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Pipeline

Small Community Wastewater Issues Explained to the Public

Lagoon Systems Can Provide Low-Cost Wastewater Treatment

It is no wonder that one of the most popular methods for wastewater treatment around the world is also one of the simplest and least expensive. Lagoon systems use natural and energy-efficient processes to provide low-cost wastewater treatment. They are one of the most cost-effective wastewater treatment options for many homes and communities.

In the U.S., most wastewater treatment lagoons are found in small and rural communities. Lagoons are especially well-suited to small communities because they can cost less to construct, operate, and maintain than other systems. They also require more land than other wastewater treatment methods, and land is more likely to be available and inexpensive in rural areas.

Lagoons can also be designed to serve individual households. They sometimes are a good option for homes on large lots in areas where other onsite systems or sewers are too costly or otherwise impractical. Lagoons also work well for many seasonal rental properties and recreational areas, because they are able to handle intermittent periods of both light and heavy use.

What are lagoon systems?

There are several different types and names for lagoons and many possible system designs. Lagoon systems include one or more pond-like bodies of water or basins designed to receive, hold, and treat wastewater for a predetermined period of time. Lagoons are constructed and lined with material, such as clay or an artificial liner, that will prevent leaks to the groundwater below.

While in the lagoon, wastewater receives treatment through a combination of physical, biological, and chemical processes. Much of the treatment occurs naturally, but some systems are designed to also use aeration devices that increase the amount of oxygen in the wastewater. Aeration makes treatment more efficient, so that less land area is necessary, and aerators can be used to upgrade some existing systems to treat more wastewater.

Every lagoon system must be individually designed to fit its specific site and use. Designs are based on such factors as the type of soil, the amount of land area available, the climate, and the amount of sunlight and wind in an area.

Other important design considerations for lagoon systems include the amount and type of wastewater to be treated and the level of treatment required by state and local regulations. Depending on local standards and the final method of disposal chosen, wastewater leaving lagoon systems often requires additional treatment, or "polishing," to remove disease-causing organisms or nutrients from the wastewater before it can be returned to the environment.

This issue of *Pipeline* includes a brief overview of some of the different types of wastewater treatment lagoons, how they work, their operation and maintenance, and some of their advantages and disadvantages. Only a few of the many possible classifications and designs for lagoon systems are mentioned here.

Readers are encouraged to reprint *Pipeline* articles in local newspapers or include them in flyers, newsletters, and presentations. Please include the name and phone number of the National Small Flows Clearinghouse (NSFC) on the reprinted information and send us a copy for our files.

If you have questions about reprinting articles or about any of the topics discussed in this issue, contact the NSFC at (800) 624-8301 or (304) 293-4191.

There Are Many Designs, Names for Lagoons

Lagoons are not all the same. Some employ different biological, chemical, and physical processes to treat the wastewater, while others may play a different role in overall treatment. Some lagoon designs provide adequate treatment for certain methods of discharge, while others should be used in combination with other lagoons or with additional treatment.

Complicating matters further, there can be several different names for the same type of lagoon. For example, the terms *lagoon* and *pond* are often used interchangeably, and names, such as *polishing*, *stabilization*, and *maturation*, can refer to a lagoon's particular role in treatment. This can be very confusing for community leaders and homeowners trying to evaluate lagoon systems.

The following is a brief overview of some of the more common types of lagoons and some of the terms used for them.

Anaerobic Lagoons

The word *anaerobic* means without oxygen, which describes the conditions inside this type of lagoon. Anaerobic lagoons are most often used to treat animal wastes from dairies and pig farms, commercial or industrial wastes, or as the first treatment step in systems using two or more lagoons in a series.

Typically, anaerobic lagoons are designed to hold and treat wastewater from 20 to 50 days.* They are relatively deep (usually 8 to 15 feet) and work much like septic tanks.

Inside an anaerobic lagoon, solids in the wastewater separate and settle into layers. The top layer consists of grease, scum, and other floating materials. This layer keeps oxygen out, allowing bacteria and other organisms that thrive in anaerobic conditions to work to treat the wastewater.

As with septic tanks and most other lagoon designs, the layer of sludge that settles at the bottom of an anaerobic lagoon eventually accumulates and must be removed periodically. Also similar to a septic tank, the wastewater that leaves an anaerobic lagoon always requires further treatment.

