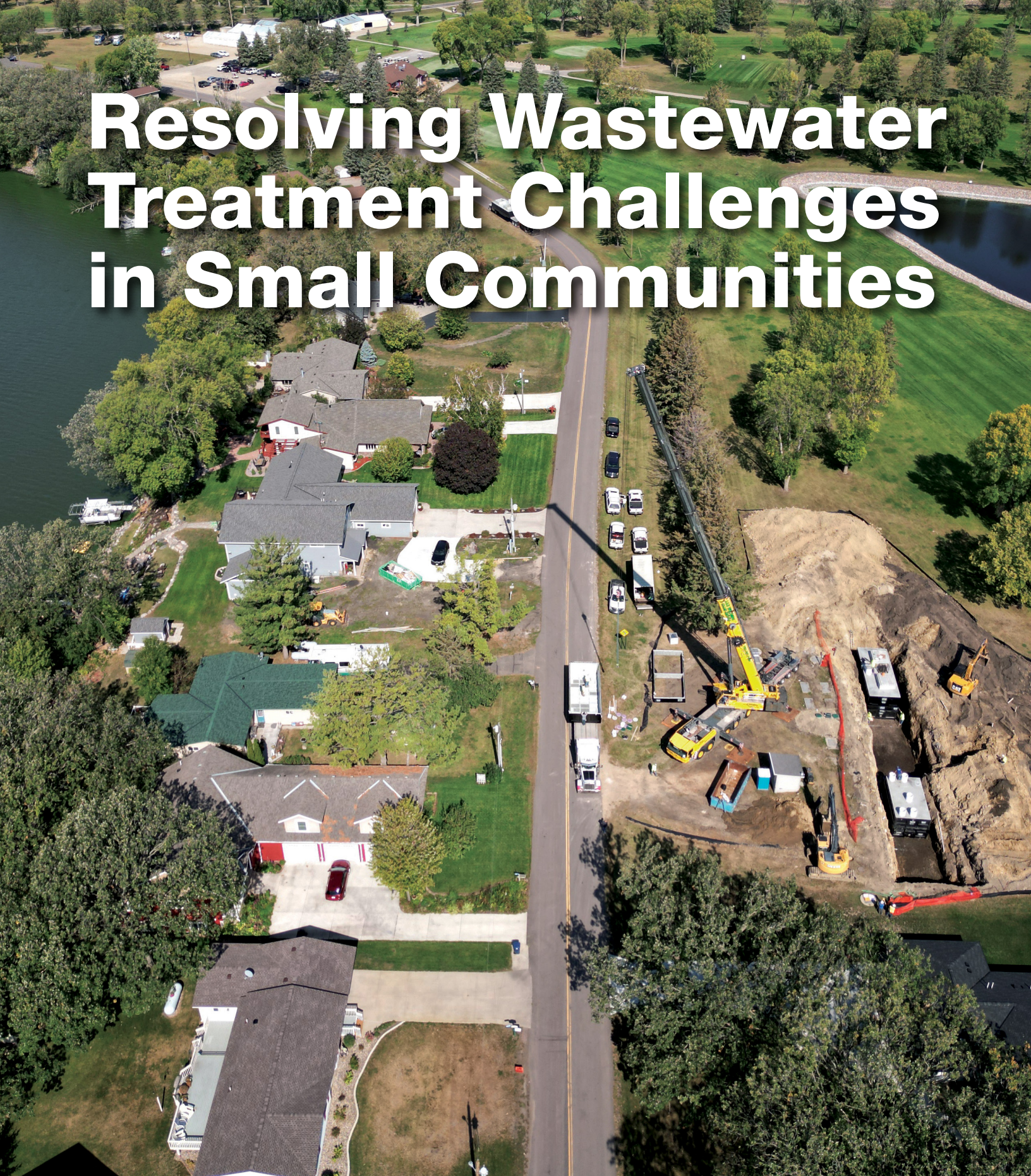


Resolving Wastewater Treatment Challenges in Small Communities



National Onsite Wastewater Recycling Association

March 2026

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Cover Photo

Septic Check



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Purpose of the Manual

This manual's goal is to provide decision-makers with the necessary information to collaborate with engineers, soils professionals, construction managers, and financial personnel to get the best wastewater management solution for their community. The concepts covered in this training course include identifying current and anticipated wastewater treatment problems, data/information needs, working with professionals, decentralized treatment options, decentralized management options, community structure options, financing, selection, and implementation.

Overview of Manual

This manual is organized into Sections that follow a typical community process for identifying wastewater management solutions when addressing a wastewater

treatment problem. It is recommended to start the solution development process at the beginning. If the initial steps are skipped, the process can be delayed due to a lack of knowledge, critical data, or consensus later in solution development.

Section 1: Overview of Wastewater Management

There are thousands of communities—groups of homes—scattered across rural and semi-urban areas, all of which face the challenge of providing effective wastewater treatment to protect themselves, water resources, and the environment, while meeting current regulations. This first section introduces the community to wastewater, various treatment solutions, and the advantages of a decentralized management option.

Section 2: Collect and Interpret Data While Working with Consultants

People can collaborate through a community process to identify wastewater issues. The approach the community takes for wastewater treatment depends on the density of the population, soil conditions near the homes and the changes in density and population expected in the future. Communities must collect and interpret such information, understand what regulations apply and keep good records. By completing a community wastewater solutions assessment, the community will understand its needs and agree on a recommended solution with a cost estimate. It is key to pick a qualified consultant when outside help is needed. Guidelines for working with the various professionals involved in wastewater treatment are provided.

Section 3: Wastewater Treatment System Options

There are many types of treatment systems. An effective treatment facility could be an individual onsite (septic) system, a multiple household cluster system, or a large collection/treatment (municipal) system. Learn the pros and cons of each so your community can make an informed choice. This section discusses

the options for collection and the primary, secondary, tertiary, and final treatment processes.

Section 4: Management, Structure, and Financing Options

Proper management is essential to ensure the long-term performance and cost effectiveness of the treatment system. Management of all wastewater treatment systems involves inspection, monitoring, operation, and maintenance of the system to prevent premature malfunctions. When multiple landowners and properties are concerned, a responsible legal management entity is usually needed to act on behalf of the community, and this may be required under some funding options. Appropriate funding of the initial capital investment and facility replacement over time, along with the costs of ongoing operation, maintenance, and administration, is important to successful wastewater treatment. This section covers various funding mechanisms.

Section 5: Selection and Implementation

Implementing a successful wastewater management plan is not easy. It requires commitment and endorsement from the entire community. In this section, all this information is brought together to focus on how to assure a successful outcome for a community wastewater management project.

List of Figures

| | |
|---|----|
| Figure 1. The various sources of residential gray and black water | 12 |
| Figure 2. Decentralized wastewater management | 16 |
| Figure 3. Centralized wastewater management..... | 16 |
| Figure 4. Distributed wastewater management | 16 |
| Figure 5. Distributed wastewater management in a community..... | 27 |
| Figure 6. Conventional system | 34 |
| Figure 7. Cluster system | 34 |
| Figure 8. Example of decentralized and centralized wastewater treatment systems | 35 |
| Figure 9. Cleanout detail | 36 |
| Figure 10. Raw gravity collection | 37 |
| Figure 11. Gravity collection with a lift station | 37 |
| Figure 12. Raw pressure collection | 38 |
| Figure 13. Directional boring | 39 |
| Figure 14. Vacuum collection | 40 |
| Figure 15. Septic tank effluent gravity collection system in a community | 40 |
| Figure 16. Septic tank effluent pump collection system..... | 40 |
| Figure 17. Septic tank effluent gravity | 40 |
| Figure 18. Septic tank..... | 41 |
| Figure 19. Septic tank with a pump vault | 41 |
| Figure 20. Septic tank with an effluent filter | 43 |
| Figure 21. Cross section of a trench system | 45 |
| Figure 22. Mound system | 46 |
| Figure 23. Aerobic treatment unit..... | 47 |
| Figure 24. Residential ATU system layout..... | 47 |
| Figure 25. Suspended growth ATU with built in septic and dosing tank..... | 48 |
| Figure 26. Sequencing batch reactor | 48 |
| Figure 27. Membrane bioreactor..... | 49 |
| Figure 28. Integrated fixed film/activated sludge | 49 |
| Figure 29. Recirculating media filter | 50 |
| Figure 30. Bottomless media filter..... | 50 |
| Figure 31. Free surface constructed wetland | 51 |
| Figure 32. Single cell residential lagoon system..... | 52 |
| Figure 33. Recycling of effluent for nitrogen removal | 54 |
| Figure 34. Tablet chlorinator..... | 56 |
| Figure 35. UV light for disinfection..... | 56 |
| Figure 36. Cross section of a gravity trench | 57 |
| Figure 37. Trench system..... | 58 |
| Figure 38. Low pressure pipe dispersal..... | 58 |
| Figure 39. Drip distribution system..... | 60 |
| Figure 40. Mound system | 60 |
| Figure 41. Combined treatment and dispersal..... | 61 |
| Figure 42. Spray distribution system | 61 |
| Figure 43. ET bed system..... | 62 |
| Figure 44. Process flow diagram for a discharging system..... | 63 |
| Figure 45. Example of an aquifer storage and recovery system..... | 65 |
| Figure 46. Wastewater management structures | 79 |
| Figure 47. Capacity development needs | 85 |

List of Abbreviations

| | | | |
|-----------------------------------|--|-------------|--|
| AOP | Advanced oxidation process | RDC | Regional Development Commissions |
| AR | Artificial aquifer recharge | RFP | Request for proposals |
| ASR | Aquifer storage and recovery | RFQ | Request for qualifications |
| ATU | Aerobic treatment unit | RME | Responsible management entity |
| AWP | Advanced water purification | RMF | Recirculating media filters |
| BNR | Biological nutrient removal | RO | Reverse osmosis |
| BOD | Biochemical oxygen demand | SBR | Sequencing batch reactors |
| CFU | Colony forming unit | SF | Subsurface flow |
| CW | Constructed wetlands | SPMF | Single-pass media filters |
| CWSA | Community wastewater solution assessment | STA | Soil treatment area |
| CWSRF | Clean Water State Revolving Fund | STEG | Septic tank effluent gravity |
| DPR | Direct potable reuse | STEP | Septic tank effluent pressure |
| DWV | Drain, waste, and vent | SWCD | Soil and Water Conservation District |
| EC | Event counter | TAP | Technical assistance provider |
| EDA | Economic Development Administration | TSS | Total suspended solids |
| EPA | Environmental Protection Agency | UF | Ultrafiltration |
| FEMA | Federal Emergency Management Assistance | USDA | United State Department of Agriculture |
| FOG | Fat, oil, and grease | WWTP | Wastewater treatment plants |
| FWS | Free-water surface | | |
| GIS | Graphical information system | | |
| HOA | Homeowner association | | |
| HRT | Hydraulic retention time | | |
| HUD | Housing and Urban Development | | |
| IFAS | Integrated fixed-film/activated sludge | | |
| IHS | Indian Health Service | | |
| IPR | Indirect potable reuse | | |
| MBR | Membrane bioreactors | | |
| MF | Microfiltration | | |
| MHI | Median household income | | |
| NO₃⁻ | Nitrate-nitrogen | | |
| NOAA | National Oceanic and Atmospheric Administration | | |
| NOWRA | National Onsite Wastewater Recycling Association | | |
| NPDES | National pollutant discharge elimination system | | |
| NRCS | Natural Resources Conservation Services | | |
| NRWA | National Rural Water Association | | |
| OWTS | Onsite wastewater treatment system | | |
| PER | Preliminary engineering report | | |
| RCAP | Rural Community Assistance Partnership | | |
| RD | Rural Development | | |



Table of Contents

| | |
|---|-----------|
| Section 1: Overview of Wastewater Management | 11 |
| What is Wastewater..... | 12 |
| Sources of Wastewater in Small Communities | 14 |
| Health and Environmental Impact of Untreated Wastewater | 14 |
| Wastewater Treatment..... | 15 |
| Summary..... | 17 |
| References | 17 |
| Section 2: Successful Community Projects - Collect and Interpret Data While Working with Consultants | 19 |
| Key Factors in Community Change..... | 20 |
| Why Some Communities Succeed | 21 |
| Making the Process Work for Your Community | 22 |
| Gathering Data | 22 |
| Boundary and Scope..... | 23 |
| Data Sources..... | 23 |
| Collection of Field Data | 24 |
| Community Wastewater Solution Assessment | 24 |
| Working with Consultants | 27 |
| Summary..... | 31 |
| Section 3: Wastewater Treatment Systems Options..... | 33 |
| General Treatment Overview | 34 |
| Levels of Treatment | 34 |
| Collection | 35 |
| Primary Treatment | 42 |
| Secondary Treatment | 44 |
| Tertiary Treatment | 53 |
| Final Treatment and Dispersal | 57 |
| Reuse..... | 63 |

| | |
|--|------------|
| Section 4: Management, Structure, and Financing Options | 69 |
| Wastewater Management Options..... | 70 |
| Community System Organizational Structure Options..... | 78 |
| Funding | 84 |
| Section 5: Selection and Implementation | 91 |
| Criteria for Choosing a System | 92 |
| Making an Informed Decision..... | 93 |
| Implementation: What, When, Who, How? | 93 |
| How Long Will Implementation Take? | 95 |
| Summary..... | 98 |
| Appendix | 101 |
| Appendix A: Homeowner Survey. | 103 |
| Appendix B: How to Use the Web Soil Survey to Find Information about Your Land. | 105 |
| Appendix C: OWTS Assessment. | 109 |
| Appendix D: Community Wastewater Assessment & Solution Report Template. | 117 |
| Appendix E: Request for Qualifications (RFQ) for Services. | 119 |
| Appendix F: Request for Proposal (RFP) for Services..... | 121 |
| Appendix G: RFP Ranking System. | 123 |
| Appendix H: Interview Questions. | 125 |
| Appendix I: Reference Questions..... | 127 |
| Appendix J: EPA Management Model Summary..... | 129 |



Overview of Wastewater Management

Learning Objectives

- Explain what is in wastewater that must be treated and the sources within a community.
- Identify the options available to treat wastewater and how it is commonly done.
- Recognize the advantages of decentralized wastewater treatment and management.

This section reviews why it is important to understand what wastewater contains, what problems it may cause, and what it takes to clean it up for recycling.

What is Wastewater

Wastewater is water that has been used and contaminated by human activity and contains a variety of contaminants that must be treated before being safely released back into the environment. Common components of wastewater include organic matter, nutrients, pathogens, suspended solids, chemical pollutants, and over-the-counter products.

Graywater vs Blackwater

Graywater and blackwater are two distinct subtypes of wastewater generated in homes and businesses, each with distinct characteristics and treatment requirements. Understanding the difference between graywater and blackwater is essential for designing effective wastewater management systems, especially in communities aiming to reduce environmental impacts and promote sustainable water use.

Graywater refers to wastewater from sources such as sinks, showers, bathtubs, and washing machines. It does not contain human waste and typically includes soap, detergent, and small amounts of food or grease. Graywater accounts for more than 50% of the typical indoor residential water usage. Because graywater has lower levels of fat, oil and grease, solids and pathogens compared to blackwater, it can more easily be treated and reused.

In contrast, blackwater is wastewater from toilets, kitchen sinks, or dishwashers. It contains human waste, urine, toilet paper, and often high levels

of pathogens and organic matter. Due to its contamination level, blackwater poses significant health risks and requires extensive treatment before it can be safely discharged or reused. Figure 1 shows the contaminants present in both gray and black water that require treatment.

Water reuse is the practice of reclaiming water from various sources, treating it, and reusing it for beneficial purposes. It can provide alternative supplies for potable and non-potable uses, enhancing water security, sustainability, and resilience. Because it is less contaminated, graywater can often be minimally treated and reused for non-potable uses such as landscape irrigation or toilet flushing, making it a valuable resource for water conservation. Non-potable reuse, such as for toilet flushing, is something to consider, but at the residential scale there is insufficient use to fully utilize all the graywater. Reuse on the landscape for communal areas and grass is another common application but is challenging in cold climates.

