The Language of Wastewater

Fact Sheet #1

Some of the Common Terms to Describe Wastewater Issues

Wastewater

For homeowners, "wastewater" includes the water that comes from toilets which carries human waste (sometimes called "black water") and also includes water from showers, sinks, washing machines and dishwashers. This latter type of wastewater is sometimes referred to as "gray water."

Onsite systems

In most cases, an onsite disposal system includes a septic tank and a leachfield or drainfield. (See our Fact Sheet about septic tanks.) Together, these components treat your household wastewater, and the remaining treated water is allowed to percolate below the topsoil into the groundwater. Special treatment technologies exist which vary from the general model of septic tank/leach field.

Septic tanks

Today, these are usually sealed, concrete or fiberglass boxes that allow for the first stage of wastewater treatment, settling and decomposition of some of the solids. Older versions of septic tanks included steel or wooden vessels. In all cases, septic tanks should be water tight and the remaining effluent should exit the tank only after settling, for additional treatment.

Leachfield/Drainfield

The remaining water from the septic tank flows (usually by gravity) to an area that is ideally designed to allow for soil microorganisms to transform some chemical pollutants to less harmful forms and separate harmful microbial contaminants from the wastewater.

Effluent

After wastewater passes through any of the processes such as a septic tank, or a leach field, or a sophisticated treatment facility, it can be called an "effluent." Because it is the product from one of many very different processes, effluent quality is variable. In some cases, it can be almost clean enough to drink, in other cases, it is an off-colored and smelly fluid. The effluent from the final phase of treatment should not be harmful to humans or the environment.

Decentralized solutions

There are many meanings to this term that usually include the traditional onsite systems described above as septic tanks and leachfields. EPA defines decentralized systems to "treat sewage from homes and businesses that are not connected to a centralized wastewater treatment plant." The "decentralized" part of the phrase relates to the treatment and dispersal of wastewater near the source that preserves local water balance and protects receiving waters. In most, but not all cases, the treatment technologies result in treated water entering the subsurface environment (i.e. groundwater). Decentralized solutions require the implementation of management activities to ensure long term effectiveness.

Cluster systems

Cluster systems are part of an overall managed program. They serve more than one dwelling and use limited conveyance (pipes) to remove the wastewater from the property where it was generated to a nearby location where it can be dispersed back to the environment. Cluster systems do not collect all the wastewater from the community, but from some subset of users where onsite systems cannot be employed. Clusters are normally considered different from individual onsite systems and smaller than central sewers.

Package systems

A small number of users may pipe their wastes to a modular wastewater treatment plant that includes many of the treatment processes of larger systems used with central collection. Most package systems discharge the treated effluent to surface water. One consideration for the use of package systems is that their operation requires the same diligence and experience as does a large municipal system. Trained operators are necessary to ensure that the treatments are occurring as designed.

Water Reuse

In many areas of the country, finding new sources of water for horticultural, industrial or business use is difficult. As with other issues of "waste," a first option to consider is the reuse of the resource. Minimally treated wastewater can be used for industrial purposes or for landscape watering. Not only does water reuse reduce the need for possibly rare supplies, but many of the reuse applications lead to treatment of the wastewater contaminants.

System management

Management usually includes inspection and regular maintenance of the septic tanks and leachfields or other treatment technologies and may include a mechanism for system repair. Management is beneficial for the operation of all types of wastewater systems. Inspection, pumping and cleaning filters can extend the life of a leach field receiving effluent from a septic tank. More advanced systems have a higher requirement for management. Greater complexity can increase the effectiveness in treating wastewater, but can also have a greater need for oversight. Experts agree that managing wastewater technologies should be a requirement to ensure the long term effective operation of the systems.

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What is Wastewater?

Fact Sheet #2

We all have some image in our mind's eye about wastewater. The problem is that each of us has a somewhat different image. This short description is not intended to be the "one right answer," but rather a starting point for discussing wastewater in your community.

What kinds of wastewater should we include in our discussion?

The United States EPA has an Office of Wastewater Management and that office addresses issues dealing with wastewater from industrial facilities, wastewater from mining practices, stormwater that is collected from our streets and roof tops as well as the wastewater that is collected through sanitary sewers in larger communities. This may be too long a list for your community, and we encourage you to focus on the particulars that are going to be subject to your future decisions.

The simplest subset of wastewater is the household wastewater that comes from your toilets, sinks, tubs, dishwashers and washing machines. If you are working on a project that is addressing only residential needs, you may want to consider just these sources of wastewater.

The hazards of human waste are a key to understanding treatment.

Human health is affected when individuals are exposed to human wastes. Bacteria that reside in our digestive tract are mostly beneficial, but some cause disease. In cases of typhoid, hepatitis and many forms of dysentery, our fecal wastes are the primary means for disease transmission. In fact, the history of human civilization has been strongly influenced by progress in the sanitary treatment of human waste. For this reason, the treatment of wastewater often refers to the disinfection of human wastes which takes place by isolation, heat or chemical treatment, and biological action.

For an increasing part of the country, there can be no "waste" of water.

Water supply is a significant constraint to growth for many communities. In some places, the availability of water is a constraint. In other places, the increasing cost for developing water distribution infrastructure (dams, large pipes and pumps) is daunting. Water that has been used once can often be used again. One of the considerations for many communities is not just the safe disposal of used water, but re-using that water for appropriate purposes.