Odor can be a problem with anaerobic lagoons. However, in many cases odor can be managed through a variety of methods, such as adding sodium nitrate, recirculating pond effluent, and through regular maintenance.

Aerobic Lagoons

Dissolved oxygen is present throughout much of the depth of aerobic lagoons. They tend to be much shallower than other lagoons, so sunlight and oxygen from air and wind can better penetrate the wastewater. In general, they are better suited for warm, sunny climates, where they are less likely to freeze. Wastewater usually must remain in aerobic lagoons from 3 to 50 days to receive adequate treatment.*

Wastewater treatment takes place naturally in aerobic lagoons with the aid of aerobic bacteria and algae. Because they are so shallow, their bottoms need to be either paved or lined with materials that will prevent weeds from growing in them.

Sometimes, the wastewater in aerobic lagoons needs to be mixed to allow sunlight to reach all of the algae and to keep it from forming a layer that blocks out the air and sun completely.

Aerated Lagoons

Aerated lagoons are very common in small communities. These systems use aerators to mix the contents of the pond and add oxygen to the wastewater. They are sometimes referred to as partial-mix or complete-mix lagoons depending on the extent of aeration. Partial-mix aerated lagoons are sometimes facultative lagoons that have been adapted and upgraded to receive more wastewater.

With the exception of wind-driven designs, most aerators require energy to operate. However, energy costs are almost always considerably less than those for other mechanical community treatment systems. Aeration makes treatment more efficient, which offsets energy costs in some cases. Aerated lagoons require less land area and shorter detention times for wastewater than other lagoons. More information about partial-mix aerated lagoons is included in the articles on pages 5 and 6.

Facultative Lagoons

Both aerobic and anaerobic conditions exist in facultative lagoons, which also are called stabilization ponds, oxidation ponds, photosynthetic ponds, and aerobic-anaerobic ponds. They are the most common type of wastewater treatment lagoon used by small communities and individual households.

Facultative lagoons can be adapted for use in most climates, require no machinery, and treat wastewater naturally, using both aerobic and anaerobic processes. Because they are used so often by small communities, facultative lagoons are described in detail beginning with the article on page 4.

**Exact detention times for wastewater in lagoons are based on factors such as the particular design, the amount of wastewater to be treated, and the level of treatment desired.*

Discharge Design

A design feature that can distinguish lagoons is how they discharge wastewater.

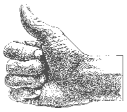
Continuous Discharge Lagoons. These lagoons release wastewater continuously, so the rate of output roughly equals the rate of input. The hydraulic flow pattern in the lagoon is designed so the wastewater remains in the lagoon long enough to receive treatment before it reaches the outlet.

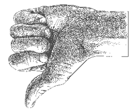
Controlled Discharge Lagoons. In these lagoons, wastewater is discharged in controlled amounts, usually once or twice per year. This method is common in cold climates where discharges typically occur after spring thaw and again in fall.

Hydrograph Controlled Release Lagoons. This design can be used for lagoons that discharge directly to surface water. It includes devices that measure the level and quality of the wastewater and receiving water and the velocity of the receiving water to determine when conditions are most favorable for discharge. This method can sometimes eliminate the need for further treatment.

Complete Retention Lagoons. These lagoons are only practical in very dry climates where evaporation rates exceed rainfall amounts. Wastewater is never released from this type of lagoon. Instead it is allowed to evaporate and, when soil conditions are favorable, to slowly percolate through the soil at the bottom of the lagoon.

Advantages *and* Disadvantages *of Lagoon Systems*





- Lagoon systems can be cost-effective to design and construct in areas where land is inexpensive.
- They use less energy than most wastewater treatment methods.
- They are simple to operate and maintain and generally require only part-time staff.
- They can handle intermittent use and shock loadings better than many systems, making them a good option for campgrounds, resorts, and other seasonal properties.
- They are very effective at removing disease-causing organisms (pathogens) from wastewater.
- The effluent from lagoon systems can be suitable for irrigation (where appropriate), because of its high-nutrient and low-pathogen content.

- Lagoon systems require more land than other treatment methods.
- They are less efficient in cold climates and may require additional land or longer detention times in these areas.
- Odor can become a nuisance during algae blooms, spring thaw in cold climates, or with anaerobic lagoons and lagoons that are inadequately maintained.
- Unless they are properly maintained, lagoons can provide a breeding area for mosquitoes and other insects.
- They are not very effective at removing heavy metals from wastewater.
- Effluent from some types of lagoons contains algae and often requires additional treatment or "polishing" to meet local discharge standards.

