of a UV system are a source of UV light and a wastewater contact chamber which minimizes the depth of water through which the UV rays must pass. If available, a UV system can be attached to a wastewater outfall.

Advantages:

UV light is a safe, clean method of disinfection that leaves no residuals that can become harmful.

UV light does not rely on an external supply of chemicals.

UV light does not pose a threat to downstream aquatic life.

Potential Limitations:

The ultraviolet light must contact the organisms in order to be effective. This can be difficult to achieve by the presence of suspended solids or materials that will interfere with transmission of light through wastewater.

The wastewater feeding into the ultraviolet light unit must be high quality.

UV light requires potentially high capital and operation and maintenance costs. Frequent sampling and analysis is necessary to insure against over- and under-utilization of the system. Over-utilization can increase the costs to operate.

The lamps, ballasts, and reactors must be maintained at peak efficiency.

Disinfection processes reduce the risk of infection for humans and animals.

CHAPTER 14

Sludge and Septage Management Alternatives

Sludge Management Alternatives

Sludge, also known as residuals and biosolids, is the thick residue generated in wastewater and water treatment processes. Treating sludge produced at centralized wastewater treatment plants may represent 50 percent of the total operation and maintenance cost of a treatment plant. This chapter describes alternative sludge and septage handling methods such as composting, currently not widely used in North Carolina, but that have the potential for wider use.

Sludge treatment generally consists of three steps: stabilization, dewatering, and utilization or disposal. Stabilization involves killing the disease-causing organisms and is accomplished by biological processes or by the addition of lime. Stabilization also controls odor by reducing levels of volatile solids in the sludge.

Aerobic Digestion

Aerobic digestion of sewage sludge is commonly used by small communities as a means of stabilization prior to land application. If application sites are in reasonably close proximity to the source of sludge, direct application of liquid sludge is clearly the most economical approach. If not, dewatering via sand drying beds or mechanical devices may be used to reduce the volume of sludge to be hauled away.

Aerobic digestion as practiced by small communities is typically performed in an open tank. Continuous introduction of air allows biological oxidation of organic matter under aerobic conditions. Aerobic digestion results in a reduction in biodegradable volatile solids, improved dewaterability, and odor reduction.

Advantages:

Low odor potential.

Simple and reliable process.

No chemicals are required.

Potential Limitations:

Very high power consumption.

Aeration system requires high maintenance.

Larger-volume tank required for cold climate application.

There is a potential for foaming.

Lime Stabilization

Lime stabilization or chemical stabilization to raise the pH of sludge has been used by small communities in Europe and the United States for many years. Lime treatment has several advantages over biological conditioning.

Rivers and Associates, Inc.

Sludge storage lagoons at a mechanical treatment facility in eastern North Carolina. The variation of sludge levels permits flexible sludge wasting and land application operations.

Advantages:

Low capital cost.

Ease of use.

Improved pathogen reduction.

Lime stabilization also serves as an ideal temporary or interruptible supplemental process for periodically overloaded existing digestion systems.

Potential Limitations:

Inability of the process to reduce the sludge mass.

Large increase in additional inert solids for dewatering and disposal.

The benefits of this process are usually lost after two weeks of storage.

Dewatering Beds

Dewatering involves removing the excess water from the sludge and is often accomplished on sand drying beds where water evaporates or drains away. Filter presses and centrifuges are also used and the water is returned to the wastewater treatment plant.

Vacuum-assisted beds are a relatively recent innovation developed in the mid-1970s. They use porous plates instead of sand and a vacuum to draw off the water. These systems are more costly to build but do not need as much land, require less labor, and use shorter drying times.

Other alternatives for sludge dryings beds include paved beds and reed beds. Paved beds allow the use of heavy equipment for sludge removal. Reed beds combine an underdrained sand bed with a dense strand of vegetation for improved dewatering through evapotranspiration and drainage through “pathways” made by plant roots, resulting in an infrequent need for sludge removal and bed cleaning, which are some of the most time-consuming tasks facing plant operators. Reed beds offer a low-maintenance alternative for smaller sludge handling facilities.

In general, sludge dewatering beds are a simple, widely used, and effective system of sludge handling. The beds may be enclosed. Capital costs may be substantially increased if beds must be covered.

Advantages:

Minimal skill and operator attention.

Low construction costs.

Potential Limitations:

Covering the beds may be required in cold or wet climates.

Potential odor and vector problems.

Considerable land requirements.

Land Application

Land application of stabilized sludge is commonly practiced by small, rural communities. Many sanitary landfills refuse or are reluctant to accept sludge. As an alternative to landfilling, land application is a simple process and provides substantial benefit to agricultural and marginal lands. Sewage sludge can be applied onto or below the land surfaces of pastures, cropland, forests, highway median strips, lawn and home gardens, ball fields, golf courses, parks, cemeteries, and reclaimed land. Sewage sludge is applied to the White House lawn. Sewage sludge acts as a good soil conditioner and source of organic matter and nutrients. Sludge can be applied as a liquid or as a dewatered cake. The sludge soil, groundwater and crops must be monitored.

Advantages:

Simplicity.

Low cost.

Stabilized sludge can be utilized as a soil conditioner and source of organic matter and nutrients.

Potential Limitations:

Care must be taken to avoid inappropriate application of sludge containing heavy metals, the presence of which must be monitored (though few sludges contain metals that are at levels which will cause a problem).

Storage requirements may be con-

Land application of stabilized sludge is commonly practiced by small rural communities.

Composted sludge can be sold as a fertilizer or a soil conditioner.

siderable to accommodate sludge generation during wet, frozen soil conditions.

Costs may increase substantially if large storage volumes are required. The costs of specialized application vehicles may be high.

Suitable areas for land spreading of stabilized sludge are becoming difficult to find in urbanized areas of the state and country.

Sludge Composting

Composting sludge is also an option for small towns. Composting is a natural process that breaks down sludge into humus-like material that communities can then sell as a low-grade fertilizer or a soil conditioner provided certain conditions are met.

In composting, sludge is mixed with a bulking agent, usually sawdust, wood chips, bark, straw, leaves, or rice hulls. The bulking agent provides carbon, helps expose the sludge to more oxygen, and reduces the moisture level of the sludge. The composting process takes several weeks to complete, during which time the pile generates high temperatures and must be exposed to oxygen either by turning the pile, or forcing air through the pile with a blower.

The simplest method of composting, and the one most likely to be found in rural communities is called windrow composting. In this method, the sludge-bulking agent mixture is stacked in long rows and mechanically turned by a tractor or other machine. The piles are turned daily at first and later about three times a week.

Sludge composting requires high quality sludge without heavy metals, and a readily available supply of sawdust and the space to construct the shelter for compost piles. Composting facilities must be conscientiously operated, including monitoring the temperature, moisture, and oxygen levels, and keeping the product weed and pathogen free.

Depending on the chosen operation of the composting process, composting methods can produce a compost that is either totally free of pathogenic organisms or only partially free. Site restrictions will apply to the latter type of compost, but may not pose a problem for small communities depending on where the compost is used.

Advantages:

Less expensive and requires less energy than incineration.

Produces a more manageable product for land application.

It is a more productive use than landfilling.

Well-managed composting facilities can benefit public relations and community pride.

Potential Limitations:

Severe odor problems in poorly managed or designed facilities.

Public relations problems related to any odor problems.

The need to site the facility in a sparsely populated area.

Septage Management Alternatives

Septage is a high-strength organic liquid and solid material which accumulates in properly operating septic tanks at a rate of approximately 70 gallons per person per year. Every year in North Carolina nearly 400 million gallons of septage is generated. This material is highly variable but typical characteristics include large quantities of grit and grease, a highly offensive odor, a high potential for foaming, poor settling and dewatering characteristics, high solids and organic content, and possibly some accumulation of heavy metals. The average septic tank should be pumped approximately once every five to eight years, not just when a disposal system problem occurs.

Septage handling begins at the home location when the hauler pumps out the septic tank. This material is then transported to a permitted wastewater treatment facility or to a land application site. The septic tank pumpers are required to receive a permit from the Department of Environment, Health, and Natural Resources, Division of Solid Waste Management each year. Fees for pumping septic tanks in North Carolina generally range from $100 to $150 for a 1,000-gallon tank.