Community discussion is key.

Regardless of your personal opinion about what is and what is not "wastewater," a community project will progress more effectively with a stronger common understanding of the issue and the definitions that capture the greatest local interests.

Why Is Safe Management of Wastewater Important?

Fact Sheet #3

Hundreds, and maybe thousands of communities in the United States are the host to improperly managed wastewater. In some cases, the failure of septic systems is obvious with evidence of odors or known drinking water contamination. In other cases, the failures are leading to contaminated ground water and lakes and streams that may not be obvious to local citizens or visitors. All wastewater should be properly managed to protect health and the well being of our families and neighbors. To promote discussion in your community, the important reasons for addressing wastewater deserve more focus.

Failing septic systems can threaten our health.
The history of human civilization is strongly influenced by the quality of wastewater management. During earlier times, millions of lives were lost due to the contamination of drinking water by human waste. While the frequency of such health epidemics is low in the United States today, incidents of water borne disease still occur and addressing failing wastewater systems is a path to prevent microbial contamination. Today, the most common path for human waste caused illness is swimming in public waters. Many public beaches are contaminated with poorly treated wastewater and some beaches need to close for days or weeks at a time.

In still other cases, nitrate contamination of ground water is the result of poorly designed or located wastewater treatment. A 1996 survey found that almost six million Americans were drinking water with nitrate levels above recommended standards. As water of high quality gets more scarce in many parts of our country, protecting ground water by reducing the nitrate contamination is of increasing value.

Failing systems degrade community aesthetics and hurt civic pride.
Maybe it is overly simplistic, but you can consider two kinds of communities: those that are responsible in addressing local issues and those where obvious problems remain unaddressed. The unmistakable odor of a septic system failure is one sign that a community is not doing its best

to manage problems. Local residents may learn to live with the occasional evidence of a failing system, but visitors gain an impression about the town that can not be easily dismissed. It is human waste, and it is not a problem to be ignored.

Failing systems violate the law.

More counties and states are paying attention to their responsibility for protecting human health. That responsibility can include requiring home owners, or neighborhood associations to fix their wastewater problems. Repaired or replaced systems must protect drinking water sources and meet surface water quality standards to be consistent with federal and state laws. Continually ignoring such requirements can lead to fines and extensive and expensive legal battles before a solution is finally implemented. Future developers may be hesitant to promote expansion in an area that faces uncertain costs because of improperly managed wastewater. States may impose building restrictions that will stifle new investment and cause property values to decline.

Wastewater should not be a growth control mechanism.

In several communities, future growth is restricted because of a limitation of available wastewater treatment. Very rural areas have a higher capacity for treating wastewater onsite, but continuing to focus growth in rural areas exacerbates the problem of urban sprawl. Without the consideration of a range of wastewater solutions, developers will avoid areas of limited capacity and continue growth in areas with less infrastructure and ultimately, expand the area that needs to be served with public services. One outmoded policy is the use of minimum lot sizes to ensure adequate separation between onsite septic systems and drinking water supplies. Unfortunately, the lot size requirements consume unnecessarily large areas of land and drive up house prices. Good planning is based on the consideration of a community's goals for housing and business density. Given those densities, creative wastewater experts can design the appropriate solutions.

Fixing failed systems increases property values.

The status of a septic system is a focus for prospective home buyers and their lenders. As a result, a homeowner that can prove a properly functioning system will have an easier time selling a house. For those homeowners not selling, but hoping to put on an addition, satisfactory wastewater treatment may be required by local authorities to allow expansion. In both cases, the consequence of fixing failed systems is increased property value.

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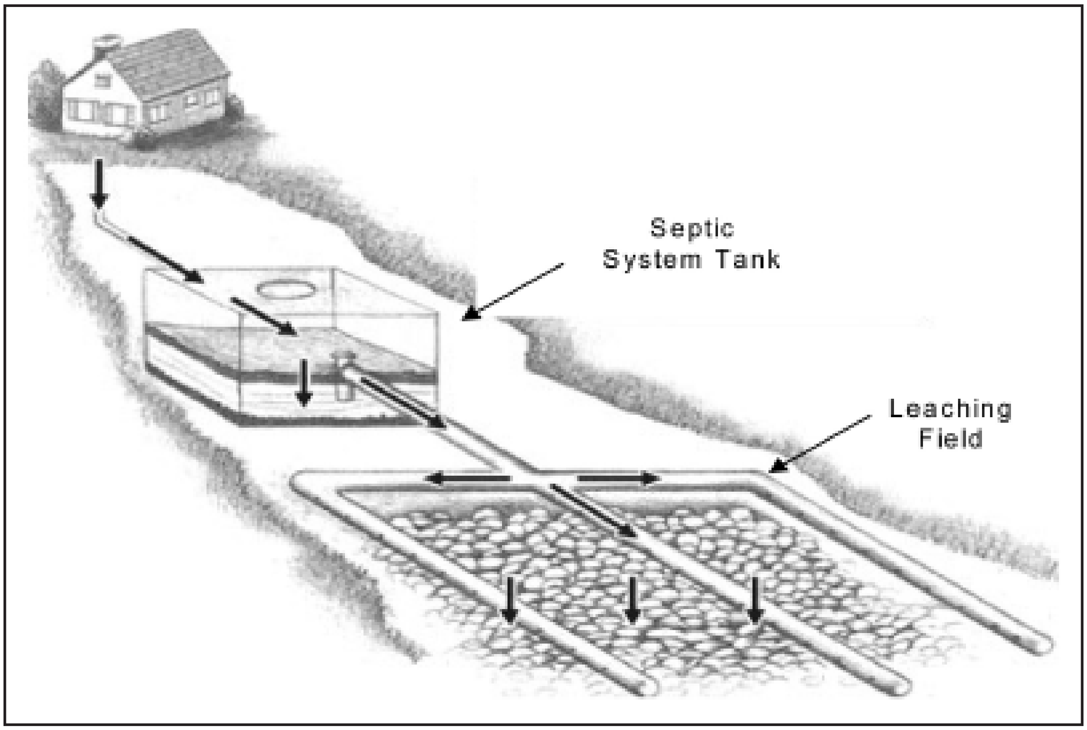
The Septic System