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Pipeline Is Now Online

Pipeline's publisher, the National Small Flows Clearinghouse (NSFC), went online last fall with its World Wide Web site. The site is updated regularly, and now includes the latest issues of *Pipeline* and several of NSFC's other publications.

The site is accessible via the address http://www.nsfc.wvu.edu. Also included are the latest issues of the newsletter *Small Flows, The Small Flows Journal*, and NSFC's *Guide to Products and Services.*

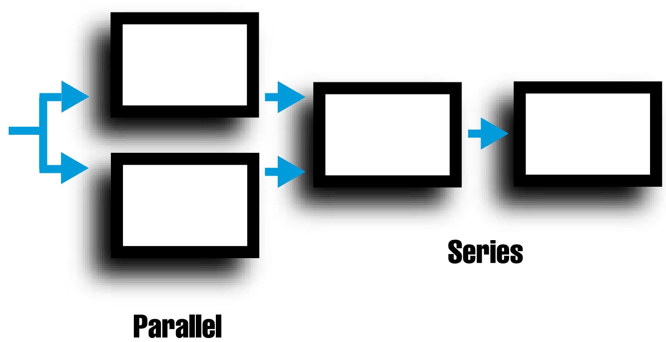
In addition, the NSFC's Web site offers public education information under the section "Wastewater Trivia," and includes more than a dozen links to other wastewater-related sites.

All visitors to NSFC's Web site are encouraged to leave messages or suggestions to the Web master under the "Contact Us" section. We look forward to seeing your comments about the Web site and about future *Pipeline* issues.

Two, Three, or Four Lagoons Are Better Than One

Many community systems are designed to use more than one lagoon in a series, in parallel, or both. This is because two or more small lagoons can provide better quality treatment than one large lagoon, in most cases. Multiple lagoons are less common in systems designed for individual households.

In systems that employ more than one lagoon, each lagoon cell has a different function to perform, and a different kind of lagoon design may even be used for each cell. (See the article on page 2 for information on the different types of lagoon designs.)



In Series

When lagoons operate in series, more of the solid material in the wastewater, such as algae, has an opportunity to settle out before the wastewater is discharged. Sometimes serial treatment is necessary so the effluent from lagoon systems can meet local discharge standards.

Some lagoon systems are designed to use more cells during the summer months when algae growth is highest.

In Parallel

In parallel means that a system has more than one cell that is receiving wastewater at the same stage of treatment.

This system design is particularly useful in cold climates or where lagoons are likely to be covered with ice for part of the year. Because biological processes are involved, wastewater treatment slows down in cold temperatures, making treatment less efficient. Parallel cells are often used during winter months to handle extra loads.

Facultative Lagoons Treat Wastewater Naturally

Facultative lagoons can be fascinating places. Like other small bodies of water, they are constantly full of life and activity. Wastewater is treated through natural processes with the help of bacteria, algae, and other organisms living in the lagoon.

How They Work

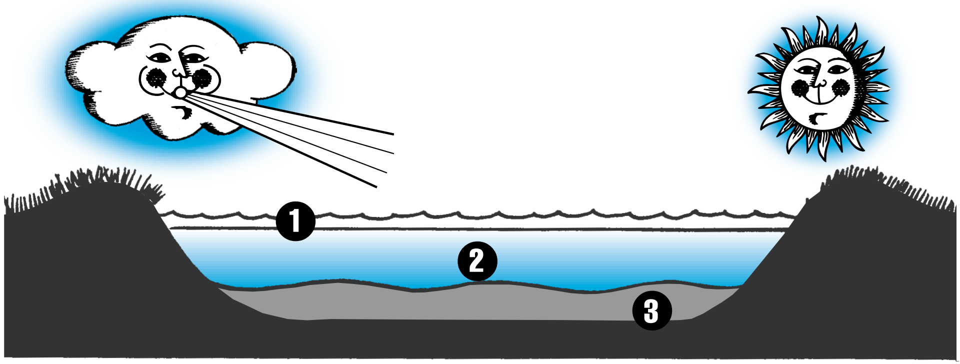
Like most natural environments, conditions inside facultative lagoons are always changing. Lagoons experience cycles due to variations in the weather, the composition of the wastewater, and other factors. However, in general, the wastewater inside facultative lagoons naturally settles into three fairly distinct layers or zones. Different conditions exist in each zone, and wastewater treatment takes place in all three.