Pathogens

The most critical component of wastewater is pathogens, or disease-causing organisms. These include viruses, protozoa and bacteria shed by the human body and found in wastewater from all sources in the house. Water contaminated with these pathogens poses a public health risk and can spread disease. Fecal coliform bacteria are pathogenic organisms that are an indicator for the presence of other pathogens in wastewater. They are residents

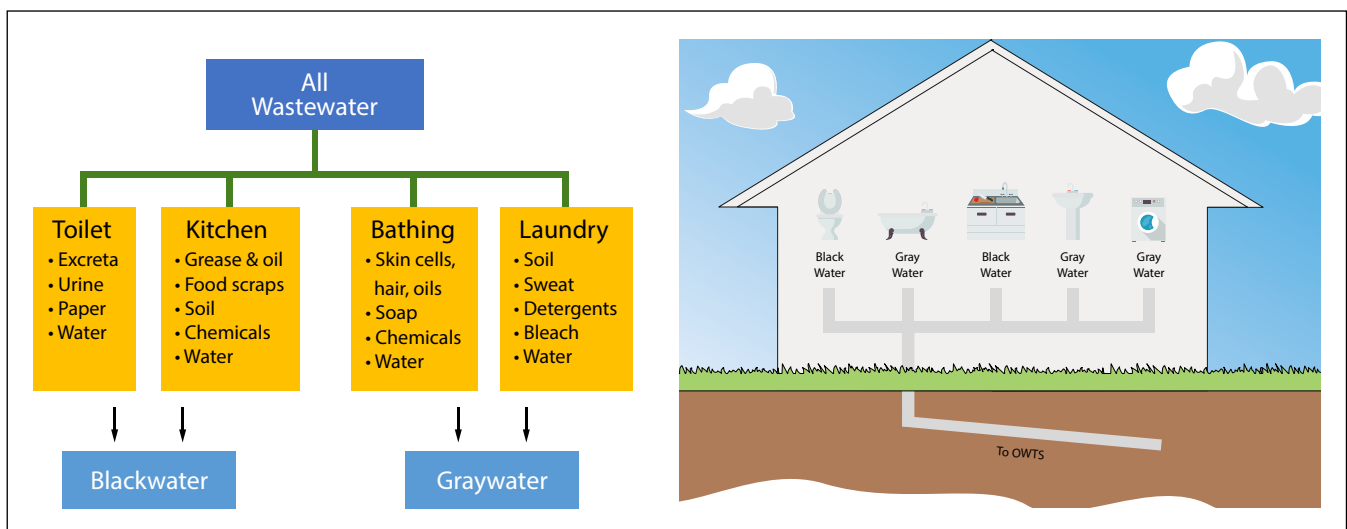


Figure 1. The various sources of residential gray and black water

of the human intestinal tract and are also fairly easy to identify through testing. A typical concentration of fecal coliform bacteria in wastewater from a residence is 10 million+ colony forming units (CFU)/100mL; the concentration leaving a septic tank is typically 1 million CFU/100 mL.

Nutrients

The next critical component of wastewater is the many macro- and micronutrients that enter wastewater via food particles, human excretions, cleaners, personal-care products, and other materials. The nutrients of primary environmental concern are phosphorus and nitrogen. Phosphorus is a macronutrient essential for the growth of all plants and microorganisms. Phosphorus (P) is the most limiting nutrient to the growth of plants and algae in freshwater lakes and streams. Any additional phosphorus in freshwater will promote the growth of more algae and plants. The typical household wastewater contains 4 to 15 pounds of phosphorus per year. In a properly functioning septic system, P is tightly held by soil particles.

Nitrogen is another macronutrient essential for plant and microorganism growth. Nitrogen (N) is present in wastewater in four forms: organic N, ammonia, nitrite, and nitrate. As the ammonia form of N moves through a treatment system it changes to the nitrate form. It is possible in some treatment systems for nitrogen to change to nitrogen gas and be lost to the air (our air is 78 percent nitrogen), but in most systems nitrogen ends up as nitrate. Nitrates at high levels (over 10 ppm) in drinking water can be toxic to infants under 6 months, causing methemoglobinemia or “blue baby syndrome.” Ammonia in surface waters can be toxic to fish. Excess nitrogen in saltwater can cause eutrophication.

Micronutrients such as mercury, zinc and many others are present in very small quantities in most residential wastewater. They come from products such as hair dye, makeup, alloys, and cleaning products. Other micronutrients are vitamins and minerals present in the food we eat.

Solids

The majority of the solids entering the residential wastewater stream are organic. Organic solids include food particles, fats, oils, greases, human feces, hair, toilet paper, and other substances. The concentration of organic matter in wastewater is measured by the

biochemical oxygen demand (BOD) value. BOD is the measurement of the amount of oxygen consumed by bacteria while stabilizing, digesting, or treating biodegradable organic matter under aerobic conditions. The typical BOD concentration in untreated household wastewater ranges from 270 to 400 mg/L. Inorganic solids entering the wastewater include soil from washing hands and clothing, the inorganic fraction of food wastes and toilet paper, and components of cleaners (carriers in detergents). These solids are separated from wastewater during treatment by settling or flotation. They cannot be oxidized or decomposed by bacteria, so they are stored until the tank is cleaned (pumped). The solids, organic and inorganic, which remain suspended in the liquid effluent, are measured as total suspended solids (TSS). BOD and TSS are the most widely used indicators of the “strength” of wastewater. The lower the value, the better.

Chemicals

The residential wastewater stream also includes nonhazardous products used in homes to clean fixtures and people, such as soap, detergent, shampoo, toilet bowl cleaners, bleach, drain cleaners, and salt from water softeners. Many of these products are disinfectants and can have harmful cumulative effects on people or treatment systems when used in excessive amounts. Medications are another kind of chemical that enter our wastewater stream. Unwanted medications should never be disposed of in a wastewater treatment system. Hazardous chemicals can also enter wastewater: paints, paint thinners, antifreeze, and large amounts of strong disinfectants can cause problems in treatment systems.

Water

By far the largest share of the total wastewater volume is water. The typical resident (adult or child) uses an average of 50 gallons of water per day. This quantity amazes most people until they consider how much water is used for laundry, dishwashing, bathing, and toilet flushing. This means a family of four is likely to generate more than 200 gallons of wastewater per day—not including lawn watering and other outdoor water uses. These values assume that there are no water leaks within the home. On average, 12% of water use in the US is due to leaks (DeOreo et al., 2016). A water audit is a valuable tool for assessing water usage and reducing leaks.

The water is, of course, the component of the wastewater we want to reuse. However, the nutrients and organic components removed from the water during treatment can also be valuable resources provided they are delivered to the right place for reuse (for example, N and P are useful as plant food for crops and lawns).

Sources of Wastewater in Small Communities

Everyone generates wastewater. Typical residential indoor water use is 30-80 gallons per person per day, whereas commercial properties vary significantly in their water use. This wastewater must either be treated onsite with an onsite wastewater treatment system (OWTS) or sent to a wastewater treatment plant. Table 1 summarizes the most common wastewater sources in small communities and the management considerations.

Sources of Concern

- Any waste that contains hazardous chemicals should not be put into a wastewater treatment system.
- Stormwater from sump pumps, roof drains and other sources of rainfall do not belong in a wastewater system.

- Treated water from pools and hot tubs that has been chemically disinfected can overload and harm wastewater treatment systems.
- Waste related to water treatment, such as water softeners, may add excess chloride to the system, which can be harmful to microorganisms and other aquatic species.
- Waste from commercial, institutional, or industrial sources that exceed the capacity of the wastewater treatment system or contain substances not removed with traditional methods should be directed to other treatment options.

Health and Environmental Impact of Untreated Wastewater

When we are sick, we are shedding harmful bacteria and viruses. Without proper treatment, the effluent from our homes and businesses can make others sick. In addition, organic material and nutrients can cause negative environmental impacts. In one way or another, all water is recycled. In the past, people believed wastewater could be disposed of—it would just disappear. This idea has caused many people to assume that when they dispose of wastewater they also dispose of any problems or hazards related to it. Today, we recognize that we must treat and recycle water to maintain sustainable supplies of safe drinking water

Table 1. Sources of wastewater within small communities

| Source | Examples | Key Considerations |
|-------------------------------|--|---|
| Residential | Toilets, sinks, showers, laundry, kitchen discharges | Primary domestic wastewater; volume influenced by household water use |
| Commercial | Restaurants, offices, laundromats, shops with sinks/dishwashing | Varied waste streams may include higher fats/oils, cleaning discharges and may require pretreatment |
| Institutional | Schools, churches, hospitals, municipal buildings | Domestic plus any facility-specific wastes, cleaning discharges |
| Industrial | Light manufacturing, workshops, refining, chemical processing | Additional pollutants; often regulated and may require pre-treatment |
| Infiltration and inflow (I&I) | Aging/cracked sewer lines, roof drains, and sump pumps, allowing groundwater and stormwater to mix with the wastewater | Increases wastewater volume, especially during rain events or wetter times of year |
| Nonpoint sources | Yard waste, urban surface drainage | Can carry debris/pollutants into sewer lines; indirect impact on treatment systems |

for future generations. To clean or treat wastewater for recycling, it is important to understand what it contains, the problems it may cause, and the processes required.

In addition to water that we want to recycle, wastewater contains pathogens (disease organisms), nutrients such as nitrogen and phosphorus, solids, chemicals from cleaners and disinfectants, and even hazardous substances. Given the complexity of wastewater, it seems clear that we need to treat it not only to recycle water and nutrients but also to protect human and environmental health.

Many people, however, are not very concerned about wastewater treatment until it affects their lives. They can ignore it until bacteria or nitrates show up in their drinking water, the lake gets green in the summer, the beach is closed, or the area begins to smell like sewage on warm days. Sometimes residents discover they cannot obtain a building permit or sell their home without an inspection or upgrade, or that there is no room on their property for a new or replacement system. Often when one homeowner has a wastewater treatment problem, others in the neighborhood have the same problem. People do not always report sewage problems to their neighbors for a variety of reasons, including the risk of enforcement actions.

There are communities that have leaking collection systems which allow ground and surface water to impact their treatment systems. Some communities have collection systems but lack follow up treatment of the collected wastewater. In some areas, systems were installed that allow partially treated effluent to be discharged to cesspools, seepage pits, and drywells. According to the 2019 Closing the Water Access Gap report, 2 million Americans live without running water and basic indoor plumbing and many more without sanitation (Dig Deep and US Water Alliance). There are enormous disparities across the country, states, and localities of availability, amount, accessibility, and use of funding for onsite wastewater treatment systems (OWTS), and more importantly, for the households and residents who rely on them.

Some property owners do not know the location of their OWTS and have never pumped their tanks. The OWTS may not meet current standards, or the system may be undersized or require additional capacity. Other community challenges arise from limited water supply and fluctuating community size.

Wastewater Treatment

A viable system or systems for responsible community wastewater management must provide effective and manageable treatment at a reasonable cost. To accomplish these goals, each community needs to evaluate all available treatment options. This will require significant diligence from community residents, and they will likely acquire a substantial amount of information from external sources.

There are two primary methods for treating wastewater, with the primary factor being how close homes or businesses are to the treatment system.

Decentralized Management

There are over 32 million OWTS, serving approximately 25% of the US population. These systems are most commonly located in rural or peri-urban areas. Individual and small multiple-household OWTS are frequently referred to as decentralized, onsite, or septic systems. There are many treatment options for individual properties. Most of these options discharge effluent into the soil for final treatment. Individual onsite systems need adequate space (low overall property or population density) and appropriate soil to facilitate treatment. The exceptions are a self-contained treatment system that discharges the effluent to the surface or a water body. These decentralized systems are most commonly owned and managed by individual property owners.

This approach is particularly beneficial in rural areas, small communities, or rapidly urbanizing regions where centralized infrastructure may be impractical or too costly. Decentralized systems can be tailored to local needs and use a wide range of technologies to treat wastewater efficiently. These systems promote water reuse, reduce environmental pollution, and enhance resilience by minimizing the risk of system-wide failures. Additionally, decentralized treatment supports sustainable development by integrating ecological principles and reducing the energy footprint associated with long-distance wastewater transport. Some key advantages of decentralized wastewater treatment are:

1. **Cost-effective infrastructure:** It reduces the need for extensive sewer networks and large treatment plants, lowering capital and maintenance costs.

2. Scalability and flexibility: Systems can be tailored to local needs and expanded as communities grow.
3. Environmental protection: Local treatment reduces the risk of pollution from system-wide failures and supports water reuse for irrigation or other purposes.
4. Energy efficiency: Smaller systems often consume less energy and can incorporate renewable energy sources.
5. Resilience and reliability: Decentralized systems are less vulnerable to disruptions and are more likely to continue operating independently during emergencies.
6. Community empowerment: Local management encourages community involvement and awareness of water conservation and sanitation practices.

As shown in Figure 2, decentralized management includes individual onsite systems as well as small and large cluster community scale systems.

Multiple-household onsite systems collect wastewater from a small number of homes (two to 100s) and deliver it to a nearby site. Typically, they are called cluster onsite systems because they use treatment options similar to those in individual homeowner systems and treat lower volumes of wastewater than centralized systems.

Centralized Management

Municipal-style centralized systems collect wastewater through a large network of pipes and deliver it to a

central treatment facility. There are several collection and treatment methods available. Centralized collection and treatment systems serve large cities and small communities. The treatment concepts used in large municipal systems are generally similar to those used in decentralized treatment systems. The methods used to accomplish these tasks, however, are different due to volume, contents, operating systems, and discharge standards. A vast majority of centralized systems discharge to a river, stream, or other water body. As shown in Figure 3, all wastewater is routed to a single location. A municipality most commonly owns these systems.

Distributed Management

Distributed management (see Figure 4) is a method to manage wastewater infrastructure where a responsible management entity (RME) combines onsite, cluster, and centralized treatment in a cost effective and

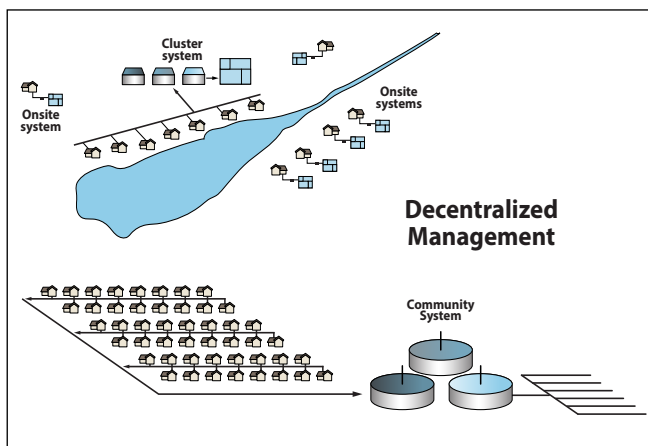


Figure 2. Decentralized wastewater management

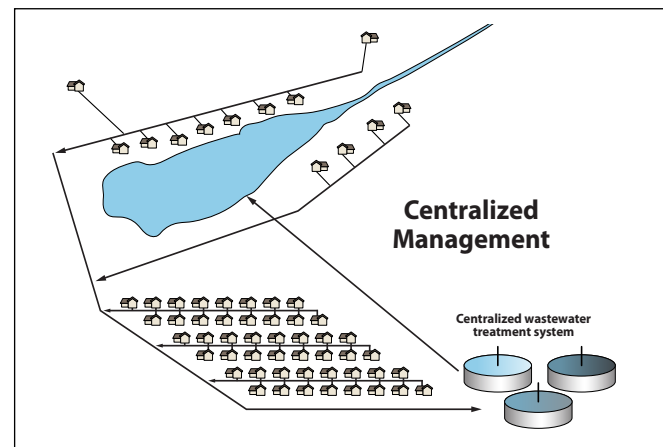


Figure 3. Centralized wastewater management

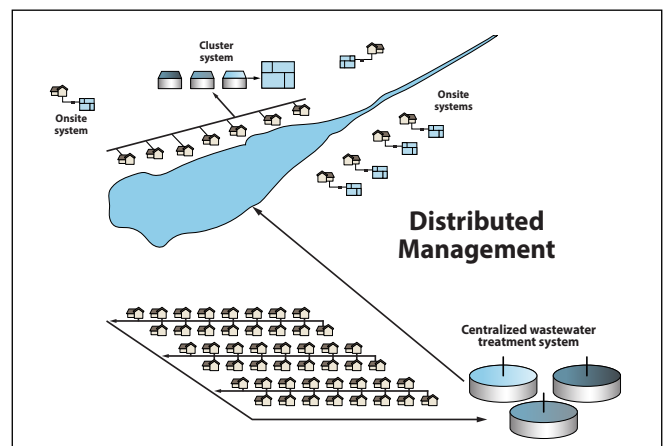


Figure 4. Distributed wastewater management

sustainable structure. It often involves systems such as septic tanks, onsite package treatment units, community sized media filters, and graywater recycling for non-potable reuse, which can reduce energy use, infrastructure costs, and conveyance losses while improving resilience during outages or floods. Benefits include localized treatment, potential water reuse for irrigation or toilet flushing, and simpler maintenance in rural or peri-urban settings. Challenges include maintaining treatment performance over time, ensuring consistent regulatory compliance, managing odors, and financing initial capital, as well as addressing variability in waste streams and soils. When well designed, operated, and monitored, distributed management ensures that decentralized systems complement centralized networks, enhance rural development, and support sustainable water management in communities with limited infrastructure.