Septage Addition to the Liquid Stream of Wastewater Facilities

Septage offloading to wastewater treatment plants will vary depending on the treatment plant. Septage can be introduced to the liquid stream through any manhole in the collection system, at the head of the wastewater plant, or through a separate storage facility at the plant which would then "bleed" septage into the wastewater plant as the plant can handle the wastewater flow. There are advantages and disadvantages to each of these methods. The method used depends on the size of the plant and the preferences of the operator. A separate storage facility and metered addition is often used when funding is available for construction.

Primary considerations at the waste water treatment plant are aeration and solids handling capacity, since septage addition will substantially increase oxygen demand and solids content in the wastewater. Most sewage treatment processes are able to treat septage, some more effectively than others. Extended-aeration plants are generally considered best suited for septage treatment. Activated-sludge and trickling filter plants are suitable if organic design loads are not exceeded. Contact stabilization processes appear least suitable to septage addition.

Advantages:

Easily implemented.

Low capital costs, except for holding facilities.

Convenience due to dispersed plant locations.

Acceptable to the public.

Potential Limitations:

Additional sludge generated at the plant.

Dilution of concentrated septage followed by reconcentration.

Increased operation and maintenance requirements.

Septage Addition to the Sludge Stream of Wastewater Facilities

Septage can be added to the sludge at a wastewater treatment plant at some point between the wastewater treatment phase and the sludge handling phase. This technique continues to have significant potential for application in North Carolina and throughout the country and may be one of the most cost-effective means of treating septage. Since septage is more similar to sludge than to conventional sewage this process is worth consideration. The sludge handling system to which the septage is added may involve thickening, digestion, grinding, and dewatering. Numerous treatment processes exist for each of these stages. The addition of septage must be controlled in order to avoid overloading. A central receiving point with controlled access is the preferred method of offloading the septage. Holding facilities may be needed to allow controlled addition of septage to the sludge stream.

An evaluation of the suitability of each wastewater facility for accepting septage would be necessary. Holding facilities may be required to control the rate and quality of septage addition. A realistic estimate of septage volumes would be required before implementing this technique.

Basic components of this technique include a central offloading facility with controlled access, preferably with holding facilities and metered addition of septage and a well-operated wastewater treatment plant with sludge handling facilities.

Cost figures for septage addition to the sludge stream vary with the plant's sludge-handle capacity, mode of handling, type of process employed, and other factors. Increases in labor requirements, power costs, and chemical costs are expected to be proportional to the quantity of septage accepted.

Advantages:

Avoids some problems associated with septage addition to the liquid stream.

Low capital investment.

Potential Limitations:

May result in substantial increases in plant operation and maintenance costs.

Additional equipment may be required.

Septage Composting

Composting involves mixing septage with a suitable bulking agent (woodchips or sawdust), and a method for circulating air through the mixture to insure proper conditions for pathogen dieoff and odor reduction. The major advantage of composting is that the final product is potentially suitable for many more uses than septage. It can in some cases be sold to offset some of the operating costs. Only a few septage composting facilities are currently operating in the United States. Composting of sewage sludge has received wider application.

Septage can be composted in any form. The required bulking agent mixtures will depend on the percent solids. As a result, some pretreatment may be cost effective, particularly if bulking agent costs are high.

The static pile method of composting consists of an elongated ridge-shaped pile over a perforated pipe. Air is pulled through the pipe to provide adequate oxygen in the pile. A three-to-four-week composting period is usually followed by a four-week curing period. Bulking material can be recovered by screening after the composting or curing stage, and then reused.

Basic components of the composting process include: septage handling facilities, including holding facilities and possible dewatering facilities; a bulking agent for composting; an aeration system; and, mechanical mixing equipment required for some composting techniques.

Composting has a low capital cost which would facilitate small operations in rural areas near the septage generation point. A feasibility study on the operation of a composting facility would be necessary. Only minimal effort would be required to make a preliminary decision on cost-effectiveness of composting versus other handling methods. Sale of the compost product could offset some of the operating costs of the process and eliminate disposal costs associated with other treatment methods.

Advantages:

Composting septage produces a stable end product with few pathogens.

Composting is operationally simple, and not affected by weather.

The end product can be marketable, achieving resource recovery.

Potential Limitations:

Requires a stable, long-term supply of bulking agent.

Composting is more expensive than land application.

May require collection and disposal of leachate.

Labor intensive, if materials handling is not mechanized.

Independent Septage Treatment Facilities

If land is not available for land spreading or if an adequate treatment plant capacity is not available within reasonable proximity (10 to 20 miles), independent facilities for the treatment of septage may be warranted, although none currently exist in North Carolina. Independent facilities can vary in scope from simple lime stabilization systems for land application to complex mechanical septage treatment plants comprising multiple physical and biological processes. Independent septage treatment facilities using technologies compatible with the capabilities of a small community would most likely be aerobic digestion or lime stabilization.

Aerobic Digestion

Aerobic digestion of septage is very similar to aerobic digestion of sewage sludge. An independent septage treatment facility using an aerobic digestion process would employ screening and grit removal as part of a preliminary treatment scheme. Residuals from these processes require regular disposal at permitted sites. Currently, in North Carolina there are no independent facilities for the aerobic digestion of septage in existence.

Although the aerobic digestion process is a relatively simple means of stabilization, there are several important concerns related to its use at an independent septage treatment facility. First, power costs are likely to be quite high to accomplish the transfer of oxygen. Second, supernatant (remaining wastewater liquid) decanted (poured) from the digester must be disposed of properly. Supernatant may require additional treatment prior to introduction to a subsurface disposal system as well as storage prior to use in an irrigation system.

Lime Stabilization

Lime stabilization is among the most cost-effective options for stabilization of septage to meet land-application criteria and conditions of septage prior to dewatering. The process is simple, fully developed, and requires a minimum of operator skill and attention.

Lime stabilization involves addition of sufficient lime or other alkaline material to raise the pH to 12 for a period of 30 minutes. This destroys pathogenic organisms, improves dewaterability, and removes objectionable odors. The stabilized septage may be applied to the land as a liquid or dewatered first, using sand drying beds. If dewatered, treatment and disposal of the filtrate must be considered.

Advantages:

Simple batch processes are used.

Minimal operator skills are required.

It is an economical process.

Lime stabilization meets EPA pathogen reduction criteria.

The process reduces objectionable odors.

The process improves dewatering.

Potential Limitations:

Lime stabilization does not destroy harmful organic compounds.

The process increases the mass of solids to be handled.

If mechanical lime feed systems are used a high degree of operator attention is required.

The operation is dusty.

There is the potential for ammonia releases at high pH levels.

Ultimate Septage Disposal or Utilization Methods

After septage is handled and treated, its liquid and solid components must still be finally disposed of or utilized. At plants with surface discharge permits the liquid portion is frequently incorporated with other treated wastewater and discharged to surface waters. The solid fraction is generally handled by a land disposal method.

Land Surface Application of Septage

The most widely used method of septage disposal is land application. Post-application disking of the disposal site is required within six hours of appli-

Land application of septage as part of an onsite wastewater management effort in eastern North Carolina.

cation if the septage is not lime stabilized. Lime-stabilized septage can be spread over grassed areas. Slopes may not exceed 12 percent.

Surface application may be implemented at sites permitted for that purpose. Agreements among the N.C. Department of Environment, Health and Natural Resources, Division of Solid Waste Management, and land owners and septage haulers are necessary before a permit to land apply can be obtained from the division. Uses of harvested crops are restricted. Actual application rates are generally determined on the basis of annual nitrogen loading rates for different crops.

Septage offloading at ultimate disposal points can be done at a storage facility during wet weather or the septage can be discharged from the truck onto the disposal site. Septage in the storage facility should be spread on the site as soon as weather permits.

Basic components of the surface application process include: suitable permitted land area; septage stabilization facilities that may be required; and, storage facilities that should be provided for use during inclement weather (or an alternative disposal method should be available). Costs are highly variable, but may be offset by nutrient addition to, and conditioning of, the soil.