The top layer in a facultative lagoon is called the aerobic zone, because the majority of oxygen is present there. How deep the aerobic zone is depends on climate, the amount of sunlight and wind, and how much algae is in the water. The wastewater in this part of the lagoon receives oxygen from air, from algae, and from the agitation of the water surface (from wind and rain, for example).

Aerobic bacteria and other organisms live in the aerobic zone and contribute to waste-water treatment. This zone also serves as a barrier for the odors from gases produced by the treatment processes occurring in the lower layers.

The anaerobic zone is the layer at the very bottom of the lagoon where no oxygen is present. This area includes a layer of sludge, which forms from all the solids that settle out from the wastewater. In the anaerobic zone, wastewater is treated by anaerobic bacteria; microscopic organisms, such as certain protozoa; and sludge worms, all of which thrive in anaerobic conditions.

Names for the middle layer include the facultative, intermediate, or aerobic-anaerobic zone. Both aerobic and anaerobic conditions exist in this layer in varying degrees. Depending on the specific conditions in any given part of this zone, different types of bacteria and other organisms are present that contribute to wastewater treatment.



The top layer 1 in a facultative lagoon is called the aerobic zone, the second layer 2 is called the facultative zone, and the third layer 3 is the anaerobic zone.

How Treatment Occurs

Throughout facultative lagoons, physical, biological, and chemical processes take place that result in wastewater treatment. Many of these processes are interdependent.

For example, on the surface, wind and sunlight play important roles. Surface agitation of any kind adds oxygen to the waste-water. For this reason, facultative lagoons are designed to make the best use of wind in the area.

The amount of wind the lagoon receives is not only important for the oxygen it contributes, but also because it affects the overall hydraulic flow pattern of the waste-water inside the lagoon, which is another physical factor that contributes to treatment.

Time is another important factor in treatment. Facultative lagoons are designed to hold the wastewater long enough for much of the solids in the wastewater to settle and for many disease-causing bacteria, parasites, and viruses to either die off or settle out. Time also allows treatment to reduce the overall organic strength of the wastewater, or its biochemical oxygen demand (BOD). (*For an explanation of BOD, refer to the section "Testing" on page 6.*) In addition, some of the wastewater eventually evaporates and percolates very slowly through the soil below when site conditions are favorable.

Sunlight is also extremely important to facultative lagoons because it contributes to the growth of green algae on the water surface. Because algae are plants, they require sunlight for photosynthesis. Oxygen is a byproduct of photosynthesis, and the presence of green algae contributes significantly to the amount of oxygen in the aerobic zone. The more warmth and light the sun provides, the more green algae and oxygen there is likely to be in the lagoon.

The oxygen in the aerobic zone makes conditions favorable for aerobic bacteria. Both aerobic and anaerobic bacteria are very important to the wastewater treatment process and to each other.

Bacteria treat wastewater by converting it into other substances. Aerobic bacteria converts wastes into carbon dioxide, ammonia, and phosphates, which, in turn, are used by the algae as food. Anaerobic bacteria convert substances in wastewater to gases, such as hydrogen sulfide, ammonia, and methane. Many of these byproducts are then used as food by both the aerobic bacteria and algae in the layers above.

In addition, the sludge layer at the bottom of the lagoon is full of anaerobic bacteria, sludge worms, and other organisms, which provide treatment through digestion and prevent the sludge from quickly accumulating to the point where it needs to be removed. How often sludge must be removed from facultative lagoons varies depending on the climate, the individual lagoon design, and how well it is maintained. Sludge in all lagoons accumulates more quickly in cold than in warm temperatures. However, many facultative lagoons are designed to function well without sludge removal for 5 to 10 years or more.

In every lagoon, there are likely to be other plants and organisms that contribute to, and benefit from, the wastewater treatment processes taking place. These types of interdependent relationships are what make the treatment process in lagoons work.

Lagoons Use Simple Design

Lagoons are relatively simple systems to design and construct. However, they always should be designed by qualified professionals who have had experience with them.