Fact Sheet #4



SOURCE: U.S. EPA, 1991

What are the primary components of a septic system?

The septic system includes the septic tank, and an effluent distribution system that in the simplest systems is a leach field. Wastewater from a home or business enters the septic tank that allows for the separation of solids, scum, and liquid. The liquid is an effluent which flows to the leach field, where biological reactions convert some of the waste chemicals to less harmful compounds. The leach field also filters harmful organisms out of the effluent allowing for the treated water to percolate into ground water as a safer product.

Where can I learn more about the operations and safe maintenance of a septic system?

The US EPA has a series of fact sheets that describe septic systems and their more complicated sister systems. These are available on the internet: www.epa.gov/owm/septic.

Some more detailed description is available at: www.septic-info.com/doc/display/46.html.

Many states have their own descriptions of septic systems and recommendations for their proper management and contacting the appropriate regulatory body will help direct you to their information www.nesc.wvu.edu/nsfc/pdf/WWBLRG34-2003.doc%20.pdf.

Failing Septic Systems

Fact Sheet #5

What are failing septic systems?

The wastewater from every home and business needs to be treated before it reenters surface water or groundwater. For a conventional septic system, harmful bacteria should be filtered out and phosphorus should be retained by the soil so that downstream users are not harmed. Nitrogen is only marginally removed by such systems. When the system fails to remove the bacteria it can be called "a failed system". Symptoms of a failed system are surfacing of untreated wastewater, backup into the homes and less obvious, but still important, contamination of ground water and nearby surface water.

Is this an issue I should care about?

If your septic system smells, periodically backs up in your yard or into your house; you already care. If a local system contaminates drinking water supplies or causes excessive algae growth in nearby surface waters, then you and your neighbors should care about it. And, if any of these conditions occur, you will have difficulty selling your house and you or your neighbors may be reported to local authorities. If your system is not showing any of the signs of failure, but you live in an area where each property has a septic system and there's no effective program to ensure that existing septic systems are performing adequately, then failing septic systems should be of interest to you and your neighbors.

How frequently do systems fail?

There is no simple answer to this question. A well maintained septic system can function properly for decades, while a poorly designed or installed system can fail within months of its first use. Some estimates at the national level report that 5 to 10 percent of all septic systems are not functioning properly thereby threatening surface and groundwater.

What is the real problem in failing septic systems?

There are several potential problems with failing systems. The most harmful is the contamination of drinking water supplies. In some cases, well water may be contaminated with bacteria, viruses, or other pathogens and the users of that water may be at risk for disease. Often, septic systems will back up which can lead to untreated wastewater reaching the surface. In these cases, physical contact and accidental ingestion of the wastewater can lead to skin and digestive system problems. Other, obvious problems are odors that come from septic systems where they are improperly installed or untreated water reaches the surface. For communities, such failures cause damage to the local economy, loss of property values and reduced quality of life for residents.

I hear a lot about phophorus and nitrogen contamination. Is this the result of failed systems?

Phosphorus and nitrogen reduction are not typical design elements of most septic systems. However, phosphorus reduction is a fortunate advantage to most soil based systems unless there is a failure leading to the rapid movement of effluent from the septic tank to surface water. Even for well designed systems, nitrates from wastewater will enter the groundwater and excessive nitrates can cause health problems, particularly for pregnant women and infants. Sometimes adverse conditions arise when nitrogen or phosphorus pollute nearby surface waters. In these cases, the fertilized surface water stimulates excessive algae growth which can degrade the recreational and aesthetic value of those waters and that surface water is no longer able to sustain a diverse set of species.

What can homeowners do to prevent failing systems?

Existing septic systems can be inspected and maintained to ensure that they function properly. In the absence of an organized community effort, each homeowner is responsible for ensuring the proper function of their system, and ensuring homeowner responsibility is a community challenge.

What can a community do to fix failing systems?

In hundreds of cases around the country, communities have worked together to develop effective wastewater solutions. In some cases, these communities have implemented community or “shared” systems, and in other cases, they have implemented programs to ensure that individual onsite systems perform as intended by instituting inspection and maintenance programs which define decentralized wastewater management.

What can a community do to address nutrient problems?

This series includes two fact sheets that describe the issues associated with nitrogen and phosphorus. Both of those include responses for addressing nitrogen and phosphorus contamination.

To find more GMI Fact Sheets, try our web site: www.gmied.org.

Solutions for Failing Septic Systems

Fact Sheet #6

What are the possible solutions to fix failing onsite septic systems?