Advantages:

Soil conditioning and nutrient addition.

A centralized disposal site is unnecessary.

Minimal labor is required.

Relatively simple procedure.

Generally low cost.

Potential Limitations:

Potential public health hazard if untreated septage is spread.

Potential for surface and groundwater contamination.

Odor and vector problems may occur.

Spreading is restricted during inclement weather.

Storage facilities and stabilization may be required.

Subsurface Application

Subsurface application of septage involves the injection of septage into the soil or burying it within a shallow furrow to reduce the potential for odors, human contact, and vector transmission. This process minimizes odor and vector problems; however, there are fewer sites available for subsurface application. The process is currently not used in North Carolina.

Subsurface disposal may be accomplished using either a farm tractor and tank trailer with the necessary application devices, a tank truck similarly equipped, or tractor-mounted equipment fed with septage from a central holding facility through a flexible "umbilical cord." Disposal by this method may be implemented in much the same manner as described under surface application.

Basic components of the subsurface application process include: suitable land area(s) permitted by the N.C. Department of Environment, Health, and Natural Resources, Division of Solid Waste Management; distribution equipment (including injection devices); and, septage storage facilities.

Advantages:

Soil conditioning and nutrient addition.

Centralized disposal area unnecessary.

Limited labor is required.

Relatively simple procedure.

Generally low cost.

Odor and vector problems are minimized.

Potential Limitations:

Injection is limited during inclement weather.

Groundwater monitoring is recommended.

Storage facilities or other disposal method is required.

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APPENDIX

Where To Go For Help

Federal Agencies

Appalachian Regional Commission
Administration Building, Suite 5106
116 W. Jones Street
Raleigh, NC 27603-8001
(919) 733-7232

The Appalachian Regional Commission provides grants to communities in the Appalachian region of the United States, including the 29 counties in western North Carolina. Funds from the ARC are limited to water and wastewater projects which involve the creation of economic opportunities .

Economic Development Administration
300 Fayetteville St. Mall, Room 128
Raleigh, NC 27602
(919) 856-4570

The Economic Development Administration distributes grant funds for sewerage projects which will provide economic development opportunities for targeted communities. It also provides technical assistance for economic development planning.

Rural Development Administration/ Farmers Home Administration

In addition to its loan and grants program, the RDA in conjunction with FmHA also provides services for communities which it funds including project planning assistance, engineering and architectural assistance, reviews of financial records, and data collection and analysis. FmHA currently has local offices in most counties in North Carolina as well as nine district offices in the state. The district offices should be contacted for inquiries regarding community wastewater projects. The water and waste disposal programs of the RDA are proposed to be combined into the new Rural Utilities Service of the USDA.

Rural Development Administration/
Farmers Home Administration
State Office
4405 Bland Road, Suite 260
Raleigh, NC 27609
(919) 790-2731

FmHA District Offices:
FmHA District I
400 Dellwood Road
Building E, Suite 1
Waynesville, NC 28786
(704) 452-0319

FmHA District II
Oak Summit Office Park
910 State Farm Rd., Suite 210
Boone, NC 28607
(704) 262-5902

FmHA District III
325 East 4th St.
Lumberton, NC 28358
(919) 739-8194

FmHA District IV
Wrightsville Building
2300 W. Meadowview Rd., Suite 202
Greensboro, NC 27407
(910) 294-7181

FmHA District V
630-A S. Garnett St.
Henderson, NC 27536
(919) 438-3141

FmHA District VI
109 West Blvd. Hwy. 64 Bypass
Williamston, NC 27892
(919) 792-1006

FmHA District VII
4001 Carya Dr., Suite B
Raleigh, NC 27610
(919) 856-4196

FmHA District VIII
New Hanover County
Administration Building
4006 Oleander Dr., Suite 3
Wilmington, NC 28403
(910) 392-5696

FmHA District IX
Executive Sq. Building
2002 S. Glenburnie Rd.
New Bern, NC 28560
(919) 638-4735

Soil Conservation Service
4405 Bland Rd., Suite 205
Raleigh, NC 27609
(919) 790-2909

The Soil Conservation Service is a federal agency under the U.S. Department of Agriculture. The main focus of the water resources planning staff of the SCS is on flood prevention although water supply, land treatment and water quality are major considerations. They provide project planning, engineering and financial assistance.

US Environmental Protection Agency
345 Courtland St., N.E.
Atlanta, GA 30365
(404) 347-7109

The EPA Region IV office has a public-private partnership regional coordinator who could provide assistance in planning public-private partnerships for developing wastewater facilities.

US EPA National Small Flows Clearinghouse
P.O. Box 6064
Morgantown, WV 267506
(800) 624-8301

The EPA National Small Flows Clearinghouse provides a variety of referral and information gathering and distribution services regarding small wastewater systems. The Clearinghouse publishes two newsletters, Small Flows *and* Pipeline, *with free subscription, maintains a computer bulletin board for free, and can provide literature packages and audio-visual materials about virtually all small wastewater systems and technologies as well as planning, financing, and management issues for free or at low cost. The Clearinghouse's literature is geared toward both community leaders who may be unfamiliar with wastewater systems and technical professionals. The Clearinghouse gives toll-free technical assistance and advice on specific problems and makes referrals to other agencies.*

Water Resources Division
U.S. Geological Survey

P.O. Box 30728
Raleigh, NC 27622
(919) 571-4000

Through a 50-50 cost sharing program, the Water Resources Division of the U.S. Geological Survey assists federal, state and local agencies in collecting and analyzing hydrologic data to be used as the basis for sound water management decisions.

State Agencies

Construction Grants and Loans Section

Division of Environmental Management
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919) 733-6900

General loans, emergency loans, and high-unit cost grants are available through the N.C. Clean Water Revolving Loan and Grants Fund. Also administered by the Division of Environmental Management, the State Revolving Fund is a federally funded program to provide low-interest loans to governments and utility districts for the construction of wastewater treatment facilities. DEM also provides other assistance on wastewater systems for small communities.

Division of Community Assistance

N.C. Department of Commerce
Methodist Building
1307 Glenwood Ave., Suite 250
Raleigh, NC 27605
(919) 733-2850

The Division of Community Assistance distributes Community Development Block Grants for water, wastewater and other community development projects. In addition to providing project planning assistance for municipal and county governments, DCA also conducts water and sewer rate studies.

Division of Soil and Water Conservation

N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919)733- 2302

The Division of Soil and Water Conservation provides planning for small watershed projects, surveying, classification of soil types, and other services. The division's management assistance includes appointing watershed trustees, administering the N.C. Agriculture Cost-Share Program for non-point source pollution control, and assisting local soil and water conservation districts on a broad conservation agenda.

Local Government Commission

N.C. Department of the State Treasurer
325 N. Salisbury Street
Raleigh, NC 27603-1385
(919) 733-3064

The Local Government Commission must approve all debts entered into by local governments in North Carolina. The LRC helps governments to determine the appropriate method of debt financing.

North Carolina Cooperative Extension Service

Box 7602
Raleigh NC 27695-7602
(919) 515-2811

The North Carolina Cooperative Extension Service (NCCES) is an outreach component of the College of Agriculture and Life Sciences and North Carolina State University. The NCCES conducts educational and adaptive research programs in community and rural development, water quality, residential and business, solid waste management, and onsite and community wastewater treatment, disposal and utilization. There are NCCES centers in all North Carolina counties, and there is a specialist staff housed at North Carolina State University. The NCCES provides project planning assistance, educational material and programs, data collection and analyses, public issues education and engineering assistance as resources permit. Some NCCES major projects include: animal waste management, land application of agricultural and municipal wastes, residential septic tank management, residential water conservation, watershed management and water and waste management in the food processing industry. The NCCES is also involved in the areas of ground and surface water quality protection and solid waste recycling. Of particular interest to rural communities is the NCCES development and demonstration of alternative wastewater systems.