Permit requirements and regulations concerning aspects of lagoon design vary from state to state, but there are some design issues common to all lagoons. The following is a description of some of the design details for facultative lagoons and partial-mix aerated lagoons, two common lagoon designs used by small communities.

Site Conditions

Certain site-related factors, such as the location of the water table and the composition of the soil, always must be considered when designing lagoon systems.

Ideally, lagoons should be constructed in areas with clay or other soils that won't allow the wastewater to quickly percolate down through the lagoon bottom to the groundwater. Otherwise, lagoons must be artificially lined with clay, bentonite, plastic, rubber, concrete, or other materials to prevent groundwater pollution. Special linings usually increase system costs.

In addition, most areas in the U.S. have laws concerning the siting of lagoons, including their distance from groundwater below, and their distance from homes and businesses. Lagoons also should be located downgrade and downwind from the homes they serve, when possible, to avoid the extra cost of pumping the wastewater uphill and to prevent odors from becoming a nuisance.

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

In addition, water from surface drainage or storm runoff should be kept out of lagoons. Sometimes it is necessary to install diversion terraces or drains at the site.

Size and Shape

The exact dimensions of lagoons vary depending on the type of processes they use for treatment, the amount of wastewater that needs to be treated, the climate, and whether other lagoons or other types of treatment are also being used. The size and shape of lagoons is designed to maximize the amount of time the wastewater stays in the lagoon. Detention time is usually the most important factor in treatment.

In general, facultative lagoons require about one acre for every 50 homes or every 200 people they serve. Aerated lagoons treat wastewater more efficiently, so they tend to require anywhere from one-third to one-tenth less land than facultative lagoons. Many partial-mix aerated lagoons are simply former facultative lagoons that have been adapted to receive more wastewater.

Lagoons can be round, square, or rectangular with rounded corners. Their length should not exceed three times their width, and their banks should have outside slopes of about three units horizontal to one unit vertical. This moderate slope makes the banks easier to mow and maintain. In systems that have dikes separating lagoon cells, dikes also should be easy to maintain. Interior bank and dike slopes are determined by the size and depth of the lagoon, potential wave action, and other factors.

The bottoms of lagoons should be as flat and level as possible (except around the inlet) to facilitate the continuous flow of the wastewater. Keeping the corners of lagoons rounded also helps to maintain the overall hydraulic pattern in the lagoons and prevents dead spots in the flow, called short-circuiting, which can affect treatment.

Facultative lagoons are designed to hold wastewater anywhere from 20 to 150 days, depending on the discharge method and the exact size and depth of the lagoon. Aerated lagoons tend to require shorter detention times to treat the same amount of wastewater. In cold weather, however, biological treatment processes in all lagoons slow down, making longer detention times necessary.

Facultative lagoons are usually 3 to 8 feet deep, so they have enough surface area to support the algae growth needed, but are also deep enough to maintain anaerobic conditions at the bottom. Water depth in lagoons will vary, but a minimum level should always be maintained to prevent the bottom from drying out and to avoid odors.

Partial-mix aerated lagoons are often designed to be deeper than facultative lagoons to allow room for sludge to settle on the bottom and rest undisturbed by the turbulent conditions created by the aeration process.

Hardware

Wastewater enters and leaves the lagoon through inlet and outlet pipes. Modern designs place the inlet as far as possible from the outlet, on opposite ends of the lagoons, to increase detention times and to prevent short-circuiting. Some lagoons have more than one inlet.

Outlets are designed depending on the method of discharge. (*Refer to the section "Discharge Design" in the article on page 2.*) They often include structures that allow the water level to be raised and lowered.

Aerators, which are used instead of algae as the main source of oxygen in aerated lagoons, work by releasing air into the lagoon or by agitating the water so that air from the surface is mixed in. Aeration always causes turbulence and mixing in the lagoon.

Different aerator designs produce either fine or coarse bubbles, and work either on the water surface or submerged. Subsurface aerators are preferable in climates where the lagoon is likely to be covered by ice for part of the year.

Safety Is Important With Lagoon Systems

Lagoons can attract children, pets, and unsuspecting adults, who may think they look like good places to play and even swim. For this reason, laws in most areas require lagoons to be surrounded by high fences with locking gates and have warning signs clearly posted.