There is a range of solutions that can be categorized into four types for this short summary: central sewers, better managed onsite systems, cluster systems and more novel solutions.

What are the relative benefits and weaknesses of centralized sewers?

Central sewers are predictable systems that require little effort from homeowners and have no particular requirements for the siting of houses or businesses. On the other hand, the capital costs for installing the pipes and treatment facility can be high, and the operating costs of the system can also be high. Besides costs, there is the potential to increase development on sites previously unable to support individual septic systems. In most cases, central sewer systems release effluent to surface water and this effluent may degrade the quality of that receiving water. Surface water releases can also affect local hydrology, especially if the source water comes from a different watershed (inter-basin transfers) or from ground water lowering the water table. And, when a central system fails, the damage to receiving waters can be catastrophic.

How do well managed, onsite systems fix the problem of failing septic systems?

In many cases, new systems or retrofits can replace a failing system. The reasons for failure include poor design, and changing use (in some cases vacation homes evolve into full time residences). The key to ensuring that these systems do not result in problems down the road is a management system that can track their effectiveness and kick in actions to address problems in a timely fashion. Sometimes this management can be the function of a municipality and sometimes, the coordinated efforts of homeowners or private service providers can accomplish the monitoring and repairs.

What are the advantages and disadvantages of cluster systems?

Cluster systems collect the wastewater from several adjacent homes and businesses and manage that wastewater close to its source. Cluster systems allow for development of individual lots that may not have the capacity to accept a septic system and avoid some of the expense of central sewers. Clustered solutions generally provide soil based treatment for effluent which can protect surface water quality. Soil dispersal also keeps the water within the local basin which is different than some large collection systems which move water to a different watershed. Some of the costs of larger systems are avoided with appropriately sized clusters. There is not the need for long expanses of pipe, nor are lift stations usually necessary. Typically, the treatment system in clusters requires less capital, operation, and maintenance costs. On the down side, cluster systems need to be custom designed for each locality which can introduce additional costs and the need for a limited collection system and a central (but small) treatment system may result in higher capital and management costs than a managed onsite solution. Just as with a centralized sewer system, cluster systems need appropriate administrative and management which adds to the operating costs, although still generally less than a centralized system.

What are some alternative approaches to wastewater management?

One basic set of less traditional solutions relies on the decrease in wastewater generation. Composting toilets and the separation of grey water, urine and black water are ways that the amount of wastewater managed through treatment is decreased. Other alternative solutions use natural systems to filter, and convert pollutants to less hazardous forms. Wetlands can be used to treat wastewater, and the construction of wetlands provides habitat for plants and animals as well as meeting the needs of wastewater treatment. More important, any solution, whether traditional septic tank and leach fields or more novel technologies are only innovative if they are centrally managed to ensure long term effective wastewater treatment. Gimmicks may be novel, but they are not innovative.

Can we mix some onsite solutions with centralized or cluster solutions?

In some cases, the wisest solution may be a mix of solutions. Some lots that have functioning systems can be kept in place creating less demand within the neighborhood for a larger system. In new developments, lots that have sufficient capacity for onsite treatment could be utilized and only those lots with insufficient capacity would be considered for collection pipes and a more centralized, or cluster system located on an appropriate site. Older downtowns served with conventional sewers can be complemented with managed onsite systems not currently connected and the design of cluster systems to address failures without expanding a central plant. Introducing management for all of the systems, onsite and more centralized, will allow each to maintain the effective treatment of wastewater and may reduce long term replacement costs. Rightsizing a more centralized solution will also help control costs.

Describe more about "management."

Central sewer systems usually have trained operators that oversee the day-to-day functions of a treatment plant and respond quickly to the problems that may occur. While onsite and small clusters may be simpler than large treatment facilities, their effective operation also benefits from oversight. Management is the consideration of the operating effectiveness and the appropriate responses to systems not working optimally. Management provides the ounce of prevention that will often save the need for providing a pound of cure to a failed system.

How do we choose among these different technologies?

Deciding the best solution for your community requires that wastewater experts have access to a thorough assessment of local conditions. Local soil types, hydrogeology, the density of housing, the proximity of drinking water and surface water, and climate are going to affect the practicality of appropriate technologies. Local input can help them consider preferred directions to move forward for addressing your wastewater needs. More importantly, if a community is going to be considering different options, there needs to be a mechanism for the citizens to work with wastewater engineers to consider the relative benefits of each approach. To consider the technical issues and the process issues, there are several support organizations available and we encourage you to get in contact with them.

How Much Does It Cost?

Fact Sheet #7

What is it going to cost to replace my septic system?

The unsatisfying answer is – it depends. However, if you get out your paper and pencil, you can begin to understand the range of costs to consider. The figures cited in this Fact Sheet are based on a limited set of examples in Vermont and elsewhere, and your specific location may result in significant cost differences.

Septic tanks – Tanks themselves usually cost less than $1,500, and vary with their size. The installation of a new tank requires digging a hole and connecting large diameter pipes and that is a variable cost depending on local contractor fees and the difficulty of digging in your yard. A good ballpark number for concrete tanks is about $2.50 per gallon, installed, although these numbers will be different in different parts of the country.

Leachfields – This is probably the biggest variable in your calculation (until we talk about central collection systems). It is important to employ a trained installer, because these pipes need to be installed at the appropriate grade. If your soil is perfect, the installation of delivery pipes is straightforward and low cost, a low range cost for installing a leach field using existing contours and soils is $2,000. Having to regrade an area, add additional, customized fill material and any pumping will add significantly to the cost and a new leachfield can cost more than $20,000.