Overview of Treatment Levels

Primary – Most treatment systems begin with primary treatment. The goal of primary treatment is to decrease organic and inorganic solids by the physical process of sedimentation. This is accomplished by reducing the velocity of the wastewater enough to allow the solids to settle out.

Secondary – The next treatment step biologically removes suspended or dissolved organic solids and reduces pathogens. Biological treatment can occur under aerobic and anaerobic conditions. Most commonly, aerobic conditions are used during secondary treatment. This is accomplished through biological metabolism of organics either as suspended solids or in solution.

Tertiary – Finally, many wastewater treatment systems will have tertiary treatment which includes further reduction of BOD and TSS, the reduction of nutrients, and disinfection of pathogens. This is accomplished by various chemical or biological methods in advanced treatment units and with disinfection processes.

Summary

Small community wastewater treatment systems are designed to manage and treat sewage locally, offering a practical and sustainable solution for areas without access to large-scale infrastructure. The systems help protect public health and the environment by

treating wastewater close to its source, reducing the risk of contamination, and enabling water reuse. Their adaptability makes them ideal for rural areas, remote locations, and developing regions, where centralized systems may be economically or logistically unfeasible.

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Successful Community Projects - Collect and Interpret Data While Working with Consultants

Learning Objectives

- Describe characteristics of successful community projects.
- Describe the data needed to complete a Community Wastewater Solutions Assessment.
- Identify sources to obtain needed data.
- Utilize a Community Wastewater Solutions Assessment to address wastewater treatment challenges.
- Define the services your community needs.
- Describe the steps needed to hire a consultant.
- Develop a proposal request for a consultant to perform work for their project.
- Describe the process to work with a consultant after they are hired.

Every community would naturally like to skip the challenges of completing the assessment process and go straight to the solution, but that doesn't work that way. The process of finding a viable solution to a community wastewater issue can take several years from inception through implementation. Working through the steps stimulates the people in the community to learn, to understand and negotiate their differences, and to define an acceptable solution to everyone involved in the community. Such a decision will ensure that your community's wastewater is adequately treated at a reasonable cost and accommodate your community's future plans.

Key Factors in Community Change

When a community faces wastewater treatment issues, a successful outcome often depends more on the process it follows to address them than on the sewage treatment technologies available to it. A key factor shaping community change is whether members share a community vision and have a clear mission. Other factors that can influence how change occurs include having and following an action plan, encouraging new leaders and initiatives, securing necessary technical and financial resources, and taking time to document successes and reward participants. Because these factors are so important, each is discussed in greater detail on the following pages.

Shared Vision and Clear Mission

Initiatives with a clear, specific focus, such as increasing the number of compliant septic systems or restoring a specific shoreline to native species, achieve much higher rates of change than broad “healthy communities/ healthy lakes” efforts that lack a targeted mission and objectives. While the mission should be specific, it should not get hung up on the implementation mechanism. An appropriate mission would be “to provide effective, functioning, and affordable wastewater treatment for the entire community,” rather than specifying a certain type of treatment facility. People will be willing to act on a vision only to the extent they feel ownership of its content.

Action Planning

Identifying specific community changes (new or modified programs, policies, and practices) may be the single most important thing you can do. To be most effective, action steps must identify who will implement and who will track and monitor progress and specify a reasonable and honest timeline and budget. Turning the plan into reality through action is critical; if the plan sits on a shelf, energy that could be channeled into action may instead become cynicism.

Leadership

A change in leadership can dramatically affect the pace of change driven by a community group. Nurturing diverse leadership and encouraging new leaders and

initiatives is invaluable for avoiding substantial loss of momentum. Excluding members of any constituency based on their position on an issue, economic status, education, race, age, geography, or any other factor may weaken the project’s credibility and mandate within the entire community. Leaders with skill in effective, two-way communication and conflict management get to the core of community building work.

Resources

Nothing can be more frustrating than knowing what you want, why it is important and how to get it, but not having the resources to get it done. In addition to financial assistance, technical assistance is invaluable for identifying practical and realistic goals. It may provide the added benefit of someone who knows how to find funding or professional help. Learn from the successes of all community members; local knowledge is often the most practical kind.

Make the Outcomes Matter

Recognize people who are helpful, who give of their time and heart to community concerns. Celebrate successes frequently and take the time to thank everyone who has contributed. Documenting successes helps focus attention on what you are most effective at and recognizes and rewards the participants. Some actions may not yield the outcome you hoped for, but documenting these efforts helps future leaders learn from your experiences.

Gaining Community Endorsement

How hard can it be to achieve community endorsement? Success depends on the level of connectedness people feel with their neighbors. If people know, respect and trust each other, they can build bridges that transcend economic, educational, ethnic, or other differences. Conversely, few people respond well to the best-intended efforts of others when they perceive that the message is, “We’re here to help, this is what we are going to do to you, and the bill will arrive shortly.” Finding an appropriate technological solution to a community’s wastewater problems is the easy part. Working together as a community to do so is challenging. To ensure all community members feel adequately represented and fairly treated, regardless of the choices made

along the way, follow the process below.

1. Form a steering committee - While community-wide participation and endorsement is critical, a steering committee will be needed to do much of the work of assessing community needs, talking with resource people, developing consensus, and implementing action steps.
2. Develop a community vision - Hold a community meeting to help identify the positive values the community wishes to preserve, making a sincere effort to recognize the values and concerns of everyone. You need an unbiased assessment of your community's existing assets before you make decisions.
3. Develop a work plan - The work plan identifies goals and specific actions you need to take. It describes steps that are practical and measurable, responsibility for each step, a timeline, criteria for making decisions and measuring success and a budget.
4. Keep everyone informed - For people not actively involved in the project, progress often appears slow. It is vital that you take every opportunity to keep the community informed of progress and decision opportunities.
5. Implement and evaluate - The steering committee is responsible for ensuring that progress is made, time and money are invested responsibly, and action steps are implemented. Integrate evaluation tools into your action steps so you can recognize mistakes early, learn from them and not lose significant momentum.

Why Some Communities Succeed

Many communities have successfully solved wastewater issues while others have been polarized and derailed. Unsuccessful outcomes often result from failure to understand the concerns and priorities of all community members. No one wants to consume drinking water contaminated with fecal material, but a resident already struggling on a fixed income may feel that "the water hasn't killed anyone yet," especially if a new treatment facility is likely to increase utility bills. Some people may view the community engagement process as pandering to political correctness—

an unnecessary step that delays the engineering discussions and technological solutions. But ignoring citizen involvement will often lead to longer delays, greater resentment, and a much weaker consensus on the best resolution. It is important to recognize that solutions to wastewater issues are more dependent on the community's process (people) than on the science and engineering (technology) available.

Citizens of communities that succeed:

- Clearly understand their current situation before they start looking for solutions.
- Know that only they can make the best decisions for their community.
- Take responsibility for and ownership of the problem.
- Have or develop members with strong leadership abilities.
- Have a clearly defined vision and mission and set appropriate goals.
- Take the time and energy to identify and examine all options before making decisions.
- Gather information from as many sources as possible before acting.
- Keep all affected parties involved and informed all along the way.
- Identify criteria for making decisions.

Characteristics of Successful Communities

Communities that successfully find viable solutions to their wastewater challenges have three key characteristics.

- Understand: Successful communities understand their current situation clearly before they start looking at solutions. Understanding the current state creates vision and direction – you have to know where you are to see where you should go.
- Effective leadership: These communities also have, find, or develop effective leadership from within the community and create a steering committee that champions the project. Communities are less successful when a small group makes decisions without discussion and expects everyone to agree

(and pay the bill), or when the community lets engineers, consultants, or funding sources dictate their choices.

- Review: It's critical to periodically review the project status and adjust if needed. Plans, financial status, access to property, etc., can all change. Periodic assessment avoids continuing down a previously prescribed path that is no longer valid for the community's needs.

Unsuccessful communities often descend into disarray, with people resenting their friends and neighbors because of their position on the issue. Many elected officials end up "un-elected" even when they have tried to do their best—and the original wastewater problem continues.

Successful communities use a civic engagement model to involve diverse interests and views from the community. Civic engagement refers to organizations' intention and actions to reach out, facilitate interactions, and create feedback channels with a community. Multiple methods should be used to reach community members, including community meetings, potlucks, newsletters, social media, radio, and newspapers. Using a webpage to post meeting minutes, progress reports, budgets, and other useful information allows communities to access it at any time.

Successful communities:

- recognize the bias and self-interests of professionals they're working with,
- define an appropriate goal,
- determine the appropriate boundaries,
- identify and examine all options (takes time & energy),
- identify and use all of the criteria for making the decision,
- involve all interests in the steering committee, and
- keep all affected parties informed.

Making the Process Work for Your Community

To implement a community process that moves the project to completion, the steering committee must collaborate with the entire community, including those

with the legal authority to make official community decisions. The entire process, from start to finish, may take three to seven years. You will go through five distinct phases, as discussed in Section 5.

Steering committee five phases:

- Understand the situation and define the problem
- Explore the options for treatment, management, organization, and funding
- Sort through the options and make decisions
- Implement the decisions—making final plans and constructing the treatment system
- Manage the treatment system—operating and maintaining the treatment system

Making Change Go Smoother

Making decisions about basic community infrastructure needs, such as wastewater treatment, is usually difficult when it represents a significant departure from past practice. People will work together when an issue matters to them. If they do not think it affects them, they will resist any change, especially when it is expensive. This is especially true when the local government unit has never dealt with wastewater issues.

Preparing a citizen-based group to address wastewater issues helps the decision-making process go more smoothly. The result will be viable solutions that provide economical and environmentally responsible methods for safely recycling the community's wastewater.

Gathering Data

Before your community can review wastewater treatment options, the steering committee needs to compile a wide array of information to help everyone better understand the situation and present it to the community. Committee members or other volunteers will need to collaborate with the permitting authority and other organizations to assemble that information. This section discusses some of the

THINGS TO REMEMBER

Without a good base of information, it is difficult to make an informed community decision. Resolving wastewater issues in an existing community can be extremely frustrating and time-consuming without complete background and physical properties information.

information you will need and where that information might be found. Just as the wastewater treatment situation varies a great deal from community to community, so too does the information communities need to make an informed sewage treatment decision. Therefore, the suggestions in this section should be viewed only as a starting point: all the information discussed may not be necessary in every situation and, in some cases, information other than that discussed here may be necessary. A consultant will likely be needed to collect some of this information.

Once the information is gathered, steering committee members, consultants, and other key community members will need to take a hard look at the data to determine what it all means. Transforming raw data into useful information enables the community to gain a clearer understanding of what is happening today and what is likely to happen in the future. This provides a better sense of direction as the project proceeds. The data collected will be the first step in the development of a Community Wastewater Solutions Assessment (CWSA).

An assessment of existing community assets and practices that will affect the community in the future should be presented at an initial town meeting. The information presented must be unbiased and give a complete picture. The question underscores the critical nature of this step: If you do not know where you are or what you have to work with, how will you know where you want to be and how to get there? This step is sometimes skipped in communities, on the assumption that all existing infrastructure is bad, outdated, or malfunctioning. This assumption is often inaccurate and leaves some community members not trusting the process and potentially increases the cost of the solution.

Boundary and Scope

Before beginning data collection, the estimated boundary and scope of the potential project should be determined. There are times when the community has clear boundaries defined by political boundaries, although some homes and businesses may be near the boundary and in need of service. Other times, geography may provide a natural boundary for the project due to water features or challenging terrain. The community must start with a broad view and recognize that there may be areas outside the project

scope after initial work, or that a single solution will not solve the wastewater treatment challenges. In some communities, parts of the project may make sense to tackle one by one rather than all at once. If the project boundary is not clear at the outset, it may need to be reevaluated after data collection.

Data Sources

Every piece of information discussed may not be necessary in every situation and, in some cases, information beyond that listed above may be required. After discussing your community's problem, determine what kind of data you need. Assign specific pieces of this data collection step to several individuals. Initially, the community should resist hiring a consultant or engineer to handle this, as it can be expensive unless grant funding is available. Many types of information are readily available, but the sources and completeness of the data vary by jurisdiction. It is up to each community to collect and interpret the data. This information and your interpretations of it are the basis for evaluating options and making decisions throughout the process. Each entry below lists the type of information that may be necessary, where that information may be found and the reason the information may be useful in the community's decision-making process.

Onsite Wastewater Treatment Parcel Record Data

One of the most important steps in data collection is getting the records for the existing treatment system by parcel. These records can provide valuable information about age, design (type, size, location, etc.), soil conditions and history of repairs for individual systems within the community. Records are increasingly available electronically, although access to this information varies by authority. Certificates of operational status are frequently required when property changes hands or when building permits are required—compliance inspections have a limited validity period that must be confirmed locally. Current certificates may indicate the system's condition and reduce the need for another inspection. Local onsite sewage treatment professionals, such as installers, pumpers, and service providers, may also have this information.

Individual Community Parcel Data

Information is needed about wastewater generation on each parcel in the potential project. This information is best gathered through a survey. This survey could be mailed out or the data collected online, over the telephone or in-person. An example of a survey is in Appendix A. The example given can be adapted to suit your community's situation. This information is valuable for determining the property's wastewater generation, future needs, and the data available on its existing system. Key information collected includes the number of bedrooms and residents, business type, water-using devices, available water use data, system component location, system maintenance information, and performance issues with system.

Government Records and Regulations

Regulations vary across the country, from state to state and even county to county. As a community, you should identify the regulations that will impact your potential project. You can search online for your state's regulations or check the *EPA's list*. For local regulations and records, determine which department regulates OWTS and other wastewater permitting.

Many local government programs may have data useful to the community and its consultants. In addition to wastewater treatment records, many other data sources may be relevant to your community. See Table 2.

Collection of Field Data

Some community assessment projects rely solely on records to develop a potential solution. This results in several challenges, including the absence of a detailed, accurate map; the assumption that OWTS cannot be fixed or replaced; a lack of assessment of on-site solutions for each property; and limited evaluation of alternatives. Instead, the community should have a property-by-property investigation performed. A standard survey format is provided in Appendix C or is available *online*. This is the only way to accurately determine existing conditions and the potential for onsite treatment. As each property is evaluated, a viable treatment system for the community as a whole should be at the back of the consultants' minds. How each property impacts surrounding properties, any limitations that extend beyond individual property boundaries and potential solutions that will solve

multiple problems should be explored. During this field work two questions will be answered:

1. What is the existing system on each property? Is it in compliance with local/state regulations? What is the system's condition?
2. Is there room for a replacement system on the property? If Yes, what type? If No, what are the property's options?

Field evaluation starts with locating and mapping all utilities and confirming the lot size. The consultant will determine the status of the current systems by checking septic tanks and other components and probing drainfields/soil treatment areas. Conducting soil observations and determining limiting conditions determines the status of current systems and plans for future ones. This allows the consultant to identify a site for a new system and evaluate treatment options. Even if it is passing/compliant, it is wise to determine if there is additional space on the property for a replacement system. Nearby locations for a cluster system should also be evaluated if insufficient space is available on parcels.