Operators also need to be careful around lagoon systems. In addition to special personal hygiene practices, such as never eating or smoking while at work, there are certain occupational safety practices and standards that should be observed by anyone working near a body of water.

Although lagoons are usually not very deep, there have been drownings in them. Lagoon bottoms can be both very slick and sticky in places from linings, slime, clay, and sludge, which make it difficult for anyone who has entered a lagoon to get out. There are certain precautions that workers and communities can take to prevent accidents.

Safety training should be made available for homeowners, operators, and anyone else working with these systems. Refer to the list of contacts on page 7 for some potential resources.

Lagoons Need Proper Operation, Maintenance

One of the advantages of lagoons is they usually require fewer staff hours to operate and maintain than other systems. However, this doesn't mean they can be neglected. Routine inspections, testing, record keeping, and maintenance are required by local and state agencies, and are all necessary to ensure that lagoons continue to provide good treatment.

Routine Inspections

How often lagoons should be inspected depends on the type of lagoon, how well it functions, and local and state requirements. Some lagoons need more frequent checking in the spring and summer, when grass and weeds grow quickly and when seasonal rental properties are occupied.

Systems with more than one lagoon operated in parallel or series may need operators to check and adjust flow levels or divert flows to and from certain lagoon cells to optimize performance. With aerated systems, mechanical components need to be checked and serviced as needed and according to manufacturer recommendations.

Most inspection visits include brief checks of the banks, dikes, grounds around the lagoon, inlet and outlet pipes, and the appearance, level, and odor (if any) of the water. Records should be kept of every visit and all observations, including information about the weather or other factors that may be influencing lagoon conditions. More extended inspections and formal sampling and testing are periodically necessary.

With regular inspections, testing, and record keeping, operators become familiar with the natural cycles and particular requirements of a system, as well as what factors tend to influence its performance.

Testing

Tests required for lagoons include those that measure the wastewater's temperature, pH, and the amount of dissolved oxygen, solids, nitrogen, and disease-causing organisms in the effluent.

Regulatory agencies use water quality measures as indicators of treatment system performance. Among the most important indicators are biochemical oxygen demand (BOD) and total suspended solids (TSS). BOD is important because it measures how much oxygen organisms in the wastewater would consume when discharged to receiving waters. TSS measures the amount of solid materials in the wastewater. If BOD or TSS levels in the effluent are too high, they can degrade the quality of receiving waters.

Together, the results of all these tests can provide a picture of the conditions inside the lagoon and show how well it was performing at the time the tests were taken. But because lagoon conditions change constantly, most tests must be performed several times, and sometimes at specific intervals or times of the day, to get an accurate overall view of the lagoon's health.

Operators can be trained to take samples and perform some or all of the tests themselves. It is usually more practical for part-time operators of small systems to send samples out to a lab to be tested.

Maintenance

Mowing grass and controlling weed growth in and around the lagoon is one of the easiest and most important tasks in lagoon maintenance. Long grass and weeds block wind and provide breeding areas for flies, mosquitoes, and other insects. Weeds also can trap trash, grease, and scum, which cause odors and attract insects. Weeds are used as food by burrowing animals, who can cause damage to banks and dikes. In addition, dead weeds may contribute to increased BOD levels.

It is also important to control weeds that grow on the water surface, like duckweed and watermeal. These weeds take up valuable space that should be occupied by algae, and they can stop sunlight and wind from penetrating the wastewater.

Scum that collects on the water surface should be removed for the same reasons as duckweed, but also to control odors and insects and to prevent inlet and outlet clogging. Trash, leaves, and branches that blow around the lagoon should be picked up because they can also clog inlet and outlet pipes.

Finally, the depth of the sludge layer in lagoons should be checked at least once per year, usually from a boat using a long stick or hollow tube. In most lagoon systems, sludge eventually accumulates to a point it must be removed, although this may take years. Performance will suffer if too much sludge is allowed to accumulate.

Facultative Lagoon Color Is Important

Bright rich green color—indicates good conditions; plenty of green algae is present.

Dull green or yellowish color—could mean that an undesirable type of algae (blue-green, filamentous algae) is becoming dominant in the lagoon, indicating poor conditions.

Gray or black color—can indicate anaerobic conditions.

Tan, brown, or red color—can indicate either soil in the water from bank erosion or the presence of algae with different pigmentation.