System management – The most common step in managing an onsite system is establishing a mechanism to communicate with homeowners, collect information and ensure that inspection and maintenance are taking place. A starting point for management costs are $50 per year per household, but will vary depending on the number of managed systems and the existence of an actual office location to house the functions (phones, computer, staffing.)

A typical maintenance task sometimes included in a management strategy is pumping your tank. This cost ranges from $100 to $300 and this is typically performed every three to five years. If problems arise, an inspection of your leach field could require excavation and should cost between $200 and $500.

Initial planning costs – Before any new system is installed, a site review and soil test is necessary. This can cost $100 to $500 dollars depending on the sophistication of the tests to accomplish a system design acceptable to regulators.

Planning and design costs – An individual onsite system that can not use existing soils and grades will require the design of a customized solution. This may add an additional $200-500 to your costs, but may only show up in the overall system price, not separated from the purchase and installation of the system.

Alternative technologies and advanced treatment – If your site has poor soils and poor separation from neighbors and water sources, alternative technologies may be required. In general, these advanced treatment technologies are expensive, rarely less than $5000 in addition to the other costs noted above. One exception is the use of composting or incinerating toilets which can cost between $2,000 and $6,000 but decrease the costs involved with septic tank and leach field design and installation. Any savings from using these kinds of toilets are only available when local regulations allow for septic tank and leachfield capacities to be down-sized or eliminated.

The Gund Institute for Ecological Economics developed a spreadsheet-based calculation device including some of the costs for specific septic tank and leachfield technologies and also includes their relative effectiveness in meeting wastewater treatment goals. You can find that spreadsheet on the internet www.uvm.edu/giee/AV/OSDS (click on "Alternative (improved) Septic Tanks")

Cluster systems and off-site technologies – You may be investigating the options of pursuing off-site treatment of your wastes. In this case, the estimation of costs is complex and usually the responsibility of a wastewater engineer. The categories of costs include a collection system which will require buried pipes for possibly long distances traversing steep grades and shallow bedrock. Other costs are affected by the location and technology of the ultimate treatment facility. Nitrogen reduction or other advanced treatment to protect a nearby water source will increase the costs. Wastewater engineers are becoming more consistent in recommending long term system management which is an additional cost to consider.

Central sewers – The field of decentralized wastewater technologies is blossoming for the simple reason that traditional central sewers are becoming more expensive to design, build and operate. A traditional central sewer uses a large diameter collection pipe with multiple manholes and occasional lift stations leading to a wastewater treatment facility that requires close oversight.

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Comparing Economic Costs: Advanced Course

Fact Sheet #8

Comparing economic costs for wastewater systems can be confusing. Is there a way to think more systematically about the costs for different systems?

There are two ways to consider cost which differentiates your management choices. The first separates the capital costs of installing a system with the operating costs for keeping the system functioning over its life time.

The second approach considers the manner in which the systems are financed. Some aspects of a project can be funded with community funds such as grants or tax revenues. Other aspects of a system will be funded by user fees or direct homeowner costs. The choice of funding sources addresses the issues of fairness and affordability.

What are some of the factors that determine capital costs?

Most simply, the capital costs are going to include the collection infrastructure (such as pipes and pumps) and the treatment facility. The collection infrastructure is affected by the geography of the project such as the pitch of the sewer to ensure proper velocity, and soil conditions. The number and type of users will affect the need for large or small diameter conveyances. In many cases when central collection is the choice, the installation of large diameter pipes, manholes and lift stations is the major cost in a centralized system. The treatment facility adds a variable cost to the project total depending upon the technologies incorporated.

What are the factors that influence operating costs?

As with capital costs, the choices in the treatment options are the greatest factor for consideration. For onsite systems, the operating costs will include septic tank management and utility costs, while more centrally located treatment requires the kind of professional oversight that adds to overall operation costs. Central systems can also face significant operating costs to power and maintain the lift stations as well as staffing the treatment facility.

Why is it so important to differentiate community costs from non-community costs (homeowner investments and user fees)?

The simple answer is politics. Each homeowner will determine their support for a project based on the economic impact that the system will have on their household budget. If the community costs can be distributed over a wide number of houses through the tax structure, then homeowners and businesses that are tying into the new system will be more supportive. On the other hand, spreading the costs out to non-users will alienate them from supporting the project unless they receive some additional benefits such as management services.

Addressing capital costs funded through community funds.

There are several sources of funds to support wastewater management. The most favorable are grants which your community may be eligible depending on local conditions. Other available funds include low interest loans and the capacity to raise local funds through bonds. One resource to help you consider your options is the state agency that oversees wastewater management.

Addressing capital costs funded through user fees and homeowner investments.

In general, homeowners foot the bill for the infrastructure that is in place on each lot (such as septic tanks) and to pay for the continuing operation of community operated facilities.

Addressing operating costs funded through user fees or household budgets.

Often times, utilities operate the community operated facilities and utility associations can provide information on the range of costs.

And, keeping in mind the costs of an uncertain future.

You will need to make decisions today for investing in wastewater solutions that address future conditions. Building too much today will cost you unnecessary dollars. Building too little will require additional work, down the road. In general, a solution that allows you a flexible set of options in the future will keep your long term costs lower.