Onsite Wastewater Section

Division of Environmental Health
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919) 733-2895

The Onsite Wastewater Section is the principle agency involved in providing a comprehensive statewide program for the sanitary control of onsite wastewater treatment and disposal as a joint effort among local health departments, regional onsite wastewater specialists (soil scientists), engineers and other professional staff in the Division of Environmental Health. The section provides training and continuing education to local environmental health specialists, private consultants, and firms involved in the onsite wastewater industry. The section is not a source of financial assistance for development of onsite systems. The section will publish a detailed technical manual on onsite wastewater systems in late 1994.

Solid Waste Section

Division of Solid Waste Management
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687

The Solid Waste Section is responsible for the proper treatment and disposal of septage and sludge removed from wastewater systems permitted under the authority of the Division of Environmental Health. All land application sites for this septage or sludge from these systems must be permitted by the Division of Solid Waste Management.

Local Health Departments

Local health departments and districts serve each of the 100 counties in North Carolina. They should be contacted for technical assistance and to ensure regulatory compliance regarding onsite or subsurface-disposal wastewater systems. Most health departments provide (and require) multiple site evaluations for soil-absorption systems. In North Carolina, the local health department must approve the application of a technology to a site as well as decide soil loading rates and daily wastewater flow based on proposed use. A small number of health departments are involved in engineering assistance, data collection, and project planning.

Nonprofit Organizations

Community Action Agencies

Community action agencies are nonprofit organizations which provide a variety of poverty-relief services to low-income communities. Some provide services related to water and wastewater access for individual households and communities. Some are active in the actual construction of facilities while others provide community support services such as community organizing and grant writing assistance. For more information on community action agencies contact the North Carolina Community Action Association, P.O. Box 98475, Raleigh, NC 27624-8475, (919) 790-8900.

Councils of Government

Councils of Government are regional planning and service organizations. As regional organizations they can often provide more comprehensive services on water and waste disposal issues than can the counties and municipalities within their jurisdictions.

North Carolina Rural Communities Assistance Project, Inc.

P.O. Box 941
Pittsboro, NC 27312
(919) 542-7227

North Carolina Rural Communities Assistance Project, Inc. provides a variety of free onsite technical assistance, training, planning, and other outreach activities on wastewater, water, and solid waste issues for small communities, water and wastewater systems, and individuals across the state. NC/RCAP makes in-kind contributions related to wastewater and other projects and can provide access to a low-interest alternative loan fund and engineering assistance for planning wastewater projects in low- and moderate-income communities at no cost. NC/RCAP also advocates for safe and affordable water and waste disposal for all North Carolinians and educates communities on these issues.

North Carolina Rural Economic Development, Inc.

Four North Blount St.
Raleigh, NC 27601
(919) 821-1154

The North Carolina Rural Economic Development Center, Inc. works to stimulate economic growth in the state's rural areas through research, demonstration projects, and policy and program development. As a clearinghouse for rural development professionals and others, the Rural Center is a source of new ideas and information to assist people in economic development.

North Carolina Rural Water Association, Inc.

P.O. Box 540
Welcome, NC 27374
(704) 731-6963

The North Carolina Rural Water Association, Inc. provides training and onsite technical assistance to rural water and wastewater systems. NCRWA is a membership organization but nonmember systems can also receive free assistance. NCRWA offers a loan program for projects to improve existing water and wastewater system facilities and also offers health insurance, property and casualty insurance, and workers' compensation insurance for systems.

Other Organizations

There are many other organizations in North Carolina that provide assistance related to wastewater systems. The *North Carolina Rural Services Directory,* published by the North Carolina Rural Economic Development Center, Inc., lists nearly 100 organizations that provide assistance on water and wastewater issues. The *Directory of Water, Wastewater, Groundwater, and Solid Waste Resources for Rural Communities*, published by North Carolina Rural Communities Assistance Project, Inc., also provides information on other wastewater-related organizations.

GLOSSARY

Terms Encountered in Wastewater Management

"A" Horizon. The layer of soil formed at or near the soil surface, having properties that reflect the influence of accumulating organic matter or eluviation.

Absorption. The process by which one substance is physically taken into and included with another substance.

Acidity. A measure of the acid character of waters; indicated by low pH's (below 7.0); associated with aggressive and corrosive waters.

Activated sludge. A process commonly used in conventional centralized sewerage systems for removing organic matter from sewage by saturating it with air and adding biologically activated sludge. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.

Adsorption. The process by which pollutants are attracted to and held on the surfaces of soil molecules, thus immobilizing them.

Ad valorum tax. A method of determining user charge rates based on a percentage of assessed property values.

Advanced waste treatment. Physical or chemical treatment following secondary or biological treatment. Also called tertiary treatment.

Aeration. The exposure to the chemical action of air.

Aeration tank. Serves as a chamber for injecting air into raw or settled wastewater as it is mixed with return sludge. The same as aeration bay, aerator, or reactor.

Aerobic. Life or processes that occur in the presence of oxygen. In an aquatic environment such as wastewater, "aerobic" refers to the presence of free or dissolved oxygen.

Aerobic treatment. Process by which microbes consume complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth. Types of aerobic processes include aerobic tanks, extended aeration, trickling filtration and rotating biological contactors.

Aggregate, soil. A group of soil particles cohering so as to behave mechanically as a unit.

Algae. Simple rootless plants that grow in still waters in relative proportion to the amounts of nutrients available. When they grow in large numbers in wastewater treatment ponds they can affect water quality adversely by lowering the dissolved oxygen in the water. But they can help treat wastewater in small natural treatment units.

Alkalinity. The capacity of water or wastewater to neutralize acids. High alkalinities (above 300 to 500 mg/l) are usually associated with hard waters. Alkalinity is not the same as pH because water does not have to be strongly basic (high pH) to have a high alkalinity. Alkalinity is a measure of how much acid can be added to a liquid without causing great change in pH.

Alternating and dosing system. An onsite disposal system that uses tanks, automatic siphons, pumps, or other mechanisms to control the package of waste effluent from the septic tank to the drainfield. The system allows for dose and rest cycles that improve waste assimilation in the drainfield.

Alternative wastewater system. A fully proven system that reclaims or reuses wastewater, productively recycles wastewater components, recovers energy, or eliminates the discharge of pollutants.

Anaerobic. A life or process that occurs in the absence of oxygen. In an aquatic environment such as wastewater, "anaerobic" refers to the absence of free or dissolved oxygen.

Angstrom (Å). One hundred millionth of a centimeter. Expressed as 10-8 cm.

Aquaculture. Developing plants and animals that grow in water or wastewater and cleanse wastewater by digesting pollutants. The harvest is used as fertilizer, food, and so on.

Aquifer. An underground geologic formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Amortization. The process of allocating an asset, a liability, or an amount over future accounting periods. It is the gradual reduction or liquidation of an account according to a specified schedule of times and amounts.

Assimilative capacity. The ability of a site to absorb and treat hydraulic and nutrient loading of wastewater effluent.

Attenuation. The process by which a compound is reduced in concentration over time through adsorption, degradation, dilution, and/or transformation.

"B" Horizon. The layer of soil beneath the "A" horizon characterized by a higher colloid (clay or humus) content, or by a darker or brighter color than the soil immediately above or below, the color usually being associated with the colloidal materials. The colloids may be of alluvial origin (left by rivers or floods), as clay or humus; they may have formed in place (clays); or they have been derived from texturally layered parent material.

Backwashing. The operation of cleaning a filter by reversing the flow of liquid through it, washing out matter captured in it, and returning to the wastewater treatment plant for additional treatment.

Bacteria. Microscopic, single-celled living organisms which can aid wastewater treatment systems by consuming or breaking down organic matter in sewage. Bacteria in soil, water or air can also cause human, animal, and plant health problems.

Batch process. A treatment process in which a tank or reactor is filled, the wastewater is treated, and the tank is emptied. The tank may then be filled and the process repeated.

Bedrock. The solid rock beneath the soil and subsoil.