Community Wastewater Solution Assessment (CWSA)

A CWSA is prepared based on findings from a property-by-property assessment. It incorporates the examination and mapping of individual property characteristics including, but not limited to, soil type and characteristics, building location, utilities placement, well location, setback requirements, and the status of current wastewater treatment systems. Productive interaction between property owners, community leaders, local units of government and the professionals gathering property information increases the likelihood of an open decision-making process. An open and transparent decision-making process will help achieve the overall success of the project.

The report will contain 1) a summary of desktop and field evaluations for each parcel in the community and 2) decentralized/centralized treatment options for the entire community. A range of options should be assessed, from individual onsite systems and holding tanks to soil-based clusters and municipal-type systems. The costs associated with each option need to be determined, including all capital, operational, maintenance, management, and replacement costs.

Table 2. Potential data available from government sources

| Data | Description | Location |
|--------------------------------------|---|--|
| Comprehensive land use plan | A comprehensive land use plan provides a broad framework and vision of how the community, and its citizens, intend to respond to and manage change. The plan provides the legal basis and initial tools needed to manage land use, environmental quality, resource preservation and utilization and sustainability within the county. This information is critical to water and wastewater planning because it provides the basis for future population density and growth projections. Note that the plan may change, depending on shifts in political control and citizens' future preferences. | Local regulatory body* |
| Demographic projections | Future conditions such as projected population growth or decline, aging trends or changing income levels may influence the size of a sewage treatment project and the community's ability to pay for the project. In addition, demographic information (age groups, income levels, housing stock, ethnicity, etc.) is useful for grant writing and for assessing the community's ability to pay for sewage treatment facilities. | State demographer's office and the United States Census Bureau website . |
| Drinking water supply | In some areas, source water has additional protections in place to preserve public drinking water. All potential groundwater contamination sources, including wastewater treatment facilities within these areas may be subject to special provisions, regulations, or management practices. If the community lives in an area with limited water supply, this should be noted so that reuse can be considered when evaluating options. | Well regulating program |
| Nearby wastewater treatment capacity | It is important while assessing the options to know the age, treatment method used, current capacity and future plans for all neighboring communities. This also lets other communities know that you are working on your wastewater treatment issue. | Community city administrator, engineer, mayor, or council member |
| Rules/Regulations | Rules are available for both decentralized and centralized treatment systems. | State and local regulatory body* |
| Sanitary ordinances | Sanitary ordinances are local requirements that exceed state or county rules. These may impose additional requirements such as setbacks, prescriptive designs, enforcement details, etc. | Local regulatory body* |
| Soil survey | Soil type and hydrology (water tables) influence the rate of water absorption and the effectiveness of soil treatment. The survey includes information on building site suitability, sanitary site suitability, topography, depth to water table estimates and flooding predictions which can all impact wastewater treatment design. | See Appendix C for instructions on accessing data from the soil survey |
| Shoreland regulations | These regulations monitor wastewater close to shorelines of lakes, river, streams, and the ocean. In some areas, wastewater treatment requirements are stricter. | Local regulatory body* |
| Topography data | Elevations are critical in determining whether gravity or mechanical movement of wastewater or effluent will be used in treatment systems. Topography is a critical factor in the amount of disturbance required to install collection systems. | State or local regulatory body* |
| Temperature, precipitation, frost | System design and management should account for precipitation patterns and totals, as well as seasonal management practices related to freeze dates. Depth of frost, which is the critical soil temperature value, varies annually and geographically based partly on snow cover. These variables may influence not only the depth of system components but also the type of system installed. | Soil and Water Conservation District (SWCD) Natural Resources Conservation Services (NRCS) National or state climatological service through the National Center for Environmental Information (NOAA) |
| Zoning ordinances | Zoning ordinances establish guidelines for permitted land uses and development densities. Although many state codes include rules for onsite sewage treatment systems, local ordinances may vary from them to account for local conditions and make special provisions for less common wastewater treatment facilities. | County Environmental Services or Planning and Zoning or Land Management offices |

* Local regulatory body – varies by locality - may be County Environmental Services, Planning and Zoning, or Land Management, or, in some limited cases, the state.

In addition, the consultant should identify a preferred alternative and the rationale for that recommendation. The options to consider are shown in Table 3.

The community may need a combination of what are viewed as centralized and decentralized as shown in Figure 5. Completing a CWSA gives the community a comprehensive picture of the current wastewater situation and provides a clear definition of the problem and the study area boundaries. OWTS are fully examined and considered in this process ensuring that all cost-effective options are on the table. The result is a list of options to address the problem with a preferred option identified with cost estimates.

This report could be used as a Preliminary Engineering Report (PER) required for some regulatory and funding programs. A PER describes the need for a project, presents an analysis of alternatives to the proposed project, including a life cycle present worth cost analysis of any feasible alternatives, a description of the proposed project, a detailed construction cost estimate, a total project cost estimate, and an annual operating budget. Be sure to confirm the PER requirements with the potential funding source to ensure the CWSA includes the required information. A template for a CWSA is provided in Appendix D.

Funding a CWSA

Funding for a CWSA may be available through Federal, local and community sources. Historically, federal sources have been:

- **EPA's WaterTA** (water technical assistance program) provides free technical assistance to communities for a variety of water, wastewater, and stormwater projects. The type of programs supported vary

depending on the current funding source.

- **USDA** - USDA typically relies on others (such as RCAP, NRWA, consultants) to provide technical assistance, but USDA can be a source of funding for organizations.
- The **Rural Community Assistance Partnership (RCAP)** is a national network of nonprofit partners with over 350 technical assistance providers across the country. RCAP provides technical assistance, training, and resources to rural communities across every state, U.S. territories, and tribal lands.
- The **National Rural Water Association (NRWA)** is a non-profit organization dedicated to training, supporting, and promoting the water and wastewater professionals that serve small communities across the United States with each state having a NRWA affiliate with technical assistance providers.
- State and local wastewater management programs may have additional resources.

Interpreting the Data: What Does It Tell Us?

The data collected must be turned into information that is useful to the steering committee, to professionals collaborating with the community and to potential outside funding sources. To ensure an understandable and well formatted CWSA is produced, input and review by the steering committee and key resource people will be needed. Many permitting authorities and agencies have GIS capabilities that can be especially useful for displaying data collected about your community.

Table 3. Summary of decentralized and centralized options

| Decentralized Options* | Centralized Options* |
|---|---|
| Individual onsite wastewater treatment system on the property | Connection to an existing wastewater treatment plant with a collection system |
| Collection system with new or extended cluster decentralized system nearby the properties | Expansion or upgrade of an existing facility to accommodate more connections. |
| Holding tank where wastewater is hauled off site | Building of a new wastewater treatment plant |
| Combination of above options | |

* More information about these options is provided in section 3.

The interpretation step requires a focused, well-facilitated meeting (or multiple meetings) because the results are critical to the rest of the project. Community members will better understand and take future ownership in the project if they participate in collecting and interpreting the data. The steering committee needs to present the information collected and what that information means to community residents and to listen to concerns and interpretations. Be sure to record all interpretations and identify those with unanimous group consensus. This prepares the community to evaluate all of the treatment, organizational and management options available to them. You will likely find that additional information is needed as you go along. This information should be communicated to the residents and other interested parties (for example, township and county officials) on an ongoing basis.

Working with Consultants

As you assess your community's wastewater needs and available options, you may consult and collaborate with a range of stakeholders. This section will help your steering committee engage the broad spectrum of consultants you may need to meet your community wastewater needs. You will learn guidelines for picking a qualified consultant who will fit into your community effort and establish a way to evaluate proposals. Screening proposals, interviewing candidates, checking references, and involving the community in the process are time-consuming tasks. Still, they are all necessary because your community will be living with the

consultant's work for many years to come. Example questions to ask references are included in Appendix E.

Bias

Some consultants may be biased toward particular technologies or options. Recognizing these biases can help the steering committee address community concerns. No one is free of bias. Life experiences and values shape the way people perceive and interact with others. As your steering committee members listen to and interact with each other, community members and professionals involved in working on such a complex effort as identifying appropriate wastewater treatment options, they may discover that many familiar words were used, but radically different meanings were communicated. Everyone has some bias and personal stake in the outcome of a project. Accepting this makes it easier to understand how concerns can be effectively addressed to maximize the community's benefit. Indeed, the bias any project participant exhibits can help identify the project's legitimate weaknesses or areas requiring careful consideration to develop the best possible outcome. One of the best ways to guard against a consultant's bias for a particular technology (or management model, or fiscal structure) is to be familiar with your options. If you question the counsel you receive, do not hesitate to seek additional opinions. You would not undergo radical surgery without seeking a second opinion; likewise, do not commit substantial amounts of your community's money or risk implementing an inadequate treatment system for fear of questioning "the experts." The consultant assisting the community must remain completely neutral regarding any options and assist the community in defining the best option for their specific needs. There is no solution better than the other, just one that is more cost effective.

Community Consultant Needs

A consultant is defined as any professional associated with a private firm, nonprofit organization or university who provides specific information, training, or services in exchange for a fee or as part of their job responsibilities. Some, such as attorneys and engineers, are licensed and regulated by the State. This regulation assures that the consultant meets a minimum standard of training in accepted professional practices in his or her discipline.

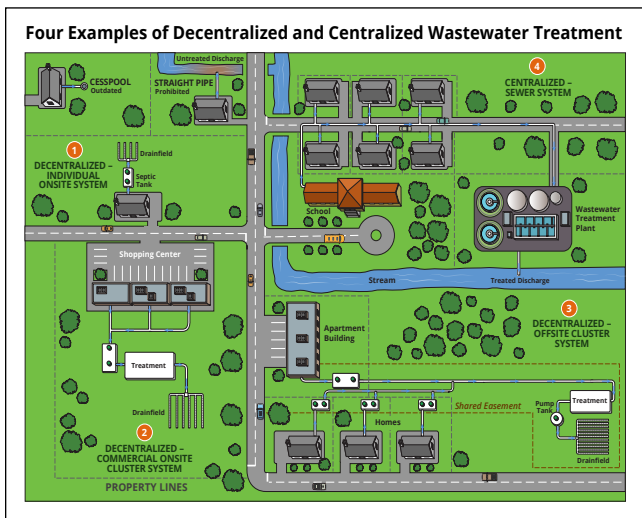


Figure 5. Distributed wastewater management in a community

The following section can help community groups work with a broad spectrum of consultants in wastewater system design, installation, inspection, management, and administration. The same principles apply to other consultants who support environmental assessment and analysis, lake management, aquatic habitat restoration, navigating government guidance and regulations, or any other area of expertise.

Some firms and individuals may have expertise in many or all of the activities listed. Your key concern is how to select a qualified consultant who will complement and integrate with your community team effort. Once you have determined that a specific consultant is necessary to solve the problems at hand, here are the steps to take. You must be able to describe the problem and the services that you need from the consultant;

otherwise, the consultant will define them for you. This can be wasteful in terms of time and money. The more precisely you define your requirements, the more likely you are to get what you need. Table 4 summarizes the wide range of consultants that may be needed for a community wastewater treatment system.

Finding the Consultants You Need

To better define your problem, discuss it with several consultants over the phone. Short phone consultations are free, and most consultants will tell you whether they are interested in and capable of providing the services that you want. Another source of consulting expertise is the faculty of local colleges and universities. Faculty can sometimes provide such services, either as part of their academic duties or as an adjunct activity. A third source of referral is

Table 4. Summary of types of consultants and services

| Title | Services Performed |
|--|--|
| Attorney | Interprets federal, state, and local laws, rules and regulations and written policy. Represents clients in legal proceedings, including development and administration of contracts. |
| Utility staff | Oversees community wastewater system; may include an administrator, engineer, and others that have knowledge of existing systems. Support defining the current status of facilities and provide recommendations for improvements required. |
| Engineer/Designer | Evaluates current system; proposes alternatives and recommends solutions; develops detailed construction specifications and drawings; may oversee construction. May also provide technical support on zoning and subdivision regulations and environmental impact studies. |
| Facilitator/Educator/Technical Assistance Provider | Provides education and facilitation during the process. May assist with preparation of applications for funding. |
| Funder | Works with the community to provide funding for a new system |
| Installer/Contractor | Installs a new system and makes repairs, sometimes designs onsite wastewater treatment systems |
| Inspector | Evaluates current system, sometimes oversees new construction |
| Planner | Develops long-range plans for the development of local infrastructure and government services |
| Pumper | Cleans out septic and other storage wastewater tanks |
| Regulator | Evaluates the design and performance data to assure it meets location regulations, sometimes designs onsite wastewater treatment systems |
| Scientist | Assists with expertise in areas such as soils, geology, ecology, or environmental chemistry who provides technical assistance |
| Service Provider/Operator | Evaluates performance of a system, operates treatment systems, and performs reactive and proactive maintenance |
| Surveyor | Prepares legally enforceable maps |

other communities, neighborhoods, lake associations or groups with similar problems. Find out from them how they resolved issues and who helped them.

If the services you require are routine, a generalist consultant will be sufficient. However, you may need a specialist if the problem and the scope of services required are unique. For example, many engineers have general knowledge of wastewater treatment, but a much smaller group specializes in low-cost systems for rural communities with shallow groundwater proximity. If the problem is highly unusual, you may need to engage a consultant outside your immediate geographic area. Just remember, a specialist or a nationally known expert will cost you more money.

You must determine who can perform the work you need and the required certifications and licenses. In addition, some tasks need to be performed by a licensed professional, but most licenses are geographically limited. For example, most engineers, operators, and chemists are state-based. Also, frequently the concept of “reciprocity” is misunderstood. Reciprocity means that you bring all your documentation for a license in one state to another, and the board in that other state evaluates it. If it complies with the state’s requirements, they will issue an equivalent license based on your qualifications. It does not mean that your license in one state is valid in another. There are also limitations on who can perform tasks within many professions at a company. Many states have lists of *licensed consultants*.

Depending on the project size and local procurement laws, it may be necessary to solicit a consultant through a competitive process, such as a Request for Qualifications or a Request for Proposals.

Develop a Request for Qualifications (RFQ) or Request for Proposals (RFP)

The first step in the RFQ/RFP process is to define the problem. The community must describe the problem and the services that you need from the consultant; otherwise, the consultant will define them for you. The consultant may expand the scope beyond what is required, not include critical information, or limit information to direct the community toward a specific solution. The community must know the project goals and the timeline for the work currently being requested. It is recommended that a CWSA be the long-term goal, but interim data collection steps may be needed. Be

sure to include all available background information. Further down the process you will be requesting a design of a new system, bid documents for installation, operation, and maintenance manuals. Community meetings are essential to keep the community involved throughout the process.

Develop RFQ/RFP

Once you have defined your problem you are ready to develop a Request for Qualifications (RFQ) or a Request for Proposals (RFP). The RFQ is a formal request for a listing of qualifications from firms or individuals that you may consider working with. A Request for Qualifications is general and easy to review. It is used to narrow the list of candidates you plan to share the RFP with. The more specific you are in your RFQ the better the firms will be able to demonstrate their experience and ability in providing the type of work you are seeking. See Appendix E for an example. A well-written RFQ asks for:

- specific licenses, certifications, education, or other credentials you require;
- deadlines, limits to proposed activity or other time constraints;
- types of references needed (for example, a specific type of wastewater project for rural communities with a population under 2,000);
- completed projects nearby;
- types of services offered;
- types of equipment or special services available; and
- a fee schedule or price structure.

After discussing the issue with a number of consultants, develop an RFP that states the problem and details the scope of proposed services to be provided by the consultant. The RFP may or may not include consultant minimum qualifications or the estimated cost of the services to be rendered. You might also want someone from your local permitting authority to review the RFP before you submit it. Governments do not normally provide lists of qualified consultants, but they will, time permitting, review RFPs and proposals received. See Appendix F for an example RFP. A well-written RFP includes:

- a deadline for response;
- the name of a community contact, with phone

number and e-mail in case the contractor has questions about the RFP;

- contact information for the individual and firm seeking the job
- request for proof of license/certification and/all insurance coverage inclusive of professional liability insurance;
- a request for references, including some for work done that was similar in scope and size to the project anticipated;
- a statement of the problem or situation, clearly specifying known data and where it can be found (and in what format);
- the community data available;
- scope of services needed;
- limitations, conflict, or exception in their offering; and
- a cost estimate with invoice/payment schedule.