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Phosphorus in Wastewater

Fact Sheet #9

Phosphorus is an element that exists in many mineral forms and in biological systems. In wastewater, phosphorus is in the form of phosphates. Phosphates are an important nutrient for plant growth and are included in most commercial fertilizers.

How do phosphates get in wastewater?

There are two major sources of phosphate in wastewater. Some detergents include phosphates and in many states, laundry detergent manufacturers are restricted in the amount of phosphate in their formulations. Dishwashing detergents still include significant percentages. The other source is from human waste. Excess phosphorus in our diet is excreted and ends up in our wastewater stream.

Why is phosphorus a problem in wastewater?

In fresh water lakes and ponds, increased levels of phosphorus cause an increase in algae growth. Most lake ecosystems have adapted to natural levels of phosphorus and only the relatively recent addition of human sources lead to algae blooms. These algae blooms die, sink to the bottom of the lake and begin to decay which depletes the oxygen necessary for other aquatic animals, including fish.

Is wastewater the only source of phosphorus in lakes?

No, phosphorus is used as a fertilizer on farms, lawns and golf courses. When soil from these areas wash into streams, the phosphorus can be transported downstream to lakes and is often a primary source of phosphorus pollution. Phosphorus is also a natural constituent of soils and accelerated erosion of land, even when people have not added fertilizer, can lead to phosphorus transport to lakes.

What happens to phosphates during onsite wastewater treatment?

One of the most effective ways to keep phosphorus from entering surface waters is to trap the chemical in soil. Phosphate adheres to soil particles very effectively and therefore, onsite wastewater treatment that includes a soil treatment process, such as in a drain field, is very good at reducing phosphorus concentrations.

If my onsite system fails, does it lead to phosphorus pollution of the lake?

If there is a direct flow of wastewater from your septic tank to a lake, the phosphorus will end up in the lake. If poorly treated water has some significant path through soils, the amount of phosphorus entering the lake will be small. If local soil conditions such as karst exist and do not allow for adequate phosphorus retention, the amount transported to lakes could be significant, especially if several homes have systems in these areas. In addition, significant soil erosion will move soils that could have significant phosphorus concentrations into rivers and lakes.

Are conditions the same with centralized wastewater management?

Typical central sewer treatment facilities capture only a small amount of phosphorus during biological treatment. The phosphorus is taken up by bacteria and remains after they settle into the immobile sludge at the plant. However, a significant amount of phosphorus can still be in the effluent, and advanced treatment such as the addition of alum is necessary to get the remaining phosphorus out of the wastewater and captured in sludge.

In areas of the country where phosphorus pollution of lakes is a problem, wastewater treatment plants must meet stringent phosphorus reduction permit limits.

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Nitrogen in Wastewater

Fact Sheet #10

This fact sheet was designed for residents in the Chesapeake Bay watershed that suffers from significant nitrogen contamination.

What is the issue with nitrogen?

Nitrogen is one of the four predominant elements making up all living organisms (the others are oxygen, carbon and hydrogen). Nitrogen comes in many forms including nitrogen gas which is the most common constituent of the air that surrounds the earth. There is no problem with nitrogen gas. Many forms of nitrogen are found in water and several of these serve as a nutrient for growth of microorganisms – the source of the problem for water quality. Nitrogen as ammonia and various oxides (NOx) are the most common forms found in water and the focus of the nutrient problem (although there are many organic forms as well, such as urea).

What kinds of problems does nitrogen cause?

While nitrogen as a nutrient is a requirement for life, too much nitrogen can cause too much growth of microorganisms (bacteria and algae). Nitrogen as a nutrient is primarily a problem in marine or estuarine environments. (Phosphorus is the primary nutrient causing excessive microbial growth in freshwater environments). Explosive microorganism growth leads to many ecological problems and because some microorganisms are hazardous to human health, people can get sick when these "blooms" of growth occur.

Where does this nitrogen come from?

There are many sources of nitrogen, but a few categories provide the greatest contribution.

- In some areas, agricultural use of nitrogen containing fertilizers leads to significant levels in surface water and sediments.
- In much of the country, nitrogen oxides (NOx) are released into the air from combustion. Eventually this form of nitrogen is re-deposited to the land through dust or precipitation. It, too finds its way to our waterways.
- In other areas, residential development and the resulting treatment of human waste causes large amounts of nitrogen to get to our surface water (and is the focus of this fact sheet)

Are all forms of nitrogen harmful?

The short answer is no. Nitrogen gas does not support any harmful biological activity. The more complicated answer relies on the recognition of the nitrogen cycle. Different microorganisms are responsible for converting forms of nitrogen from nitrogen gas to more biologically active ammonia and nitrate and back again to nitrogen gas. This cycle is critical to life on earth, and the challenge is to understand the human role in upsetting the natural cycle.

How can we reduce the nitrogen problem?

Each of the sources of nitrogen deserves its own consideration for source reduction.

- Working with farmers can identify ways to use less nitrogen and to prevent its migration away from the soils that it helps crop growth to the water where it does no one any good.
- We can also work together to support public policy efforts to reduce releases of nitrogen oxides to the air.
- Wastewater technologies are an important way to convert nitrogen from the forms that are harmful to marine ecosystems to nitrogen gas, that regular part of our air.
- Reducing sediment runoff is another way to slow the addition of nitrogen to surface water. Some forms of nitrogen adhere to soil particles and when the soil enters rivers, so does the nitrogen.