Common Lagoon Problems

weeds and long grass—Banks need to be mowed and weeded regularly. Duckweed, watermeal, and hyacinth that grow on the water surface should be physically removed, often from a boat with a tool, like a rake or skimmer.

blue-green algae—Unlike green algae, this algae is stringy and can clump, block sunlight, and cause short-circuiting. It can dominate lagoons when conditions are poor, when pH is low, or when protozoa eat all of the green algae. Blue-green algae can be physically removed like duckweed.

algal blooms—After periods of cloudy weather or abrupt temperature changes, algae can multiply quickly and then die-off. Matted algae on the surface can block sunlight and cause foul odors and should be broken up (with a boat or rake) and dispersed.

odors—Lagoons may have odors occasionally from algal blooms, anaerobic conditions, scum, and turnover of the lagoon contents after thawing. Proper operation and maintenance can help prevent odors.

short-circuiting—"Dead spots" in the flow pattern, due to obstructions in the lagoon or to wind on the surface, can cause wastewater to leave the lagoon too quickly, resulting in inadequate treatment.

erosion—Controlling burrowing animals around the lagoon can help prevent erosion of banks and dikes. Installing a stone or rock surface (called riprap) along banks and dikes can help in some cases.

burrowing animals—Muskrats and other burrowing animals can be discouraged by weeding and mowing lagoon banks. Alternately raising and lowering water levels can drive out muskrats who like their tunnels partially submerged. Otherwise, animals can be trapped and relocated.

sludge accumulation—Sludge in the bottom of lagoons should be measured at least once per year and removed as needed.

Two Montana Towns Use Lagoons

Polson

Before 1962, when Polson built its first lagoon system, the city used a series of septic tanks and chlorination to treat its wastewater.

"The disinfected septic tank effluent was discharged directly into Polson Bay and the Flathead River," says John Campbell, water and sewer superintendent for the city of Polson. "Lagoons were an improvement then, and they still work well today."

Located on Flathead Lake in northwest Montana, the city was incorporated in 1910 and has experienced slow, steady growth over the years. Recently, the growth rate has increased to about five percent per year, bringing the current population to about 4,300.

The system built in 1962 consisted of two facultative lagoons. Flows were simply diverted from one lagoon to the other every six months. To accommodate growth, the city built a new system in 1981 with three aerated lagoons and one polishing lagoon. Polson also began to operate its own lab to monitor the system.

"We decided on the aerated system based on recommendations from our engineers, public hearings, and the low operation and maintenance costs," says Campbell. "We're still using the same system today, with some improvements. We've added a wind-powered aerator and mixer that works quite well, and three floating aerators. The only weak points in the system are the original fine bubble aerators, which lie on the bottom and are very prone to clogging."

According to Campbell, residents seem happy with the lack of odor from the system and its low cost. Sewer rates are around $6.50 a month per household, but of that, actual treatment costs are only $8.25 a person per year. In addition, the system won the 1989 U.S. Environmental Protection Agency Region 8 award for operation and maintenance. Since January 1995, effluent biochemical oxygen demand (BOD) levels have averaged 16 mg/L, and total suspended solids (TSS) levels have averaged 38mg/L.

Currently, Polson is considering ways to upgrade its facilities again, because the system is getting very close to meeting its design flows. Some of the options being considered are replacing the current system with a fully mechanized plant, or expanding the system and adding land application and disinfection. The city will continue to upgrade its collection system.

"Our goal for the future is to construct the most effective, long-lasting system we can afford by 1999."

Conrad

Officials in the city of Conrad in north central Montana also are deciding about the future of their lagoon system. Parts of Conrad's system have been in use since the 1950s, but its performance has deteriorated recently, and now the town faces some costly problems.

In the 1950s, Conrad constructed its first lagoon system consisting of two facultative lagoons. In 1972, the system was upgraded and an aerated lagoon was added as the primary cell. The town, which currently has about 3,000 residents, relies on this same three-cell lagoon system today.

According to Steve Ruhd, Conrad's public works director, the system seemed to work well until 1993, when monitoring showed the quality of the effluent was getting close to being out of compliance.

"We did a sludge judge test in 1994 that showed the aerated cell about 50 percent full of sludge, the second cell about 33 percent full, and the third cell about 25 percent full! This totals to about 97,540 yards of sludge." As far as Ruhd knows, sludge has never been removed from the system.