The cost estimate or fee-for-service is sometimes not part of the RFQ/RFP process; instead, the evaluation team establishes a ranking system, and contract negotiations begin with the highest-ranked firm. This is when fees for services to be rendered are negotiated. If an agreement can't be reached (sometimes based on the funding limit offered to the community by the funding agency), negotiations begin with the next highest qualified firm until an agreement is reached and contracting can proceed.

It is best to specify a required format for responses for ease of review and comparison. The community should consider hosting a preproposal or site visit prior to accepting proposals. Transmit the RFP to at least five, and preferably ten, consultants as the more qualified bids you receive, the larger the pool to pick from.

Establish a Scoring System for Evaluating Proposals

After all proposals are received, screen them for such factors as the consultant's training and accomplishments on similar projects, potential cost and how well the consultant has understood the contents of the RFP. In general, big consulting firms are more capable but less responsive than individuals and small firms. An academic consultant will likely provide more services at a lower cost, but the quality can vary, and time deadlines may not be met. The

best approach to evaluating proposals is to speak to other clients of the consultant. In general, let the buyer beware. One of the most challenging aspects of selecting a consultant is finding one who represents or addresses your needs, rather than pushing their own technology or area of expertise. However, you may not find a single consultant who covers all your needs and may need to work with several.

A sample evaluation scoring sheet is included in Appendix G. Before employing this type of tool, the search/interview committee should agree on the range of values they wish to assign to each category and define their standards for ranking candidates.

Select Two or Three Final Candidates

Request that each candidate make a formal oral presentation. Each consultant should be interviewed without the other candidates present. Allow time for both a formal presentation and an informal question and answer period. Although unusual, it is not unheard of for a community to recognize that each finalist has strengths lacking in the others; you may wish to inquire whether consultants are willing to collaborate or provide only a portion of the services you require. A community is always wise to check references. See Appendix H - Interview Questions. Ask for a list of similar projects that have been in operation for several years. Are the host communities still happy with the outcome? Was work done on time and on budget? Has maintenance cost and time been about as expected? Will they attend meetings and how well did they deal with the public? See Appendix I for suggested questions to ask their provided references. At the end of the interview process, you will have hopefully selected a consultant to assist you with a phase, an aspect, or the entire project.

Develop a Contract

Once the consultant has been selected, prepare the formal work plan with the consultant. The work plan should specify the objectives of the effort, deliverables, timeline, project organizational structure, and a detailed budget. It should also define how the consultant will collaborate with you. Will they attend meetings? How will they respond to phone calls and provide progress reports? Depending on the project's scale, an attorney should be consulted to review the contract. The work plan should include scheduled meetings at which the consultant informs you of project progress and any associated issues. If appropriate, the consultant

should produce a final report for future reference. The consultant must be responsible for obtaining all required government permits and complying with all applicable laws, rules, and regulations. Associations and individuals may be liable for a consultant's illegal activities. All of these details, along with specific dates and performance standards for each deliverable should be summarized in the scope of work.

Scope of work/contract should include:

- Deadlines for completing project phases and final product. You may require written authorization to proceed before each phase of any project.
- Payment schedule and terms. Identify if partial payment is expected before project completion, and the procedure for change orders if necessary.
- Clear distinction as to whether any out-of-scope services will be permitted, what type (oral or written) of approval is needed and how the consultant will be reimbursed (usually on a time and materials basis). Out-of-scope services are any efforts not defined in the work plan or contract and can incur high costs. Many groups establish a maximum amount or a percentage of the contract amount for out-of-scope services, or require a consultant to agree that the described services can be provided without out-of-scope work. Even then, these services must be justified upon request.
- Specific format and delivery considerations for the final product, including whether it is to be electronic, with the number of copies of the final product you require, and the meeting or meetings needed with the steering group and community.
- Specifications of any other deliverables that will belong to the community, and whether any portion of the project is the proprietary or intellectual property of the consultant.
- Dispute resolution process.

Any work not clearly defined in your scope of work may be considered out of scope, and grounds for additional charges from the consultant you choose. A strong protection against the consultant who "discovers" that the technology you need is the one they specialize in is to require that they review specific technologies that you believe may be appropriate and provide the pros and cons of each. In this way, you can

assure your community that your final decisions are based on a comprehensive and accurate assessment of all the options.

After the Contract

There should be regular check-ins with the consultant for status updates to make sure they are on track and determine any problems they may have encountered. The community must determine the end goal for the consultant ensuring the products are formatted to meet community needs.

Summary

1. Communities should hire consultants based on a variety of factors, including their experience and success in collaborating with other small communities on similar projects.
2. It is your project - Planning a wastewater project is like buying a car. You would not go shopping without first knowing something about what you want, what you can afford and the options available. You also would not ask a stranger to pick out a car for you and expect to be satisfied. Communities need to choose consultants who are willing to collaborate with them to achieve their goals.
3. Take your time - Screening proposals, interviewing candidates, checking references, and involving the public in the process are time-consuming tasks, but they are all necessary to conducting a successful search. Any extra time spent carefully choosing a consultant can be justified when you consider that most wastewater treatment systems are designed to serve a community for 20 to 30 years or longer. Your community will be living with (and paying for) the results of the project and the consultant's work for many years to come.

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Wastewater Treatment Systems Options

Learning Objectives

- Describe the options for collecting wastewater.
- Describe the options and goals for primary treatment of wastewater and the O&M considerations with the options.
- Describe the options and goals for secondary treatment of wastewater.
- Describe the options available to treat nitrogen and phosphorus.
- List options to disinfect wastewater.
- The operation and maintenance (O&M) considerations with the options.

Individuals and communities are responsible for delivering their wastewater to an adequate and well-managed treatment facility. In addition to water being discharged, all systems must also properly recycle residuals or solids removed in the treatment process. In many small communities, each home and business has an individual onsite wastewater treatment system (OWTS) consisting of a septic tank and a soil treatment area or drainfield. When properly sited, designed, installed, and maintained, individual OWTS are highly effective at renovating domestic wastewater and protecting public health. Each OWTS has land dedicated to the treatment and dispersal of wastewater. As communities grow (both in population and in commerce), land often becomes too valuable to be dedicated to wastewater treatment and dispersal. Older OWTS are sometimes located on small lots. There may not be sufficient suitable soil available to increase the capacity of the existing system or to install an upgraded system. When land near the wastewater source is no longer available, larger wastewater treatment systems may need to be considered. If a substantial number of individual OWTS are malfunctioning, a community-scale wastewater solution may be warranted. Decentralized technologies offer a range of options for consideration. They also provide the flexibility of combining individual, residential/commercial clusters, and community-scale options to tailor a solution that fits the particular need. This section will describe the wide range of options available for collection, treatment, dispersal, and reuse of wastewater in small communities.

General Treatment Overview

Depending on the population density (property sizes) and soil conditions, treatment systems follow one of two general concepts: decentralized and centralized. However, often a combination approach is needed. Individual and multiple household OWTS are frequently referred to as decentralized. The most common OWTS, a conventional septic system, is shown in Figure 6, and it requires adequate space and appropriate soil to facilitate treatment. There are alternatives to conventional systems that do not need the same site conditions which will be discussed in this section. These systems can be designed to fit the needs of residential homes and commercial businesses.

Multiple-household onsite cluster systems collect wastewater from a number of homes and businesses (from two to 100s) and deliver it to a nearby site (see Figure 7). They are called decentralized systems because they use the same technology solutions as individual homeowner systems and treat lower volumes of wastewater (compared to a centralized system). A community water supply system is an alternative to consider if your community is also considering a multi-household wastewater system as part of the solution. This option may offer the advantage of lower capital investment costs, reduce potential negative impacts of well setbacks on individual properties, or reducing the land needed for dispersal.

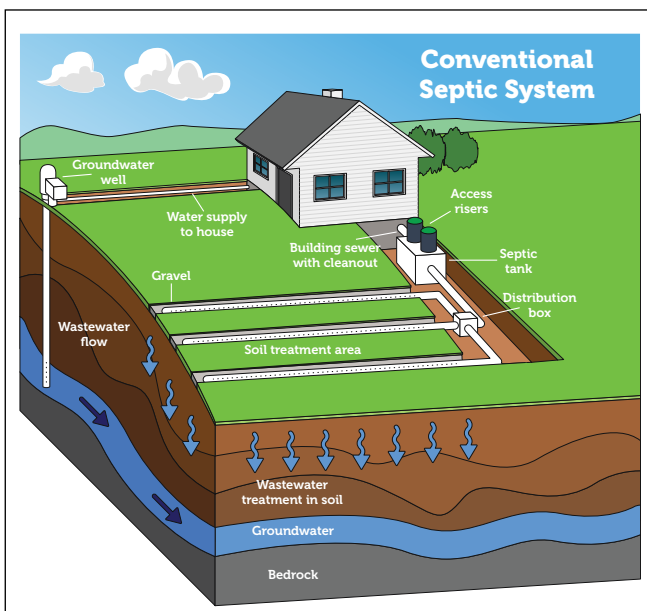


Figure 6. Conventional system

Centralized and decentralized cluster systems collect all the wastewater through a collection system. Most centralized treatment systems discharge the effluent to a lake, river, or stream. A combination of centralized and decentralized approaches is frequently found to be the most viable solution. Such a combination may use two or more treatment systems as shown in Figure 8.

Levels of Treatment

Wastewater treatment involves a series of stages to remove contaminants before the water is returned to the environment or reused. These stages are broadly categorized as primary, secondary, and tertiary treatment. Each stage progressively cleans the water to a higher standard.

Primary Wastewater Treatment

Primary treatment is the first major stage in wastewater treatment, focused on the physical removal of large solids and suspended particles. Its main goal is to reduce the load (pounds of contaminants) on subsequent treatment stages by removing materials that will either float or readily settle out by gravity. Primary treatment removes organic and inorganic solids by the physical process of sedimentation. This is accomplished by reducing the velocity of the wastewater enough to allow the solids to settle out.

Centralized wastewater treatment plants (WWTP) may include screening or grit removal prior to a settling basin. When included, screens remove large debris like rags, plastics, sticks, and other solid objects (that should not be put down the drain). This protects pumps and other equipment in the treatment plant from damage. After screening, the wastewater flows through grit chambers, where the flow velocity is

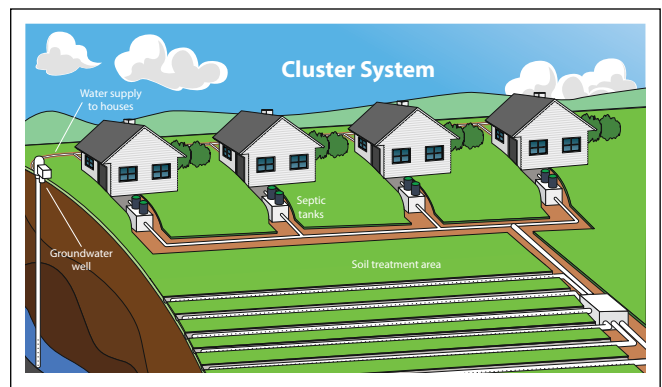


Figure 7. Cluster system

reduced. This allows heavier, inorganic materials like sand, gravel, and coffee grounds (grit) to settle to the bottom, preventing abrasive damage to equipment.

Both OWTS and WWTP perform primary treatment in a settling tank. These tanks can be circular or rectangular settling tanks called septic tanks or primary clarifiers. Here, the water moves slowly, allowing finer suspended solids to settle to the bottom by gravity, forming sludge. Lighter materials like oil and grease float to the surface. Primary treatment typically removes about 50-70% of suspended solids and 25-40% of the biochemical oxygen demand (BOD) — a measure of organic pollution.

Secondary Wastewater Treatment

Secondary treatment is normally a biological process that follows primary treatment and aims to remove dissolved and suspended organic matter that was not removed in the primary stage. This is most often achieved by using microorganisms to consume organic pollutants (BOD). The secondary treatment process significantly reduces the amount of pathogenic organisms in effluent. Secondary treatment typically removes 85-90% of the remaining suspended solids and BOD. There are many treatment options available in both the centralized and decentralized market to achieve secondary treatment.

Tertiary Wastewater Treatment

Tertiary treatment provides a higher level of purification than primary and secondary treatment. It is used when wastewater needs to meet very stringent discharge

standards, or when it is intended for reuse (e.g., irrigation, industrial processes, or even potable water).

Tertiary treatment processes vary depending on the specific contaminants that need to be removed, to include:

- Filtration: After secondary treatment, the effluent may pass through filters (e.g., sand filters, activated carbon filters, or membrane filters) to remove any remaining suspended solids, turbidity, and some dissolved organic compounds.
- Disinfection: This step inactivates or kills remaining disease-causing microorganisms (pathogens). Common disinfection methods include:
 - Chlorination: Adding chlorine (or chlorine compounds) to the water.
 - Ultraviolet (UV) light irradiation: Exposing the water to UV radiation, which damages the DNA of microorganisms, preventing them from reproducing.
 - Ozonation: Using ozone gas, a strong oxidant, to kill microorganisms and break down organic pollutants.
- Nutrient Removal (Nitrogen and Phosphorus): These nutrients, if discharged in high concentrations, can cause excessive algal growth (eutrophication) in receiving water bodies. Nitrate-nitrogen in drinking water supplies can lead to public health concerns.
 - Nitrogen removal often involves biological processes like nitrification (converting ammonia to nitrate) and denitrification (converting nitrate to nitrogen gas).
 - Phosphorus removal can be achieved through chemical precipitation (adding chemicals to form insoluble phosphorus compounds) or biological phosphorus removal by specific microorganisms.

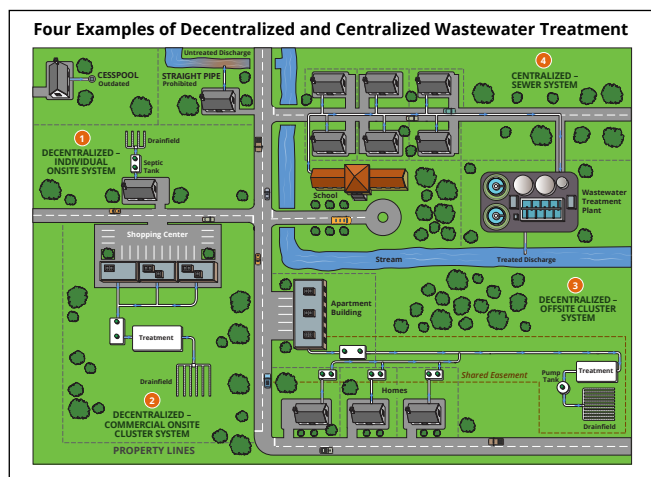


Figure 8. Example of decentralized and centralized wastewater treatment systems

Collection Overview

Collection is the system of piping, lift stations, and other appurtenances that receive and convey wastewater either by gravity or pressure to the treatment system. Designing and installing a wastewater collection system can be the most

expensive component of developing community wastewater infrastructure. Unless treatment and dispersal components are located at every site, each wastewater-generating structure must be connected to a common collection system so that wastewater can be transferred to a location to be treated. The process of installing a collection system causes considerable disruption as rights-of-way and easements become construction zones. It is a logistical challenge to plan the construction in such a manner that minimizes the impact on the citizens and on private property. The community must be aware of the cost and disruption to achieve its septic management vision.

Every home and commercial property has a wastewater piping system that collects wastewater from the source and transports the wastewater to the treatment system. This plumbing system is called the drain, waste, and vent (DWV) system because it drains wastewater from the home and vents air. You may have noticed pipes protruding from your roof. These pipes allow air to enter the DWV system as water moves through the plumbing system. Air is displaced as water flows through the piping, and this air must be vented. Likewise, after the water moves through, air must be allowed to enter the piping or a vacuum will form. This vacuum can draw water out of the toilet bowl and other gas traps, allowing sewer gases to enter the home. For most homes, the DWV system is designed to flow by gravity. Pipes are installed on a 2% slope to move the wastewater out of the home. For homes that have plumbing fixtures located in a basement or somewhere below the elevation of the DWV plumbing, a sewage pump is used to pump the wastewater up to the DWV system.