What can I do?

- If your wastewater is treated by a septic system, consider some alternative technologies for reducing nitrogen. (See below)
- If you are on a public sewer system, support local efforts to invest in biological nutrient reduction technologies
- If you live on a farm, work with your agricultural chemical supplier and local extension agent to reduce nitrogen use and maintain buffer strips between crop lands and surface water.
- If you own livestock, maintain a manure collection system that does not allow washout of manure into waterways or groundwater

What are some septic technologies that convert harmful forms of nitrogen to less harmful forms?

There are typically, two parts of your septic system, a tank and a leach field. The tank can be supplemented with an aeration device that increases the biological activity leading to the conversion of ammonia and organic nitrogen to nitrates. A second part of some specially designed tanks have an oxygen free environment that leads to the further conversion of nitrates to nitrogen gas (the inactive form). It is also possible to use vegetated, submerged wetlands for nitrate conversion.

There are alternatives to traditional flush toilets that compost human waste and also reduce nitrogen loads (composting toilets). As with all systems, nitrogen reduction for these technologies is only realized when the systems are well managed.

If you are interested in learning more about reduction of your personal nitrogen contributions, contact the Chesapeake Bay Program Office (410) 268-8816 or the Maryland Department of the Environment.

E.coli and Other Microbial Contaminants

Fact Sheet #11

E. coli is the poster child of microbial contaminants from human waste. Other microbes are more infamous in causing death and illness, but E.coli is a species regularly present in the wastes from all mammals and some reptiles and birds.

What are some of the examples of disease-causing microorganisms?

Cryptospiridium, Typhoid, Campylobacter, Shigella and Giardia are some that have been tracked to human illness. Vibrio cholera is one of the more potent and prevalent microorganisms present during events that flood water supplies with untreated water leading to a dehydrating diarrhea disease named after its carrier: cholera. Another form of microbial contamination is viruses. These very small products in human waste can not "live" on their own, but wreak havoc on hosts and are the culprits in diseases such as hepatitis and some gastro-intestinal problems. Some researchers have estimated that one-third of ground water sources in the US are contaminated with viruses.

Why is E.coli special?

E. coli is a species of bacteria normally present in the intestines of humans and other animals While most types of E.coli are harmless, it is an indicator of contamination by warm-blooded animals and therefore its presence in food or water samples suggests that there will be other pathogens present as well. To speak more generally about bacterial contamination, wastewater experts will monitor and evaluate the full class of fecal coliforms (of which E.coli is the most predominant organism).

What is the problem with microbial contamination

Microbial contamination of drinking water is the most serious threat from poorly treated wastewater. Most of the history of wastewater management is focused on reducing the incidence of microbial contaminants from human waste. Contamination by bacteria and other pathogens can endanger drinking water supplies, especially in situations where wells that do not provide disinfection are used (Surface water is almost always treated to reduce the risk of pathogenic organisms.) Contamination of local surface waters can lead to beach closings, which reduce tourism and recreation potential.

Why test for E. coli?

E. coli and its other fecal coliform cousins are much easier to test for than some of the other, more serious pathogens that can travel in water.

Other tests

Some sophisticated tests exist that can help to determine if the bacteria come from humans or other animals. If the contamination is a human source, it may indicate some failure of local wastewater treatment.

If levels are unacceptably high . . .

Knowing the source of these high levels can help focus on a location of the problem and correct it. This is especially helpful if it can help to pinpoint malfunctioning septic systems or wastewater treatment systems

What are some other sources of microbial contamination?

Agricultural Runoff – Contaminated agricultural runoff is water that has flowed over farms which have significant amounts of manure. Water picks up E. coli and other bacteria and carries them downstream.

CSOs (combined sewer system overflows) – In some communities, stormwater and sewage water are carried by the same pipes. During dry periods, the combined wastewater flows are carried to a wastewater treatment plant where they are treated and released into the receiving waters. When there is a large rainfall, the volume can be too great for the sewer or treatment plant to handle. Then, the excess water overflows, untreated, to nearby surface waters and in this way, the microbial contaminants enter into the receiving water.

Pet, bird and wildlife feces – Surface runoff from residential and other areas which have warm blooded species present in abundance carries this microbeladen water to local streams and lakes during and after rain or snow melt. Thus, land development with proper sanitary sewer management may still degrade local water resources if these natural sources are not addressed through stormwater management.

What can you do?

- Ensure your septic system is functioning properly. (See the Fact Sheet "Septic Systems" for more information.)
- If you are on a sewer system (or even if you use a septic system), make sure that downspouts and other runoff streams are not connected to your house sewer.
- If you have livestock, follow BMPs (Best Management Practices) for their grazing and care maintain buffer strips between grazing areas and waterways. Maintain a manure collection system that does not allow washout of manure into waterways or groundwater.

This Fact Sheet is one of a series produced by the Green Mountain Institute for Environmental Democracy (GMI). The production of these Fact Sheets was supported by a grant from the National Decentralized Water Resources Capacity Development Project (NDWRCDP). Several other projects supported by NDWRCDP have useful products and you can find these at the website: www.ndwrcdp.org.

To find more GMI Fact Sheets, try our web site: www.gmied.org.

The US Environmental Protection Agency includes a great deal of information about septic systems and decentralized wastewater, generally. This information can be found at: http://cfpub.epa.gov/owm/septic/home.cfm.