Biochemical oxygen demand (BOD). The rate at which microorganisms use the oxygen in water and wastewater to aerobically decompose organic matter present. The BOD in effluent is used along with suspended solids as a measure of the effectiveness of the wastewater treatment processes. All BOD levels of treated effluent are 30 milligrams per liter or lower as set by state and county health regulations. "BOD5" refers to the biochemical oxygen demand over a five-day period.

Biodegrade. To decompose as a result of the actions of microorganisms.

Biomass. A mass or clump of living organisms feeding on the wastes in wastewater, dead organisms and other debris. This mass may be formed for, or function as, the protection against predators and storage of food supplies. Biomass also refers to trees and shrubs or anything of biological origin.

Biomat. Also known as clogging mat. An organic-rich slime layer that forms on sand filter surfaces or at soil trench interfaces that reduces permeability.

Biosolids. A term referring to sludge.

Blackwater. Any water that carries animal, human, or food wastes.

Bond. A written obligation to pay (debt) a specified sum of money (called principal) at future dates (called maturity dates) along with periodic payments at a specified percentage of the principal (interest rate). Bonds are typically used for long-term debt.

Bond, general obligation. When a government pledges its full faith and credit to the repayment of bonds which it issues through various means including taxes or other revenues.

Bound water. Water contained within the cell mass of sludges or strongly held on the surface of colloidal particles. It is one of the causes of bulking sludge in the activated-sludge process.

Bulk density, soil. The mass of dry soil per unit bulk volume. The bulk volume is determined before drying to constant weight at 105° C.

Bulking. Clouds of billowing sludge that occur throughout secondary clarifiers and sludge thickeners when the sludge becomes too light and will not settle properly. In the activated-sludge process bulking is usually caused by filamentous bacteria or bound water.

Bulking agent. A material which reduces bulk density and improves aeration in a compost facility.

"C" Horizon. The layer of soil that normally lies beneath the "B" horizon but may lie beneath the "A" horizon, where the only significant change caused by soil development is an increase in organic matter, which produces an "A" horizon.

CFS. Flow rate in cubic foot per second; 1 cfs equals 0.65 million gallons per day.

Capital costs. All costs of major rehabilitation, betterments, expansion, or upgrading (as opposed to operation) of a wastewater system project.

Capillary action. A liquid's movement over, or retention by, a soil surface, due to the interaction of adhesive and cohesive forces.

Chemical oxygen demand (COD). A measure of the oxygen-consuming capacity of materials in wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in milligrams per liter (mg/l) during a specific test. Results are not necessarily related to biochemical oxygen demand because the chemical oxidant may react with substances that bacteria do not stabilize.

Chlorinator. A device for adding chlorine gas to sewage to kill infectious germs.

Chlorine. A compound added to water and wastewater usually for the purpose of disinfection.

Chlorine residual. The total amount of chlorine (combined and free available chlorine) remaining in water, sewage, or industrial wastes at the end of a specified contact period following chlorination.

Clay. A soil separate that is less than 0.002 millimeters in diameter. Clay has a smooth, sticky and plastic feel when moist. Clay forms very hard clods when dry. Clay particles may remain suspended in water for extended periods of time.

Clarifiers. Settling tanks or sedimentation basins. The purpose of a clarifier is to remove settleable solids by gravity, or colloidal solids by coagulation following chemical flocculation; will also remove floating scum through skimming.

Clay. A soil separate consisting of particles smaller than 0.002 millimeters in equivalent diameter; a textural class of soil.

Clogging mat. Same as biomat.

Closed-loop recycling. Reclaiming or recycling wastewater for nonpotable purposes in an enclosed process.

Cluster system. A system of wastewater collection and treatment facilities in which wastes from numerous homes or their sources are conveyed to a central treatment and disposal facility. Systems generally consist of small collection pipes attached to individual homes that transfer the wastes to the central treatment facility.

Coagulation. The clumping together of solids to make them settle out of the sewage faster. Coagulation of solids is brought about with the use of certain chemicals such as lime, alum, or iron slats.

Coliform-group bacteria. A group of bacteria predominantly inhabiting the intestines of humans or animals, but also found in soil. Used as an indicator of contamination.

Colloids. The finely divided suspended matter which will not settle, and the apparently dissolved matter which may be transformed into suspended matter by contact with solid surfaces or precipitated by chemical treatment. Substances which are soluble as judged by ordinary physical tests, but will not pass through a parchment membrane.

Combined sewers. Sewers that carry both sewage and stormwater runoff. During rainless periods, most or all of the flow in a combined sewer is composed of sanitary sewage. During a storm, runoff increases the rate of flow and may overload the sewage treatment plant to which the sewage connects. At such times, it is common to divert some of the flow, without treatment, into the receiving water.

Commercial waste. Any waste that is generated and disposed by a commercial establishment such as a gas station, restaurant, or dry cleaner. These wastes may contain hazardous constituents which may require special treatment.

Composting. The natural biological decomposition of organic material in the presence of air to form a humus-like material.

Composting toilet. Any device that is designed to store and decompose human waste by aerobic digestion. These systems may require special venting, plumbing, electrical, and mechanical components, and periodic maintenance.

Compound. A pure substance composed of two or more elements whose composition is constant. For example, table salt (sodium chloride) is a compound.

Conventional wastewater system. One of a variety of standard systems which is commonly used to collect, treat, and dispose of wastewater: sewers, treatment plants and septic tanks with drainfields.

Cross connection. A connection between drinking (potable) water and an unsafe water supply. For example, if a pump moving non-potable water is hooked up to a drinking water system to supply water for the pump seal, a cross connection or mixing between the two water systems can occur. This mixing may lead to contamination of the drinking water.

Decomposition. The process of breaking down into smaller particles.

Debt service. Payment of interest and repayment of principal to holders of a debt instrument.

Denitrification. The biochemical reduction of nitrate or nitrite to gaseous molecular nitrogen or an oxide of nitrogen. This condition is often the cause of rising sludge observed in secondary clarifiers or gravity thickeners. Denitrification takes place during the proper balance of nitrate and carbonaceous material and only under anaerobic conditions.

Detention time. The time required to fill a tank at a given flow or the theoretical time required for a given flow of wastewater to pass through a tank.

Dewater. To remove or separate a portion of the water present in a sludge or slurry.

Digestion. The process of dissolving solids in wastewater. Digestion of sludge takes place when the materials decompose, resulting in partial gasification, liquefaction, and mineralization of pollutants.

Dilution. The process of diluting, thinning out, or making less concentrated, as in diluting wastewater by adding it to a river or stream.

Discharge. To release; when used with "wastewater" it usually refers to wastewater released into surface waters (streams and lakes).

Disinfection. The process designed to kill most microorganisms, including essentially all pathogenic (disease-causing) bacteria. Disinfection should not be confused with sterilization.

Dissolved oxygen. The oxygen freely available in water, wastewater, or other liquid. Dissolved oxygen is vital to fish and other aquatic life.

Domestic wastewater. Wastewater that is generated by a residence. These wastewaters generally consist of human wastes and wastewater from washing machines, toilets, showers, and dishwashers.

Drainfield. Also known as absorption field, disposal field, leach field, nitrification field, seepage field, tile field, septic field and others. A system of trenches or beds or combinations of these devices designed for subsurface treatment and disposal of pretreated waters.

Economies of scale. The process in which the cost per customer decreases as the number of users increases.

Effluent. The liquid that comes out of a septic or aerobic tank, drainfield, basin, or other treatment unit after completion of the treatment process.

Environmental Impact Assessment (EIA). Also known as environmental impact statement (EIS), a process mandated by federal law, with auxiliary requirements in executive orders, regulations, agency response, state legal requirements, and other legal mechanisms, for projects or actions which are either expected to have a significant effect on the quality of the human environment or are expected to be controversial on environmental grounds. Most centralized wastewater projects require an EIA.

Eutrophication. The normally slow aging process by which a lake evolves into a bog or marsh and ultimately assumes a completely terrestrial state and disappears. During eutrophication the lake becomes so rich in nutritive compounds, especially nitrogen and phosphorous, that algae and other microscopic plant life become super-abundant, thereby "choking" the lake, and causing it eventually to dry up. In addition to dense algae growth, eutrophic conditions are typified by surface water scums, foul-smelling water, periods of anaerobic conditions, and fish kills. Eutrophication of wastewater ponds can happen due to improper maintenance. Eutrophication can also occur in other surface waters such as rivers and streams due to the increased release of nutrients and other constituents of wastewater.