Commonly a 4-inch diameter pipe carries the sewage from the structure and connects to the next component downstream. If this is an individual onsite system, the next component is normally a septic tank. If it is a community system, the drain from the house is called a lateral, and it connects to a larger sewage transmission pipe that gathers sewage from multiple sources and transfers it to the next component. The pipe leaving the structure (building sewer/building drain) should have a cleanout just outside the structure to allow access to the pipe to clear obstructions. Normally, flow is by gravity out of a structure, but in some cases, a pump inside the structure lifts the sewage and discharges it to the collection system at a higher elevation. Cleanouts are important regardless of whether the building sewer pipe is going to an individual onsite system or

a community collection system (see Figure 9). The cleanout allows ready access to clear clogs in the pipe without having to dig up the yard. Most community systems require them, and many state and local regulations require them as well.

Some communities may have existing collection systems that could potentially be used with a new wastewater treatment system. Existing components must be thoroughly assessed before being incorporated into a new or upgraded design. With older lines and components, pipe degradation and root intrusion can be a challenge. If older collection systems are not replaced some pipe materials (such as clay pipe) can break allowing root intrusion and infiltration. To identify these problems, cameras or smoke testing can be used and lines can be jetted, which can be expensive, but necessary.

Sewers can be designed to convey all the wastewater (both solid and liquid), or they may convey only the liquid portion (effluent). They may be designed to operate by gravity, pressure, or vacuum. Each option has its advantages related to installation cost, long-term operation, and maintenance as well as the space that each occupies. Some methods can be used in combination. The following is a general description of broad categories of collection options. With all collection options, clear water from storm events, ground or surface water should be excluded. The common terminology is inflow and infiltration (I&I). Inflow is clear water from sources like roof gutters, downspouts, or sump pumps illegally connected to the sanitary sewer system and infiltration is groundwater that seeps into the sewer pipes through cracks, leaky joints, or connections.

I&I can cause problems because it increases the hydraulic load on sanitary sewer systems, which

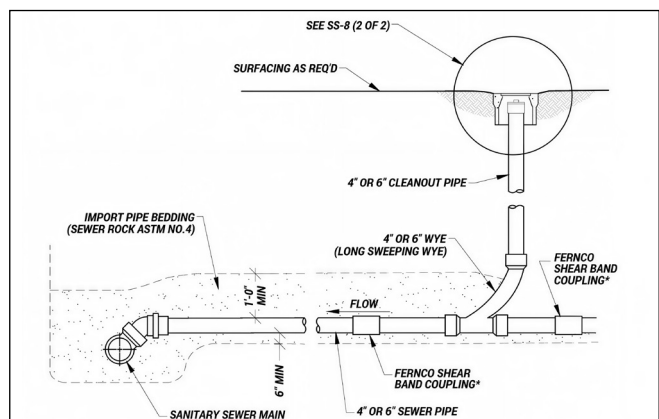


Figure 9. Cleanout detail

are designed to carry wastewater. When the system is overloaded, wastewater can flow backward and flood basements or households. It can also disrupt wastewater treatment processes and release poorly treated wastewater into the environment. The community must work to identify I&I sources and remove and upgrade components as needed. To identify I&I, communities can perform smoke testing, which involves pumping non-toxic smoke through the sewer line to reveal leaks. Water from roof drains, basement drainage sump pumps, hot tubs, swimming pools, and air conditioning condensate are not considered wastewater, and should not be put into the collection system. The discharge from water treatment systems (such as a water softener or reverse osmosis) may be managed separately particularly with OWTS because the large water volume needed to regenerate these devices could overload the system.

In multiple-household on-site applications, traditional septic tanks may be located on individual properties, or a large septic tank or multiple tanks may be placed at a central location. When tanks are located on individual properties, the settled effluent is collected and delivered to a common treatment or final treatment/dispersal site through a small diameter pipe either by gravity flow or under pressure. When raw wastewater is collected, there is no septic tank on the property. The raw wastewater is transferred via a large gravity flow pipe to a centralized tank or tanks, or via a small diameter pipe with a grinder pump station located on each property. Some designers prefer individual tanks for each home as a valuable tool in diagnosing problems caused by individual households such as I&I or excessive amounts of fats, oils, and grease.

If the commercial property has a kitchen, an external grease interceptor/tank may be needed to protect the collection system from issues from fat, oil, and grease (FOG). Other commercial businesses may need to

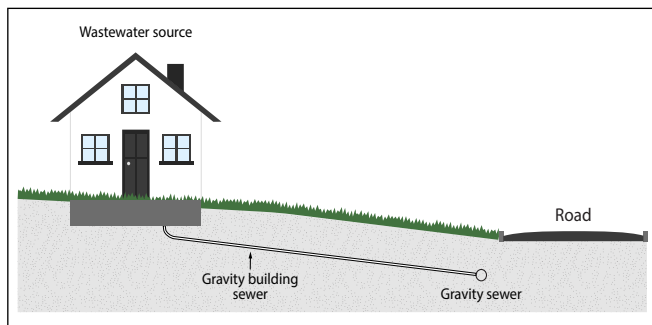


Figure 10. Raw gravity collection

be evaluated to determine if any of their wastewater sources could be challenging for treatment. Some utilities require pretreatment of other contaminants at the facility under a Pretreatment Program before being released into the collection system.

The following section provides an overview of the various options, and in Section 4 – Managing your wastewater system, the management of each option is covered in more depth.

Raw Wastewater Collection

Raw wastewater means no solids settling has been performed. The wastewater from the structure can flow by either gravity or pressure with the use of a pump, which moves the wastewater through the lines.

Raw Gravity

A gravity collection system is used to collect wastewater from multiple sources and convey the wastewater by gravity to a central location. Wastewater from each source is conveyed through a building sewer to a collection line. Collection lines serving multiple facilities are typically an eight-inch or larger diameter pipe as shown in Figure 10. Pipe diameters increase as the volume of water being transported increases. Pipes are installed with sufficient slope to keep the suspended solids moving through the system. Manholes are used to provide access to the sewer like a huge cleanout but also are used at bends in the line to minimize solids clogging the lines. As with any joint, leakage at manholes can be a problem.

If gravity flow is not possible throughout the system due to insufficient slope, lift stations (pumps) are employed. Lift stations are installed at lower elevations in the network to pump sewage to another gravity line, convey wastewater over hills, and/or to a treatment facility. Manholes are installed at regular intervals to provide maintenance access to collection lines (see Figure 11).

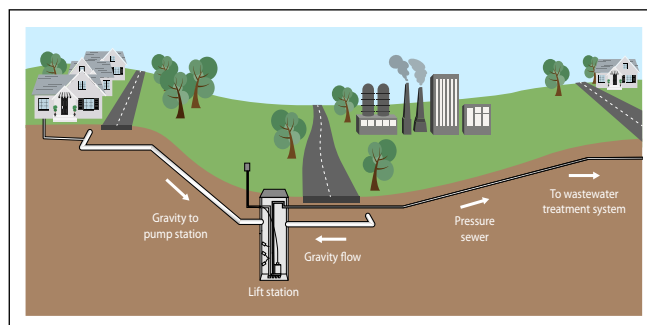


Figure 11. Gravity collection with a lift station

Properly designed and constructed gravity-collection sewers are a viable option for urban areas but are quite expensive for small communities. Ideally, gravity flow is the preferred method for conveying wastewater. However, topography is rarely conducive to pure gravity flow, and lift stations must often be included. The cost of gravity collection may be prohibitive unless there is sufficient population density to justify the installation.

Installation costs for gravity collection are high due to the size of the pipe, the depth of construction, the number of manholes, and the number of lift stations needed. A clear vision for the community's future is required in order to ensure the collection is appropriately sized. If the capacity for long-term use is built into the design, the system can accommodate the anticipated growth for the next 50 or more years. Realistically, over-building the collection means that the current users will bear the cost of that future use.

The land area required is a function of the piping installation area, with about 3 feet of trench width needed for each foot of burial depth. Manholes are installed 300 to 400 feet apart, or at shorter distances when a change in direction is required. Additional land is required for lift stations. Once installed, the components of a gravity collection are minimally visible with manhole lids and lift stations (if used) evident at the surface which can be designed to be non-obtrusive. There can be odors associated with access points and odor control may be necessary. The potential loss of trees or other local charm during installation must be considered.

Regular inspection of system components is critical. Leaky pipe connections are a potential source of groundwater and stormwater infiltration. This extra water must be treated. Infiltration must be controlled, or the capacity of the treatment system will be exceeded during wet weather conditions. Modern construction materials have reduced the infiltration issue. However, tree roots, shifting soils, and poor pipe connections (especially to manholes) are still major problems. Proper maintenance includes periodic inspection and line repair, cleaning out blockages, and repairing areas where significant infiltration is occurring. On an approximate ten-year rotation, each sewer line should be inspected via a down-the-hole closed-circuit camera so that areas needing repair can be identified. Service providers/operators must have the knowledge

and skills related to sewer cleaning technologies and the associated safety precautions.

Raw Pressure

Pressure sewers are a means of collecting wastewater from multiple sources and delivering the wastewater to an existing collection sewer, and/or to a local or regional treatment facility. Pressurized sewers are not dependent on gravity to move wastewater; and therefore, there is less concern about the local topography. A typical arrangement is for each connection (or small cluster of connections) to have a basin or pump vault that receives wastewater (see Figure 12). When the basin fills to a set point, a pump within the basin grinds the sewage as it injects wastewater into the sewer. This transfer of wastewater pressurizes the sewer. As various pumps along the length of the sewer inject sewage into the line, the wastewater is progressively moved to the treatment facility.

Key components include:

- Sewage pump basin: Wastewater from a home or building (from toilets, sinks, washing machines, etc.) flows by gravity into a sealed pump tank or basin, typically buried on the property.
- Level Sensing: Inside the tank, a level sensing device (often a float switch) monitors the wastewater level, turns the pump on/off and alerts if there is a high-water event.
- Grinding Action: When the wastewater in the tank reaches a predetermined level, the grinder pump automatically activates. The pump contains a powerful cutting mechanism, or blades, that macerate (grind) all solid waste into a fine slurry.
- Pressurized Pumping: Once the waste is ground into a fine slurry, the pump pressurizes it and pumps it out of the tank through a small-diameter

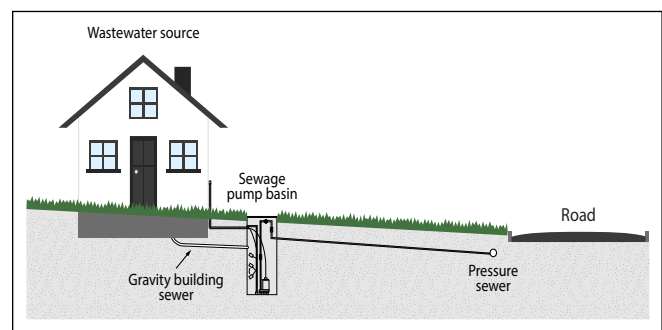


Figure 12. Raw pressure collection

pressure sewer. This pressurized slurry can be pushed uphill or over long distances (sometimes miles) to connect with a municipal gravity sewer main, a larger force main, or directly to a wastewater treatment plant. Check valves are installed to prevent wastewater from flowing back into the structure.

- **Alarm System:** Grinder pump systems are equipped with an alarm panel (with both visual and audible alerts) that notifies the homeowner if the pump malfunctions or if the wastewater level in the tank rises too high, preventing potential backups or overflows. Note: If the alarm goes off, the home must stop discharging water from the home as there is little storage in the pump tank.

The grinding action usually requires higher horsepower pumps than settled effluent lift stations. The ground slurry is more challenging to settle in septic tanks and other primary treatment processes. Less room is required on the lot for the grinder installations compared to options including full size septic tanks but there are many pumps to maintain. Raw pressure

Directional Boring

For small diameter force mains, the pipe depths are shallow just below frost depth, directional boring can be used to minimize surface damage. Directional boring (Figure 13) is a method of drilling to install service pipes while minimizing physical damage to the area above ground and can be used to lay force mains for raw wastewater grinder pumps and septic tanks followed by effluent pumps (STEP). The process follows the ground contour at minimum depth of 5 feet or deeper in frost-prone cold climate and shallower in warm climates. It avoids the need for most manhole access structures. It is easy to cross under streams, wetlands, trees, and other surface structures.

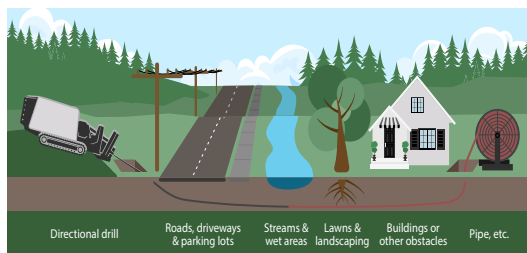


Figure 13. Directional boring

collection systems are easy to add onto as new neighborhoods are established. Shallower placement of piping, lack of manholes or lift stations, and longer sections of smaller diameter piping equates to less

expensive and less obtrusive installation. The piping can also be located along the shoulder of the road instead of the middle and can follow the ground surface topography as there is no need for a consistent slope on the piping. The land area required for a pressure collection system is a function of the area required for installation of the pump basin which is much smaller than a septic tank and the piping that connects it to the collection main. A single-family home will typically have a basin with a 30 to 70 gallon capacity installed below ground except for a tank lid 18 to 30 inches in diameter to allow access to the pump and controls.

The community must decide who is responsible for the components of the collection system, including pumps, at the planning stages of the project. Pumps are typically designed to be rebuilt, but sometimes a complete replacement is needed. The collection lines are pressurized so they are watertight by design, but pump basins should be inspected to

DO NOT FLUSH WIPES!

Sanitizing wipes do not break down the way toilet paper does. These wipes clog homeowner and municipal sewer pipes, clog grinder pumps, put stress on community wastewater collection and treatment equipment, causing cities to spend thousands of dollars on premature equipment repair and replacement.

ensure that surface and groundwater are not leaking in or there are no clear water connections. The grinder pumps are used under harsh conditions and inappropriate items flushed down the drain can cause the grinder pumps to fail.

Disposable wipes — used for changing diapers, personal hygiene, housecleaning, and more — cause significant problems when flushed down toilets. Wipes snag on any imperfection in sewer pipes, catch passing debris and grease, and create a “ball” that will grow to plug the pipe. It is vital to educate the public about what items should not enter the septic system.

Raw Vacuum Collection

Vacuum collection of wastewater utilizes a network of pipes under negative pressure to transport sewage from collection points to a central vacuum station. Unlike conventional gravity systems, which rely on downward slopes, vacuum systems use air pressure differentials to “suck” wastewater and a small amount of air through the pipes. This method is particularly advantageous in flat terrain, areas with high water tables, or places where

conventional trenching is difficult or costly, as it requires smaller pipe diameters and less excavation. The process typically involves a vacuum valve at each collection point that opens intermittently to admit a batch of sewage into the vacuum main, where it then travels to the collection station for discharge into a conventional gravity sewer, pump station, or treatment plant (see Figure 14). Pipe depths are shallow and periodic vacuum/collection basins with controls can have noise and odor concerns.

The use of vacuum collection is limited in the US due to high upfront and maintenance costs. They are more common in applications for larger communities (200+connections) and when a retrofit option is needed when other forms of collection are not economical due to specific site constraints.

Settled Wastewater Collection

STEP (Septic Tank Effluent Pump) and STEG (Septic Tank Effluent Gravity) systems are decentralized wastewater collection methods that offer alternatives to raw wastewater collection. Both systems involve primary wastewater treatment in a septic tank on each property, where solids settle out and are periodically pumped, after which the liquid effluent enters a smaller-diameter collection system. The effluent delivered to the treatment site will have an approximate 50% reduction in solids and organics. This may be a detriment to nitrogen removal systems which may need organics to

assist with the treatment process. Both STEP and STEG systems typically use small-diameter PVC pipes for their collection networks, which helps reduce excavation costs and environmental impact compared to large conventional gravity sewers. These collection options also tend to have reduced maintenance costs. The collected effluent is then transported to a central location for further treatment at a decentralized wastewater treatment plant. Figure 15 shows the layout with a septic tank at each house flowing by gravity.