For even more information on this and other wastewater topics, visit the website for National Small Flows Clearinghouse at West Virginia University's National Environmental Services Center: www.nesc.wvu.edu/nsfc/nsfc_index.htm.

Wastewater Management in the United States

Fact Sheet #12

The United States has spent hundreds of billions of dollars to build and operate wastewater treatment facilities. Homeowners have a similar investment in onsite systems. During the 1990s, the US EPA recognized the still significant costs the country faces to maintain its centralized systems and the role of onsite and other decentralized technologies in our wastewater future. This short issue paper focuses on the role of decentralized solutions.

How bad is the problem with regards to the unsafe management of wastewater?

According to EPA: "Many of the onsite systems currently in use do not provide the level of treatment necessary to adequately protect public health and/or surface and ground water quality. Many were initially sited and installed as temporary solutions as a result of the perception that centralized treatment and collection would soon replace them. Comprehensive, life cycle management did not play a role in the approval and/or in the ongoing operation of many systems. More than half the existing onsite systems are over 30 years old, and surveys indicate at least 10 percent of these systems backup onto the ground surface or into the home each year. Other data has shown that at least 25 percent of systems are malfunctioning to some degree. In a majority of cases, the homeowner is not aware of a system failure until it backs up in the home or breaks out on the ground surface. In many areas of the country, the local authority lacks records of many of the systems within the service area."

Since that 1997 EPA report, additional data supports a failure rate of between 1 and 10 percent.

In the National Water Quality Inventory, 1996 Report to Congress, state agencies designated the top 10 potential contaminant sources that threaten their ground water resources. The second most frequently cited contamination source is septic systems. The report states that "improperly constructed and poorly maintained septic systems are believed to cause substantial and widespread nutrient and microbial contamination to ground water."

Does it make a difference if the product from wastewater treatment is released to surface water or to ground water through soil treatment?

As with most environmental issues of today, there is no single best fate for the discharge of treated wastewater. One consideration is the local hydrology. If the source of a community water supply is ground water, then the recharge of the groundwater supply through soil-based treatment may be more beneficial than sending the water downstream through surface water discharge. With local surface water supplies, there still may be a benefit to ground water discharges to reverse the impact of stormwater management which almost always directs water to surface waters and makes flooding and low flow conditions more extreme. On the other hand, the quality of surface water discharges is highly regulated and much easier to monitor than ground water discharges. The problems with nitrate contamination of ground water should influence the manner in which wastewater is treated and land applied. Perhaps the best option for wastewater effluent is the possibility to re-use the water for an appropriate function. In this way, fresh water sources are preserved.

Given the complexity of issues, is there a preference between centralized and decentralized systems?

Congress asked EPA that question and EPA reported in 1997 that decentralized systems should no longer be considered temporary solutions, but are an important part of our long term solution for wastewater management. That EPA report stated: "Onsite and cluster systems can provide a high level of public health and natural resource protection."

What is the key issue to ensure that future decentralized systems meet the requirement for protecting our water resources?

There is an almost universal agreement that decentralized systems will be an important part of our wastewater management strategy. However, to avoid repeating past problems, and to open the possibilities for the creative application of a wide range of technologies, there is a need to put more emphasis on the management of all wastewater systems.

EPA is putting extensive effort into promoting the use of management systems to ensure that all wastewater management serves its long term purpose. This is not a political issue. Almost all individuals involved in wastewater management agree that management is key to the long term performance of wastewater technologies.

For even more information on this and other wastewater topics, visit the website for National Small Flows Clearinghouse at West Virginia University's National Environmental Services Center: www.nesc.wvu.edu/nsfc/nsfc_index.htm.

The Secret to Success

Fact Sheet #13

Managing Your Wastewater Systems

Centralized wastewater treatment facilities are a water quality and public health success story. While the occasional system failure can be catastrophic, more than 99 percent of the treatment plants in the U.S. treat large volumes of wastewater safely and effectively. The success of these systems is only partly explained by high quality engineering design; it is also the result of trained operator oversight.

The track record for onsite wastewater solutions is less impressive. Some estimates suggest that 5 to 10 percent of onsite septic systems are not providing safe and effective treatment of wastewater. Intelligent design choices will only reduce future problems to a point. Just as with central wastewater treatment facilities, oversight or system management is the key to improving their effectiveness.

The United States Environmental Protection Agency recognizes that onsite, decentralized systems are a part of an overall menu of wastewater solutions, especially for communities with low housing density and appropriate soils. And, to ensure that onsite systems are effective, EPA and many of its state and local partners emphasize the need for centralized management. Depending on the complexity of local systems, the risk to local water resources, and the capacity of local entities; the degree of management will vary, but certain characteristics should be included for all communities.

At a minimum, all home and business owners should have an awareness of their wastewater systems' inspection and maintenance needs and local officials should have an inventory of the systems within their jurisdiction. More usefully, responsible management entities should establish mechanisms to inspect and maintain each system in a community. In addition to inspection and maintenance, these management entities should establish a process for repairing failed systems before significant environmental problems arise.

For any community considering wastewater solutions, the role of system management is important to recognize early in its process. The integration of management should be a requirement for any solution design.

The EPA has produced a handbook that describes different management systems in more detail. It is available at www.epa.gov/owm/septic/pubs/septic_management_handbook.pdf.

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