Now Conrad is trying to find cost-effective ways to fix the problem. The city retained an engineering firm to evaluate their options, but proposals for removing and disposing of all the sludge at once ranged from $1.4 to $3.2 million. This approach would have doubled or tripled current rates of $7 to $8 per household per month.

"There is also $400,000 worth of work that needs to be done to the collection system," adds Ruhd.

Having decided that the above solution would be too expensive, Conrad is currently trying to find ways to remove the sludge gradually over a period of years. They hope to form inter-local agreements with other communities in the area to purchase equipment and hire staff to perform regular maintenance and annual sludge removal.

Wastewater Contacts

In addition to local health departments and state regulatory agencies, below are just a few of the other organizations that can provide assistance to small system operators and small communities evaluating wastewater treatment options.

The National Small Flows Clearinghouse (NSFC)

The NSFC offers a variety of assistance and free and low-cost information and materials for communities planning wastewater treatment projects. Contact the NSFC at (800) 624-8301 or (304) 293-4191 for assistance or for more information about any of the contacts listed below. See page 8 for a list of some of NSFC products.

Extension Service Offices

Many universities have U.S. Department of Agriculture Extension Service offices on campus and in other localities that provide a variety of services and assistance to small communities. For the office in your area, contact the NSFC or call the U.S Department of Agriculture at (202) 720-3377.

Rural Community Assistance Program (RCAP)

This network of nonprofit organizations can provide assistance to rural and low-income communities with almost every aspect of planning wastewater treatment projects. Call their national office at (703) 771-8636, or call the NSFC for the number of your regional office.

National Rural Water Association (NRWA)

NRWA is a nonprofit association organized to represent small water and wastewater utilities in each state and to meet their needs with operation, maintenance, management, funding, and political concerns. It offers a variety of assistance and services. Contact the NSFC for the number of your state RWA office.

ADDITIONAL INFORMATION

To order products listed as available from the National Small Flows Clearinghouse (NSFC), call (800) 624-8301 or (304) 293-4191, fax (304) 293-3161, e-mail nsfc_orders@estd.wvu.edu, or write NSFC, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064. Please request each item by number and title. A shipping and handling charge will apply.

Lagoons

This computer search of the National Small Flows Clearinghouse's Bibliographic Database contains approximately 256 abstracts of articles and papers on lagoon systems. Some topics include lagoon system design, site selection, sizing, operation, maintenance, performance, and cost. The price is $19.85. Item #WWPCCM17.

Lagoon Training Materials Available

The National Environmental Training Center for Small Communities (NETCSC) has sponsored the development of training materials for maintenance staff of facultative and aerated lagoons. The package, titled *Facultative Lagoons,* was developed by Linn-Benton Community College, Albany, Oregon, and includes instructor's guide, student manual, lesson descriptions, slides with written narrative, worksheets, and quizzes. To order, contact NETCSC at (800) 624-8301 or (304) 293-4191. The price is $88. Request Item #TRTPEP10.

Municipal Wastewater Stabilization Ponds

This U.S. Environmental Protection Agency design manual is an important reference for everyone involved in the planning, design, and operation of pond and lagoon systems used to treat municipal wastewater. It includes discussions on process theory, performance, design and design procedures, construction, cost and energy requirements, and the removal of algae, suspended solids, and nutrients. Performance information for facultative and aerated lagoons is also included. The price is $48.85. Item #WWBKDM36.

Lagoon System Case Studies

The NSFC offers case studies of lagoon systems in small communities:

Slow Rate Land Treatment (Craigsville, Virginia) describes a system that uses innovative technologies in combination with lagoons before the wastewater is discharged to land for final treatment and disposal. Item #WWBLCS09. The price is $1.90.

Year-Round Slow Rate Land Treatment (Hershey Mills, Pennsylvania) describes the advantages, concepts, and costs associated with an innovative system that uses lagoons and spray irrigation. Request Item #WWBRCS10. The price is $1.30.

Technology Package: Ponds and Lagoons

This package consists of four brochures on lagoon systems from the U.S. Environmental Protection Agency. Topics include nitrogen removal, pathogen removal, hydrograph controlled release lagoons, and total containment ponds. The price for the package is $1.15. Item #WWBRGN06.

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For Wastewater Information, Call the NSFC at (800) 624-8301 or (304) 293-4191.

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