Evapotranspiration. The total water removed from an area by transpiration from plants and by evaporation from soil, snow, and water surfaces.

Evapotranspiration system. An onsite system in which wastewater flow from a septic tank or other device is disposed of through evaporation from the soil surface or transpiration from plants. This process is most useful in areas outside of North Carolina with year-round high evaporation rates which exceed rainfall rates.

Experimental wastewater system. See "innovative wastewater system."

Extended aeration. A modification of the activated sludge process which provides for aerobic sludge digestion within the aeration system.

Facultative. Facultative bacteria can use either molecular (dissolved) oxygen or oxygen obtained from food materials such as sulfate or nitrate ions. In other words, facultative bacteria can live under aerobic or anaerobic conditions.

Feasibility study. A comprehensive investigation of the factors related to developing a community wastewater system.

Filtration. The physical removal of suspended solids or particles from effluent by soil or sand particles of other filter media.

Fixed media. A wastewater treatment process where the organisms which feed on sewage are physically bound to a substrate medium and contact with wastewater is intermittent.

Flat rate. A sewerage billing rate that is not based on water usage, but is usually based on a fixed price.

Floc. Groups or clumps of bacteria and particles that have come together and formed a cluster. Floc is found in aeration tanks and secondary clarifiers.

Flocculation. The grouping together of fine particles to form larger particles.

Flood plain. Flat or nearly flat land on the floor of a river valley that is covered by water during floods.

Flow rate. The quantity of water available and/or needed per minute, per hour, or per day to satisfy the requirements of people, livestock, and water fixtures.

GPD. Gallons per day. A measure of water or effluent flow rate.

Geology. The structure of the earth in a given region or area, including soil, rocks, and water.

Grants. Appropriations of funds from government or private sources for use in developing wastewater or other projects.

Gravity sewer. A system of conduits (open or closed) in which no wastewater pumping is required.

Greywater. Domestic wastewater composed of washwater from sinks, kitchen sinks, bathroom sinks, and tubs and laundry drains.

Grinder pump. A mechanical device that shreds solids and raises the fluid to a higher elevation through pressure sewers.

Grit. The heavy material present in wastewater such as sand, eggshells, gravel, and cinders.

Groundwater. Water found in cracks, fissures, and pore spaces in the subsurface of the earth below the water table.

Groundwater recharge. Water which flows from the surface, thorough soil, and into the subsurface saturated zone to replenish groundwater sources.

Heavy metals. Mineral elements found in soils that are essential to plant growth but in high concentrations can be toxic to plant and animal life. Typically, the quantity of heavy metals found in sludge from wastewater treatment plants is very low when compared to the quantity of naturally occurring metals in the soil. Some heavy metals such as mercury are toxic in low concentrations to plant and animal life.

Holding tank. An enclosed tank, usually fiberglass or concrete, for the storage of wastewater prior to removal or disposal at another location. Rarely approved in North Carolina.

Hydraulic conductivity. The ability of soil to transmit liquids through pore spaces in a specified direction, such as horizontally or vertically.

Hydraulic loading. The flows to a wastewater treatment plant or treatment process. Detention times, surface loadings, and weir overflow rates are directly influenced by flows.

Hydraulic potential. Also called hydraulic capacity, long-term acceptance rate, or loading rate. The ability of a soil to accept and dispose of a volume of waste effluent over time. It is used as a measure of the proper size for a soil absorption field.

Hydrogeologic characteristics. Characteristics that describe the hydrology (the distribution of water on the surface and below the ground) and the geology (the structure and content of the earth) at a site. Hydrogeologic characteristics include soil type, depth to groundwater, soil permeability, and groundwater recharge rate. These properties control the entrance of water to the subsurface and the capacity to hold, transmit, and deliver water.

Hydrology. Surface and ground water conditions at a site.

Imhoff tank. A two-story tank used for onsite and cluster wastewater systems. Sedimentation is accomplished in the upper compartment and digestion of settled solids is accomplished in the lower compartment. Not permitted for use in North Carolina.

Impact assessment fees. Charges to a property owner for a share of the cost of offsite improvements sometimes imposed on a new development or intended to cover the cost of water and wastewater facilities.

Impervious. Resistant to penetration by fluids or by roots.

Industrial wastes. Any waste that results from manufacturing or other industrial processes. These wastes often contain hazardous chemicals which require special treatment processes.

Inert. Without active chemical or biological properties, as in inert particles in wastewater.

Infiltration. The penetration of water through the ground surface into the subsurface soil or the penetration of water from the soil into a pipe through such means as defective pipes, connections and manholes.

Infiltration/Inflow. The total quantity of water entering a sewer system. Infiltration means entry through such sources as defective pipes, pipe joints, connections, or manhole walls. Inflow signifies discharge into the sewer system through service connections from such sources as area or foundation drainage, springs, and swamps, storm waters, street wash waters, or sewers.

Influent. Water, wastewater, or other liquid flowing into a septic tank, treatment plant, basin, or other treatment unit.

Innovative wastewater systems. Systems that use technologies that are developed but not yet fully proven. Also known as experimental wastewater systems.

Irradiation. See ultraviolet light.

Irrigation. A land-application technique wherein wastewater is applied to land to supply the water and nutrient needs of plants.

Lagoon. In terms of wastewater treatment, a human-made pond or body of water in which sunlight, algal and bacterial action and oxygen interact to restore the wastewater to a reasonable state of purity.

Land application. Also known as land treatment, it is method of treatment of wastewater in which soil, air, vegetation, bacteria, and fungi are employed to remove pollutants from wastewater. Some of the applied wastewater evaporates and the remainder may be allowed to percolate to the water table, discharged through the drain tiles, or reclaimed by wells.

Lateral sewer. A sewer designed and installed to collect sewage from a limited number of individual properties and conduct it to a trunk sewer. Also known as a street sewer or collecting sewer.

Leachate. The solution formed when water percolates through solid wastes, soil, or other materials, and extract soluble or suspended substances from the materials.

Leaching. The process by which soluble constituents (tiny particles) are dissolved and carried down through the soil by a percolating fluid.

Licensed professional engineer. An engineer who has been certified or approved by a state authority.

Lineament analysis. An analytical technique that uses aerial photographs to detect linear features in the landscape that are indicative of solution zones in karst terrain.

Manifold. A pipe fitting with several openings and numerous branches used in wastewater drainfields to convey wastewater between a large pipe and several smaller pipes, or to permit choice of diverting flow from one of several sources or to one of several discharging points.

Mapping unit. A soil or combination of soils delineated on a map where possible. Mapping units on maps principally depict soil types, phases, associations, or complexes.

Mastic. A scaler used to seal septic tank joints.

Media. The material that serves as a physical foundation for fixed biological processes.

MGD. Flow rate in million gallons per day; 1 mgd equals 1.5 cubic feet per second.

Microorganisms. Also know as microbes. Minute plant and animal life, some of which exist in sewage and can cause disease.

Milligrams per liter (mg/l). The weight of a substance, in milligrams, found in a liter of water. One mg/l equals 1 oz. per 7,5000 gallons. It is also equivalent to one part per million (ppm).

Mixed liquor. When the activated sludge in the aeration tank is mixed with primary effluent or the raw wastewater and return sludge, the mixture is then referred to as mixed liquor as long as it is in the aeration tank. Mixed liquor may also refer to the contents of mixed aerobic or anaerobic digesters.

Monitoring well. A well used to collect groundwater samples for the purpose of physical, chemical, or biological analysis. They are generally installed where groundwater contamination exists or has a potential to exist.

Mottles. Spots or blotches of different color or shades of color interspersed with the dominant color. Mottles indicate the depth of the seasonal high water table.

Mound system. An alternative system design in which fill material, generally sand, is laid on top of plowed soils that alone are unsuitable for wastewater treatment. Mound systems are generally used where there is an inadequate thickness of acceptable soil to support a conventional soil absorption system.