STEP Systems

In a STEP system, after the initial separation of solids in the septic tank, a pump is used to push the liquid effluent into a pressurized collection pipe network. This pressurized sewer allows for transport over varying terrains, including uphill, making them suitable for areas with uneven topography or where gravity flow is not feasible. The pump activates when the liquid level in the tank reaches a certain set point (see Figure 16).

STEG Systems

A STEG system, on the other hand, relies on gravity to transport the pre-treated effluent from the septic tank to the collection system. No pump is needed. It requires a downward slope from the septic tank to the main collection line. STEG systems are often used in situations where the topography naturally allows for gravity flow (see Figure 17).

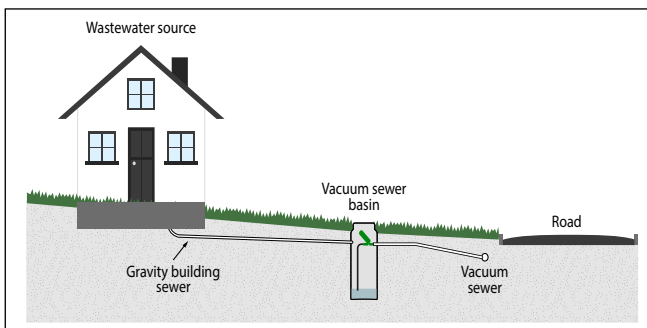


Figure 14. Vacuum collection

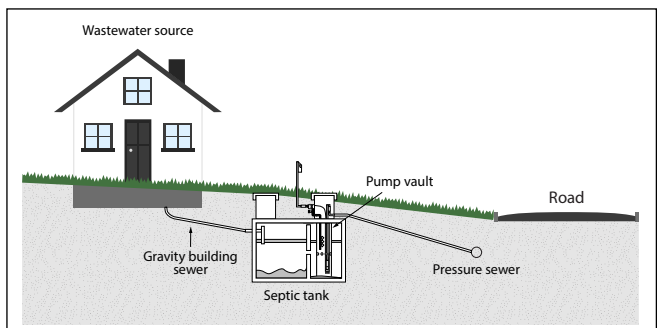


Figure 16. Septic tank effluent pump collection system

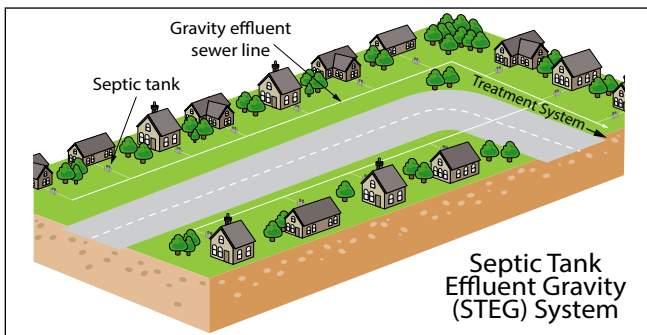


Figure 15. Septic tank effluent gravity collection system in a community

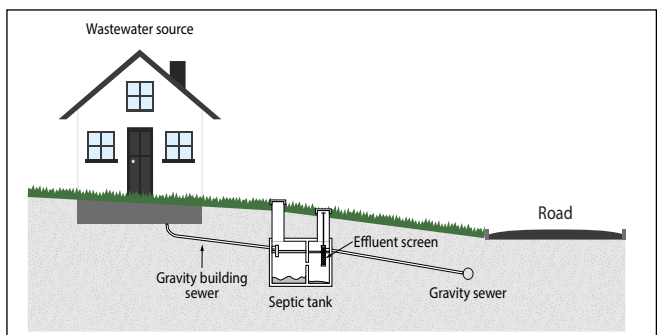


Figure 17. Septic tank effluent gravity

Septic Tank Sizing

Sizing septic tanks for STEG and STEP systems is critical to their design, as these tanks provide the primary treatment of wastewater before it enters the small-diameter collection system. While the specific requirements vary by local regulations, the septic tank will give the following functions:

- Separate solids: Allow heavy solids to settle to the bottom (sludge) and lighter materials (grease, scum) to float to the top.
- Provide anaerobic digestion: Bacteria in the tank break down a significant portion of the organic matter in the wastewater.
- Produce “cleaner” effluent: Discharge a cleaner liquid effluent that is suitable for the downstream small-diameter pipes and further treatment.
- Provide storage: Offer a buffer for peak flows and, in the case of STEP systems, function as a dosing tank for the pump.

An effluent filter/screen or a pump vault is not part of the septic tank sizing although many community systems require one. STEG/STEP tanks almost always include an effluent filter or screen at the outlet to prevent solids from entering and clogging the small-diameter collection pipes downstream. These screens typically have a screen mesh of 1/8 inch (3 mm) or less. Figure 18 shows an effluent screen while Figure 19 shows a pump vault with a screened inlet to the vault in the second compartment of the septic tank.

The septic tank sizing factors are based on the design flow tied to the number of bedrooms for residential applications or the peak usage for commercial properties, based on historical water use from water meter data when available, or estimated when not available. Another critical value is the hydraulic retention time (HRT). HRT refers to the time wastewater spends in the septic tank. A sufficient HRT allows for proper settling of solids and biological treatment. The specific regulations of the state or local health department or environmental agency will typically dictate septic tank sizing. These regulations often provide detailed tables or formulas for sizing based on the number of bedrooms or commercial use. They may also dictate specific reserve volumes, pumping frequencies, and filter requirements. These regulations may consider the use of grinder pumps, garbage disposal, wastewater characteristics, and

pumping frequency in determining the HRT. Many regulations specify a minimum HRT, often defined as two days of peak daily flow. Many jurisdictions require a minimum septic tank size, regardless of calculated flow, usually 1,000 gallons for a home with three or fewer bedrooms.

However, for STEG/STEP systems, some guidelines recommend a larger sizing to account for solids accumulation and provide a longer period between pump-outs. For example, some suggest sizing for two and one half to three times the daily design flow, or even four times the daily flow for systems with a pump (STEP) to provide adequate reserve and dosing volume. The tank must have adequate volume to store accumulated sludge and scum between pumping events. This storage capacity is why a larger tank is preferred, as it extends the pumping interval. Emergency storage is needed for STEP systems. In

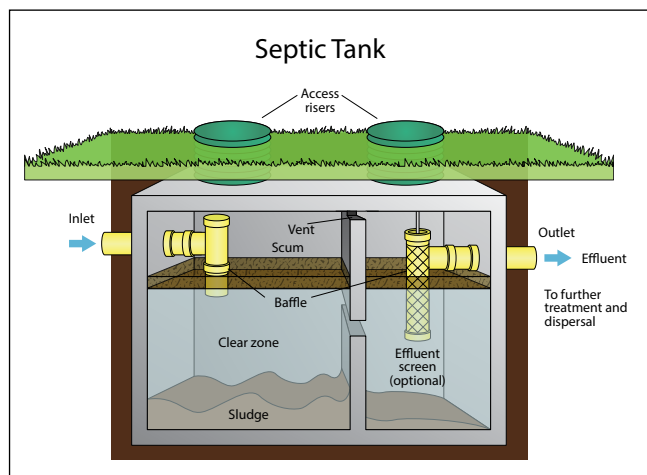


Figure 18. Septic tank

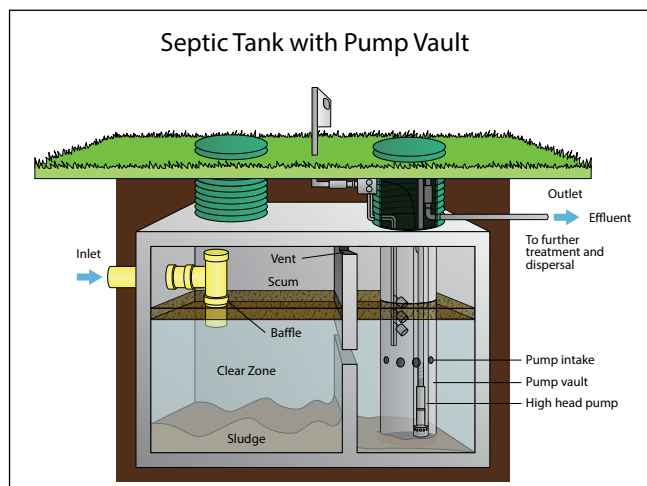


Figure 19. Septic tank with a pump vault

this case the dosing tank needs to have sufficient reserve volume above the “high-level alarm” to the inlet pipe invert elevation. This reserve volume provides a buffer in case of pump malfunction or power outage, giving the owner time to address the issue before a backup occurs. This reserve volume might be specified as a certain percentage of daily flow or a fixed volume.

Settled Effluent Collection Considerations

Once installed, the components are minimally visible. There will be cleanouts installed within the collection network, but they are not very evident at the surface and are not obtrusive. Septic tanks and building sewers must be watertight so that stormwater and groundwater do not enter the system (I&I). Settled effluent gravity systems typically cost less than raw sewage gravity collection and can be installed in shallow trenches or directionally bored when pumped.

A critical issue to decide is who will own and manage the septic tank and pump (if present). The community must decide whether on-lot costs for installation, maintenance and repair will be borne directly by the landowner or spread across the community. Septic tank residuals must be pumped out when solids account for 25 to 33% of the liquid depth, and effluent screens must be inspected annually and cleaned as needed. STEP systems with pumps should be evaluated annually and replaced as needed. System components should be standardized wherever possible to facilitate maintenance.

Collection Options Summary

For a community solution, there are many options to consider for collecting wastewater and transporting it to a common treatment site. Considerations include community size, installation impacts, vision for the future, topography, economics, operations, and maintenance. The community must have bylaws and all required legal documentation on file that authorize maintenance staff to access the collection system as needed.

Further information can be found on collection design in the EPA Alternative Collection System manual - <https://z.umn.edu/EPAAlternativeCollection>

Primary Treatment

Most wastewater treatment systems’ first process is the removal of solids. The primary purpose is to separate liquid wastewater from non-liquid waste

constituents. In individual and cluster onsite systems, liquid-solid primary treatment is provided by a septic tank. Because of greater flows and the multitude of inappropriate materials that get flushed down the drain, municipal systems have not just one but a series of processes that separate liquid wastewater from non-liquid waste products. This section focuses on liquid-solid separation technologies that are appropriate for residential and small community wastewater management systems. Primary treatment occurs in a tank that is configured and sized to accept the wastewater flow and retain it for the time required for the separation process to occur. Tanks will be termed primary tanks when serving a community and septic tanks when they serve an individual residence or other building.

Septic tanks allow gravity to separate solids from wastewater as heavier solids settle and fats, greases, and lighter solids float. The solids content of the wastewater is reduced by 60-80% within the tank. The settled solids are called sludge, the floated solids are called scum, and the liquid layer in between is called the clear zone, as shown in Figure 20.

The liquid enters the tank through the inlet baffle and displaces an equal volume out of the tank. Modern baffles are commonly referred to as sanitary tees when made of PVC pipe as shown in the figure. This baffle forces the water downward to encourage the settling of solids that are denser than water. Solids that are less dense than water will rise. Solids that sink become “sludge” on the bottom of the tank. Products

PRIMARY TREATMENT DEFINITION

Physical treatment processes involving the removal of particles, typically by settling and flotation

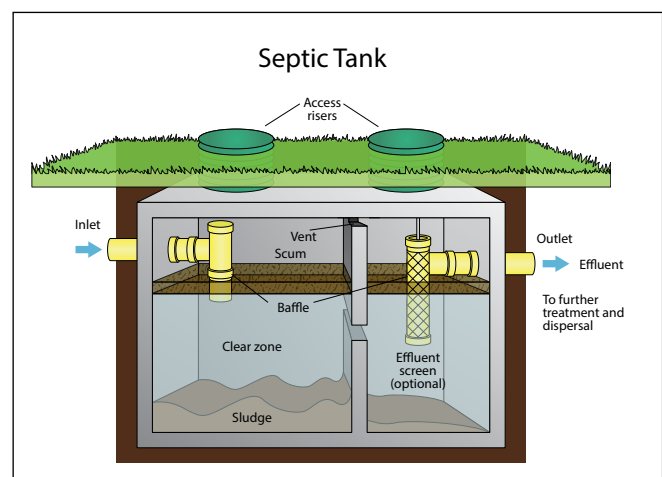


Figure 20. Septic tank with an effluent filter

that float become the “scum” layer. If the system is operating properly, the layer of water between the sludge layer and scum layer will have the lowest solids content – the outlet baffle is placed so that only water from this “clarified” zone is allowed to leave the tank. The accumulation of solids must be pumped out periodically so that the solids do not build up in the clarified zone. Today’s septic tanks include an effluent screen installed in the outlet end of the tank. The screen is designed to capture solids that may still be suspended in the effluent as it exits the tank. There are many different proprietary screens available in the market today and most are designed to capture solids in the range of 1/32 to 1/16 inch in diameter. Tanks fitted with effluent screens must have access at or near the finished grade to allow a service provider to remove and clean the screen on a regular basis.

Although the liquid in the clear zone is not highly treated, it is clarified compared to the wastewater entering the tank, the larger particles having migrated to either the sludge or scum layers. Another important function of the tank is the storage of these accumulated solids. The tank is sized large enough to hold solids until maintenance (i.e., tank pumping) is performed. Sedimentation and flotation are the primary processes occurring to remove solids. The primary residential sources of solids are the toilet and kitchen sink. Garbage should not be disposed of into tanks, but it must be accounted for in the process. Education programs are essential to help reduce the inappropriate disposal of facial tissues, sanitizing wipes, paper towels, cigarette butts, condoms, or personal hygiene products down the toilet. Limiting the amount of food particles that enter the system will minimize the load to the system. Garbage disposals are not recommended for homes with septic systems; garbage disposal owners should limit vegetables, meat, fat, oil, coffee grounds, and other undigested food products entering the system; best practices encourage either composting or throwing such items in the trash. Food waste from the sink is much harder for the bacteria to break down and when ground up may not settle well in the septic tank. Fats and oils should not go down the drain as they will accumulate in the collection system piping. Limiting the use of harsh cleaners and sanitizers will promote a healthy microbial community to digest wastewater contaminants.

Because centralized systems have higher flows and thus flush more inappropriate materials down the drain, they

have not just one but a series of processes that separate liquid wastewater from non-liquid waste products. The first step is often screening, which removes significant, untreatable, or unwanted materials before they cause problems in the treatment process. The simplest type of screen is a bar screen, which captures material between the bars; a rake is then used to manually clean the screen. The second step commonly involves a grit-removal chamber where wastewater is slowed enough for heavy solids to settle out. At the same time, lighter organics remain in suspension and flow to the primary treatment process. Materials collected in screening and grit removal are removed from the facility and brought to a landfill for disposal.

Septic tank solids include both biodegradable and non-biodegradable materials; although many of the solids will decompose, some solids will accumulate in the tank. Biological processes in the oxygen-deficient tank environment partially digest some wastewater constituents. These processes are slow, incomplete, and odor producing. This primary treatment can reduce the solids content by 60 to 80%. Because much of the material captured in the tank is organic, approximately 30 to 50% of the organic load is removed during liquid-solid separation. Effluent from primary tanks and septic tanks typically contains 140 to 220 mg/L BOD, 45 to 70 mg/L TSS, and 10-30 mg/L FOG. The performance of primary treatment components influences the nature (and performance) of subsequent components used in a treatment system.

The tank must be large enough to retain the wastewater in a quiet state to allow settling and flotation to occur. This concept is known as detention time and is an important design consideration. Excessive flow creates turbulence that can disrupt the settling process. Thus, tank volume, size, shape, and inlet baffle configuration are each designed to minimize turbulence and prevent the migration of solids to subsequent components. Accumulated solids are stored until they are periodically removed by pumping the tank. Septic tanks are pumped when solids occupy approximately 25 to 33% of the tank’s volume or on a regular schedule. The removed materials are known as septage. See the Collection – Sizing of Septic Tanks in this section for a discussion on sizing of septic tanks.