Municipal wastewater. Water containing pollution resulting from domestic wastes, typically feces and laundry wastes.

Nitrate (NO3). The most oxidized form of inorganic nitrogen and a contaminant commonly associated with septic systems. High concentrations of nitrate and nitrite (NO2) in drinking water are known to cause methemoglobinemia (a poisoning similar to that caused by cyanide) in young babies. The EPA sets a limit of 10 mg/l for nitrates.

Nitrification. The biochemical oxidation of ammonium to nitrate.

Non-functional water use. Excessive water use that is a result of malfunctioning or poorly maintained plumbing, high water pressure, or wasteful water-use habits.

Non-point source. A general source of pollution, such as surfacing effluent from a failing septic system.

NPDES. National Pollutant Discharge Elimination System, the federal government's system of controlling all discharges of pollutants from point sources into U.S. waterways. NPDES permits discharges into navigable waters from all point sources of pollution, including industries, municipal treatment plants, large agricultural feed lots, and return irrigation flows.

Nutrients. Fertilizers; any substance absorbed by living things that promotes growth. The term is generally applied to nitrogen and phosphorous in wastewater which contributes to eutrophication of water supplies.

Onsite system. A wastewater treatment and disposal facility located at or near the source of the wastewater.

Operation and Maintenance (O&M). Functions that result in expenditures during the useful life of the treatment works for materials, labor, utilities, and other items necessary for managing and maintaining the facility.

Organic. Referring to or derived from living organisms containing carbon and hydrogen.

Organic waste. Waste materials which come mainly from animal or plant sources. Organic waste generally can be consumed by bacteria and other small organisms. Inorganic wastes are chemical substances of mineral origin.

Overland flow. The land-application technique that cleanses wastewater by allowing it to flow over a sloped surface. As the water flows over the surface, the contaminants are removed and the water is collected at the bottom of the slope for reuse.

Oxidation pond. A human-made lake or body of water in which wastes are consumed by bacteria. It is used most frequently with other wastewater treatment processes.

Package sewage treatment plant. A relatively small, prefabricated self-contained primary or secondary wastewater treatment system. One might be used in a subdivision where septic systems will not meet requirements for wastewater discharge.

Parasites. An animal or plant that lives on or in another organism from which it draws its nourishment.

Pathogens. Microorganisms potentially harmful to humans and animals, including parasites, bacteria, and viruses and other disease-causing microorganisms.

Ped. A unit of soil such as an aggregate, crumb, prism, block, or granule formed by natural processes (in contrast with a clod, which is formed artificially).

Perched water table. A discontinuous, saturated area of soil which exists in the unsaturated zone (above the normal water table) as a result of a low permeability layer. Often occurs after heavy rain.

Percolation. The movement of water downward and radially through pores between the particles of soil, filtering wastewater through subsurface soil layers, usually continuing downward to the groundwater.

Percolation test. A test used to estimate the percolation rates of water through soils. Unlike most states, onsite systems in North Carolina are approved based on a comprehensive soil morphology rather than the traditional percolation test.

Perforated. Having holes, as in perforated pipe.

Performance standard. A standard that is used to judge whether predetermined requirements have been met, such as the necessary level of treatment for a waste stream, after the completion or initiation of operation. Performance standards generally are in the form of a pre-determined level of concentration of a particular compound or constituent that is allowed in a waste effluent.

Permeability. The rate at which liquids pass through soil in a specified direction. Permeability is expressed in inches per hour. Generally, fine textured soils have slower permeabilities than coarse-textured soils. Information on soil permability can be found in the Soil Conservation Service interpretation sheets or county soil surveys.

pH. A term used to describe the hydrogen-ion activity of a system; a measure of the acidity or alkalinity or water, wastewater, or other solution.

Physical and chemical treatment. Processes generally used in large-scale wastewater treatment facilities. Physical processes may involve air-stripping, comminutors, clarifiers (sedimentation and flotation) and filtration using racks or screens. Chemical treatment includes coagulation, chlorination, or ozone addition.

Phosphorous. An element that while essential to life, contributes to the eutrophication of lakes and other bodies of water.

Point source. A stationary source of a large individual emission. Wastewater treatment plants are ordinarily considered point sources of pollution.

Pollution, water. Results when something animal, vegetable, or mineral makes it more difficult or dangerous to use for drinking, recreation, agriculture, industry or wildlife.

Ponding. The accumulation of septic tank discharge in soil absorption drainfields. (Same as surfacing).

Porous. Having or full of pores that admit the passage of gas or liquid.

PPM. Parts per million, 1 ppm equals 1 part of the substance concentrated in one million parts of water (by weight).

Precipitation. A chemical reaction formed when chemicals are added to alter physical states of dissolved or suspended solids to aid in their removal during wastewater treatment. Examples of precipitation include water softening, phosphorous removal and heavy metal removal.

Pressure. The force needed to move water.

Pressure distribution. A system that uses a pump and special piping to evenly distribute waste flow from a septic tank over a drainfield. The system can improve upon gravity flow by distributing the effluent over a wider area and by permitting resting cycles.

Pressure sewer. A wastewater collection system in which household wastes are collected in a building drain and conveyed therein to the pretreatment and/or pressurization facility at a higher elevation by applying a pumping force behind it. The system consists of two major elements: the onsite or pressurization facility and the primary conductor pressurized sewer main.

Pretreatment Facility. An industrial wastewater treatment plant consisting of one or more treatment devices designed to remove sufficient pollutants from wastewaters to allow an industry to comply with federal, state, and local effluent pretreatment regulations.

Primary treatment. A first and basic stage in the treatment of sewage that removes by screening or sedimentation nearly all solid material that floats or will settle. Septic tanks provide primary treatment onsite and in conventional centralized sewerage systems screens remove floating solids and settling tanks remove heavy material.

Protozoa. A group of microscopic animals that sometimes cluster into colonies and often consume bacteria as an energy source.

Public-Private Partnership. A contractual relationship between a public and private partner that commits both to providing an environmental service. The private sector can be involved in a variety of ways, from the initial design of a facility to its daily operation and maintenance.

Pump. A mechanical device for causing flow, for raising or lifting water or other fluid, or for applying pressure to fluids.

PVC. Polyvinyl chloride. A type of plastic commonly used in the pipes of water and wastewater systems.

Receiving waters. Rivers, lakes, oceans, or other water courses that receive treated or untreated wastewaters.

Recharge. To replenish or refill, as in groundwater recharge.

Renovation. To renew or repair. Renovation of wastewater refers to the treatment processes that cleanse wastewater before it is reintroduced into the water supply.

Rejuvenate. To renew or restore to a previous condition, as in rejuvenating septic systems to make them usable again.

Residuals. A term referring to sludge.

Restrictive horizon. A soil layer that limits or restrains movement of water through the soil.

Rotating biological contactor. A device used in an aerobic process which encourages the growth of organisms that aerobically decompose wastes. The organisms are grown on surfaces of the contactors, often constructed as large discs, which are rotated to come into contact with the waste flow and with air. The process seeks to optimize organism growth by exposing them to an ideal combination of wastes and oxygen.

Sand. A soil separate whose particle sizes range from 2 to 0.05 millimeters in diameter. Sand is gritty when soil is rubbed between the thumb and forefingers.

Sand filters. Biological and physical wastewater treatment units utilizing filter tanks that remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand. Cleaner water drains from the bed. Liquid passing through the filter may be discharged to a soil absorption system or to surface water after chlorination. The sludge accumulating at the surface must be removed from the bed periodically.

Sandy loam. Soil composed on approximately equal parts of sand, silt and clay.

Sanitary district. A local public authority with a local mandate to manage and operate water and/or wastewater systems.

Sanitary sewers. Pipes in a separate system that carry only domestic wastewater. The stormwater runoff is taken care of by a separate system of pipes.

Saprolite. Geologic material breaking down in place which will ultimately form soil.

Saturation zone. The area below the water table where the soil pores are fully saturated with water.

Scum. A layer of light solids (such as hair, grease, and soap) which accumulates at the surface of the wastewater in a septic tank.

Secondary treatment. The second stage in most conventional centralized wastewater treatment systems in which bacteria consume and decompose the organic parts of the wastes. It is accompanied by bringing together wastewater, bacteria, and oxygen in trickling filters or the activated-sludge process. Effective secondary treatment processes remove nearly all solids as well as 90 percent of BOD and suspended solids. Disinfection of the effluent by chlorination is usually the last step in this process.

Sedimentation tanks. Tanks that help remove solids from sewage. The wastewater is pumped to the tanks where the solids settle to the bottom or float on the top as scum. The scum is skimmed off the top, and solids on the bottom are pumped to digestors, filtration, or other means of final disposal.

Seepage. The slow movement of water through small cracks or pores of a material, through the soil, or into or out of a body of surface or ground water.

Septage. An anaerobic slurry of solid wastes, including scum, sludge, and liquid contents of a septic tank at the time of pumping. The septage must be periodically pumped from the septic tank. Also called scavenger wastes, septic tank pumpings, residuals.

Septic system. An onsite wastewater management system. Septic systems are constructed using conventional, alternative, or experimental system designs.

Septic tank. A treatment receptacle that receives wastewater and is designed and constructed to separate the liquid and solids in the wastewater. Organisms in the tank anaerobically treat and digest organic matter prior to discharge, generally to a subsurface disposal system. Sludge settles on the bottom of the tank.

Service charge. A charge levied on a user of the treatment works which includes a user charge, a charge for capital reserve, and debt service.

Settleable solids. That matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour, but either settles to the bottom or floats to the top.

Sewer. A system of pipes that collects and delivers wastewater to treatment plants or receiving streams.

Shallow water table. The underground supply of fresh water located near the surface of the ground.

Short circuit. In a water or wastewater system, a flow of liquid that follows a path of lesser resistance, flowing by a shorter route than the normal one.

Silt. A soil separate consisting of particles between 0.05 and 0.002 millimeters in diameter. Silt has a smooth, baby powder feel when rubbed between the thumb and fingers and is not plastic or sticky when moist.

Slope. Deviation of a plane surface from the horizontal.

Sludge. A semi-solid residue of raw wastes from wastewater and water treatment processes. Sludge needs to be pumped and removed from facilities such as septic tanks periodically. Also known as residuals and biosolids.

Slug load. A higher than usual load of influent in a wastewater treatment process.

Soil. A complex, heterogeneous, porous mixture of particulate mineral solids and organic matter between which are spaces that are filled with air and water. It provides a three-phase treatment system: the solid phase consists of soil particles; the liquid phase consists of water containing dissolved substances; and, the gaseous phase consists primarily of soil air and other gases.

Soil absorption field. The area of ground to which wastewater is released from a septic tank through a series of perforated pipes.

Soil absorption system. A system consisting of trenches or beds, together with piping or gravel, installed in appropriate solids for the purpose of receiving wastewater flow from a septic tank or other treatment device and transmitting it into soil for final treatment and disposal.

Soil borings. Soil samples taken where the septic tank or soil absorption system is to be located. Samples may be tested for various soil characteristics.

Soil characteristics. Relevant properties of soil, including its clay content, texture, particle size, classification, structure, permeability, and other relevant properties.

Soil horizon. A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistence, pH, and so on.

Soil map. A map showing the distribution of soil types or other soil mapping units in relation to the prominent features of the earth's surface.

Soil morphology. The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile, and by the texture, structure, consistence, and porosity of each horizon.

Soil profile. The natural appearance and layering of soil.

Soil separates. Groups of mineral particles separated on the basis of a range in size. The principal separates are sand, silt, and clay.

Soil series. The basic unit of soil classification, and consisting of soils which are essentially alike in all major profile characteristics, although the texture of the "A" horizon may vary somewhat. See soil type.

Soil structure. The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterized and classified on the basis of size, shape, and degree of distinctness.

Soil texture. A relative proportion of various soil components, including sands, silts, and clays, that make up the soil layers at a site. Soil textural analysis can be used to determine a soil's ability to treat and dispose of septic tank effluent and in sizing the soil absorption system.

Soil type. In mapping soils, a subdivision of a soil series based on differences in the texture of the "A" horizon.

Sole-source aquifer. A groundwater aquifer which is the sole or principal drinking water source for an area and which, if contaminated, would create a significant hazard to public health.

Sorption. A process by which suspended solids and colloidal particles in waste effluent become attached to soil particles. In general, soils high in clay or organic content have high sorptive capacities.

Sterilization. The removal or destruction of all living microorganisms, including pathogenic (disease-causing) bacteria and saprophytic (living on or decaying organic matter) bacteria, vegetative forms, and spores. Sterilization should not be confused with disinfection.

Storm sewer. A separate system of pipes that carry only runoff from buildings and land during a storm.

Stormwater runoff. The water that flows over buildings and land during storms.

Subsoil. In general concept, that part of the soil below the depth of plowing.

Subsurface. Below ground.

Sump pump. A mechanism used for removing water or wastewater from a sump or wet well. It may be energized by air, water, steam, or electric motors.

Supernatant. Liquid removed from settled sludge. Supernatant commonly refers to the liquid between the sludge on the bottom and the scum of the surface of an anaerobic digester. This liquid is usually returned to the influent wet well or to the primary clarifier of a wastewater treatment facility.

Surfacing. Excess ponding resulting in introduction of partially treated effluent to the soil surface above a soil absorption system. There is a potential for disease transmission through contact with the surface effluent.

Suspended media. Opposite of fixed media.

Suspended solids. The small particles of solid pollutants which are present in sewage and which resist separation from the water by conventional means. The amount of suspended solids in effluent is used along with BOD as a measure of the effectiveness of the treatment process.

Tertiary treatment. See advanced waste treatment.

Tight soil. A compact, relatively impervious and tenacious soil or subsoil.

Topography. The general shape of the ground surface at a site (such as hilly, rolling, level).

Topsoil. (1) the layer of soil moved in cultivation, (2) the "A" horizon, (3) presumably fertile soil material used to top dress road banks, gardens, and lawns.

Transpiration. The process by which water vapor is lost to the atmosphere for living plants. The term can be applied to the quantity of water thus dissipated.

Triassic basin. A geologic basin formed during the Triassic period, composed primarily of sand stone, mud stone and silt strate.

Trickling filter. A device used in many conventional centralized sewage treatment plants that is the support media for bacterial growth, usually a bed of rocks or stones. The sewage is trickled over the bed so the bacteria can break down organic wastes. As the wastewater trickles through the filter, the bacterial slime that coats the bed material biodegrades the organic material in the wastewater.

Turbidity. The turbidity of water is attributed to suspended or colloidal matter, the effect of which is to reduce clarity and light penetration.

Ultraviolet light. A disinfection technique that utilizes a wavelength that is slightly shorter than that of visible light rays.

Unincorporated community. A community or neighborhood without an immediate local government but under the jurisdiction of the county in which it is located.

Unsaturated zone. The area above the water table where the soil pores are not fully saturated, although some water may be present. Also called the "vadose zone."

User charge. A charge levied on users of a treatment works for the costs of operation, maintenance or replacement.

Vector. An organism that carries pathogens from one host to another.

Virus. The smallest form of microorganism capable of causing disease.

Volatile. Capable of being evaporated or changed to a vapor at relatively low temperatures.

Wastewater. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.

Wastewater reuse. The use of treated wastewater for a beneficial use such as agricultural irrigation or industrial cooling.

Wastewater treatment plant. A series of tanks, screen, filters or other processes by which pollutants are removed from water.

Water table. The dividing line between the soil's saturated and unsaturated zones.

Waterless toilets. Any one of a number of types of toilets that do not use water, including composting toilets.

Watershed. The land area drained by a stream or by an entire river system.

Weir. A wall or plate placed in an open channel and used to measure the flow.

Wetlands. Areas or ground that are swampy or marshy for at least part of a year that are usually protected by federal regulations to safeguard sensitive wildlife and vegetation.

Zero Discharge. A theoretical no-discharge system.