Commercial properties need larger tank capacity to deal with challenging waste streams. Commercial kitchens will often require an external grease

interceptor/tank to prevent excess fat, oil and grease from clogging pipes and accumulating in downstream components.

Primary tanks and septic tanks are installed below ground. Prefabricated tanks are available and may be constructed of concrete, fiberglass or plastic. Larger tanks may be built in place using reinforced concrete. It is important that the septic tanks are constructed of high-quality materials so that they remain structurally sound and watertight. In areas where shallow groundwater is present, tanks must be installed to prevent flotation. All tanks must have flexible, watertight seals at all locations where pipes enter and exit and a cast-in-place or mechanically attached access riser to grade with a tight-fitting lid.

Having access to components such as primary tanks is necessary and facilitated by large-diameter manhole access at grade. Some regulations may still allow septic system manhole lids to be buried with six to twelve inches of soil, but the general regulatory trend has been to bring risers to grade over each compartment as components need regular maintenance. These lids to grade must be secured to prevent entry and secondary safety restraints in the risers are recommended and required in some states to provide extra protection.

Maintenance

During design, the anticipated quantity of solids (septage) removed from septic and primary tanks can be estimated based on the expected pumping frequency and tank capacity. Septage can be either taken to a wastewater treatment plant or land-applied after treatment, with an appropriate permit. The disposal alternative should be identified during design. Community level management of all septic tanks is recommended to coordinate maintenance and assure it is completed.

Stored solids (septage or residuals) must be removed regularly. The source's usage level determines the removal (pumping) frequency. Service providers must have the knowledge and skills needed to measure the depth of sludge and scum to determine when tanks need pumping. A properly installed and operated primary or septic tank should require no chemical additives. Additives should not be used in septic tanks, as they are unnecessary and can resuspend solids, which then exit the septic tank and cause

problems in downstream components. See section 4 for more information.

Secondary Treatment

After primary treatment, dissolved and suspended organic matter remain in the effluent. If this organic matter is not removed before the effluent is dispersed,

SECONDARY TREATMENT DEFINITION

Biological and chemical treatment processes designed to remove organic matter and reduce pathogens

microorganisms in the receiving environment will begin to process it. As they consume organic matter, they also consume oxygen, creating an oxygen demand. The resulting low-oxygen (hypoxic) conditions harm the receiving environment, causing massive fish kills. In other situations where it happens gradually, fish populations will shift. Game fish, such as trout, require high dissolved oxygen levels to thrive. Less desirable fish species, such as carp, may thrive in low-oxygen conditions.

The function of secondary biological treatment systems is to create an aerobic environment that provides oxygen to naturally occurring microorganisms in wastewater, enabling them to consume organic matter before it is released into the environment. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen microorganisms consume during the degradation of organic matter. BOD is thus another standard indicator (along with total suspended solids (TSS) of how strong wastewater is and how much treatment it needs. Several treatment components can provide the aerobic conditions required for BOD and TSS removal. A summary of typical secondary treatment parameters for organic and solids is shown in Table 5.

Additional oxygen demand is exerted by other constituents in wastewater. The breakdown of discarded proteins releases nitrogen, phosphorus, and other compounds. As nitrogen is released, it is converted to the ammonium form (NH_4^+). Like organic matter, ammonium nitrogen creates an oxygen demand as microorganisms convert ammonium to nitrate (NO_3^-). The aerobic (oxygen-rich) conditions provided in secondary treatment components facilitate this conversion.

The limitations of the receiving environment often

determine which processes are needed for wastewater treatment. Most single-family wastewater systems use soil as both a treatment medium and a dispersal medium after liquid-solid separation in a septic tank. A site with deep, well-drained soil can provide all the necessary treatment (including pathogen disinfection). But if soils are shallow or poorly drained, additional processes are needed to remove constituents before dispersal occurs. Several treatment components can provide the necessary aerobic conditions for organic and solids removal. The primary difference among these components lies in how dissolved oxygen is supplied.

Secondary Treatment - Soil-Based Systems

Soil contains a complex biological community. One tablespoon of soil can contain over one million microscopic organisms, including bacteria, protozoa, fungi, molds, and other creatures. Bacteria and other microorganisms in the soil treat wastewater before it reaches groundwater. But the wastewater must pass through the soil slowly enough to provide adequate contact time with microorganisms. To provide adequate time for treatment of septic tank effluent, it is necessary to have sufficient aerated or unsaturated soil and to limit effluent loading. Microorganisms in soil treat wastewater physically, chemically, and biologically before it reaches the groundwater, preventing pollution and public health hazards. Under certain soil conditions, subsurface absorption systems may not accept wastewater or may fail to properly treat it unless special modifications to the system design are made.

Soil microorganisms need the same basic conditions as humans do to live and grow: a place to live, food to eat, water, oxygen to support metabolism, suitable temperatures, and time to develop. Soil

microorganisms attach to soil particles via microbial slime and use oxygen and water present in soil pores. Suitably textured soil must be deep enough to allow adequate filtration and treatment of the effluent before it is released into the natural environment.

The soil treatment area (STA) provides for the final treatment and dispersal of septic tank effluent. To varying degrees, the soil treatment and dispersal zone treats wastewater by acting as a filter, exchanger, or absorber, providing a surface area for many chemical and biochemical processes. The combination of these processes, acting on the effluent as it passes through the soil, treats the wastewater. A soil treatment area can only treat so much organic matter per square foot. An adequately designed STA receiving residential septic tank effluent will produce better than secondary effluent (see Table 5) twelve to eighteen inches below the bottom of the STA. If the STA is organically overloaded, its ability to treat organics completely is compromised. For example, commercial sources may have high BOD or FOG and require additional treatment to reduce the BOD to manageable levels for the STA.

Figure 21 shows a standard soil treatment method.

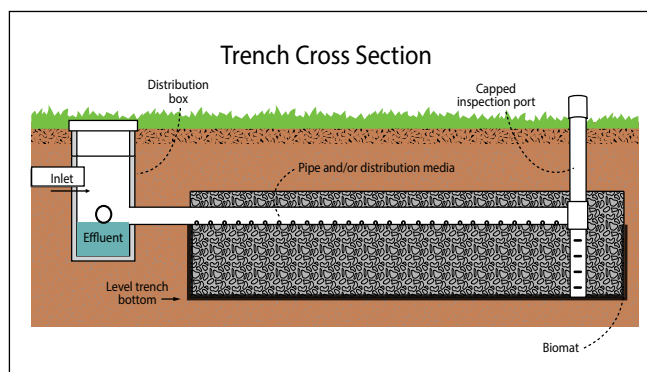


Figure 21. Cross section of a trench system

Table 5. Summary of secondary treatment standards for organics and solids

| Biochemical Oxygen Demand (BOD) | Total Suspended Solids (TSS) |
|--|---|
| Measure of how much oxygen microorganisms use up as they consume organic matter, expressed in mg/L | The measure of all suspended solids in a liquid expressed in mg/L |
| BOD is a common indicator of how strong wastewater is and how much treatment it needs | TSS is a common indicator of how strong wastewater is and how much treatment it needs |
| With secondary treatment this level should be below 30 mg/L | With secondary treatment this level should be below 30 mg/L |

Here, septic tank effluent flows by gravity through a distribution box and a pipe, and/or distribution media spreads the effluent across the trench. A biomat of bacteria forms to consume the organics present in the wastewater.

Historically, most systems used natural soil on site. Due to native soil limitations, increased regulations, and greater knowledge of soil science, more systems now use imported soil on site. Gravity is still the most common distribution method for the STA. Still, an increasing number of systems use a pump or siphon to provide uniform effluent distribution to the STA. With uniform distribution, the effluent is spread across the STA from day one, rather than waiting for a biomat to form. A separate dosing tank is required to house the pump or siphon. Figure 22 shows a mound system elevated with imported sand and a dosing tank.

STA requires appropriate site and soil characteristics, including sufficient depth of unsaturated soil between bedrock and a water table. This depth of suitable soil

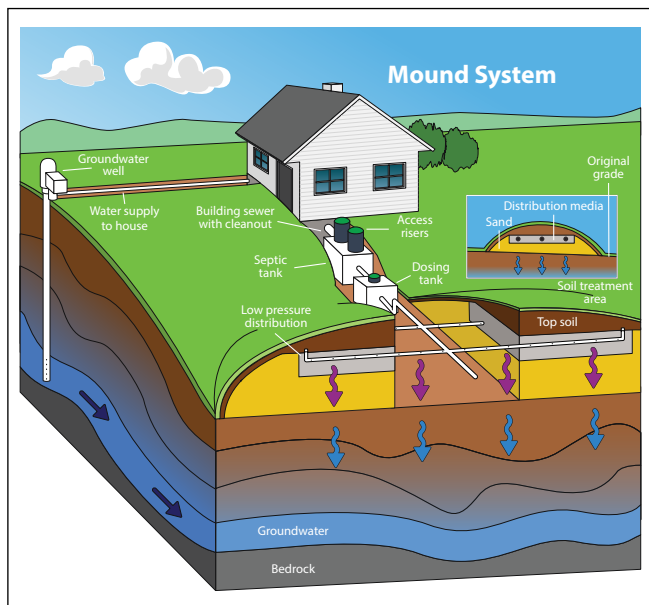


Figure 22. Mound system

ensures proper treatment and dispersal of the effluent. The area required depends on the soil type and depth. The typical sizing in state codes is called the loading rate and is measured in gallons per square foot of soil. Typical loading rates are shown in Table 6. These loading rates are based on primary treatment in a septic tank. Higher application rates may be permitted under certain regulations if the effluent has undergone advanced treatment prior to soil application.

Maintenance

During service visits when treatment components are being maintained, the service provider should evaluate the STA as part of inspections. This person should look for surfacing of effluent, signs of traffic over the system, excessive surface water collecting over the system, and any inappropriate vegetation growing over the system. When an inspection port is available, the ponding level in the distribution trenches should be measured. On pressurized systems, the pressure head should be checked, and the system serviced accordingly based on the results. If accessible, the distribution system should be evaluated for uniform effluent application across the soil treatment area. The pressure laterals should be flushed periodically to remove any accumulated biosolids.

Types of Secondary Treatment Units

The primary function of secondary treatment is to reduce oxygen demand by providing naturally occurring organisms with sufficient oxygen to process organic matter, ammonia-nitrogen, and other compounds present in wastewater before it enters the STA. Permit stipulations may permit aerobically treated effluents to be dispersed or discharged into receiving environments considered "high risk". Risk is based on the sensitivity of the receiving environment and the expected amount of additional treatment in that environment. A community may have the option to use subsurface soil dispersal, but the soil may be shallow

Table 6. Typical septic tank effluent soil loading rates

| Soil type | Typical Loading Rate (gallons/square foot) | Application Rate |
|-----------------|--|------------------|
| Sand | 1 – 1.2 | High |
| Loam | 0.5 – 0.7 | Medium |
| Silty/clay soil | 0.2 – 0.4 | Low |

with limited treatment capability. By applying aerobically treated effluent, the soil can more readily complete the treatment cycle and safely return the water to the hydrologic cycle. Likewise, if the effluent is discharged to surface waters, the lower oxygen demand will reduce environmental degradation as previously described. Nitrogen-sensitive areas can benefit from increased nitrogen removal, thereby protecting or improving surface and groundwater quality.

Aerobic Treatment Units (ATU)

Aerobic (oxygen-loving) bacteria are the workhorses of wastewater treatment. As part of their metabolism, they use oxygen to oxidize many organic compounds to carbon dioxide and water. The organic compounds serve as food to the bacteria, and the bacterial population will grow to match the food source. An ATU provides the dissolved oxygen needed to support the necessary population of active aerobic bacteria. A separate septic tank precedes some treatment units. Still, most systems designed for individual home use have an integrated tank that separates trash and paper products, replacing a septic tank, and allows solids to settle. This treatment device enables rapid decomposition of organic matter, reduces pathogens through a hostile environment, and converts nitrogen-containing compounds to nitrate. There are many brands and configurations of ATUs. An example is shown in Figure 23.

All ATUs have a device that delivers air into the water being treated. Oxygen (contained within the air) will dissolve into the water and create aerobic conditions. Depending on the manufacturer, the aeration system may be a blower, a compressor, or an aspirating

propeller. The aeration process also mixes the contents of the ATU tank, ensuring good contact between the organic compounds and the bacteria. This process is called suspended growth because the dense population of aerobic bacteria is suspended in the effluent by the aeration system's mixing action. The other common type of ATU is attached growth, in which a submerged, fixed-growth medium supports microorganisms on a fixed surface to which wastewater is applied. The effluent from an ATU can be discharged to a soil treatment area (see Figure 24) or, after disinfection, to surface water in some jurisdictions.

A typical ATU includes aeration basins filled with effluent into which air is injected. Air injection mixes the tank contents and dissolves oxygen into the effluent. The mixing action brings the suspended microorganisms or media into contact with the organic matter (food) and dissolved oxygen (fuel). Because there is plenty of food and dissolved oxygen, microorganisms thrive and concentrate within the basin, either in groups (floc) or on the media. The microbes oxidize the organic matter to carbon dioxide, produce new microbes, and form insoluble matter (residuals). The mixing of effluent, organic matter and air in the same basin is known as the activated sludge process and the concentrated mass of microorganisms is called biomass. Most ATUs appropriate for small communities or individual homes operate in extended aeration mode. Extended aeration is achieved by keeping wastewater in the basin for an extended period while providing ample air and a limited amount of food (organic matter) to the organisms. If sufficient dissolved oxygen is supplied and minimal food is available, the microbes

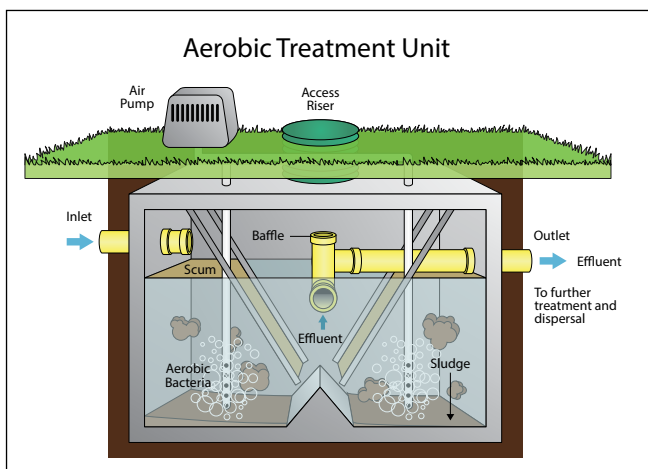


Figure 23. Aerobic treatment unit

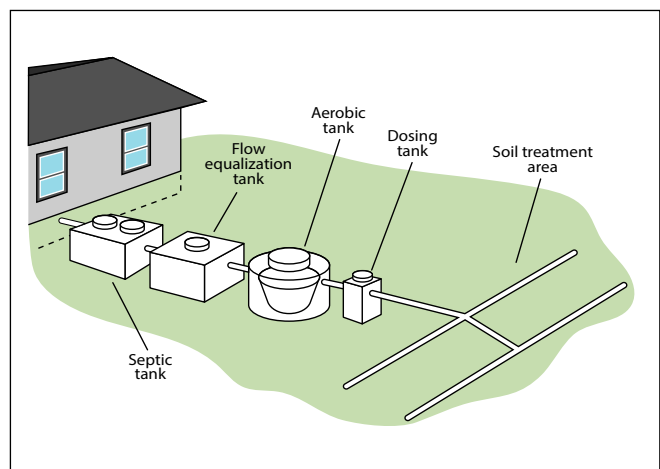


Figure 24. Residential ATU system layout

will readily consume organic carbon – including each other. The advantages of extended aeration include excellent organic carbon removal and high conversion of ammonium-nitrogen to nitrate (nitrification). The primary disadvantage is the higher electrical consumption needed for aeration. The most common ATU configurations are discussed below.

1. Complete-mix Suspended Growth - Typically, a complete-mix suspended growth aerobic treatment system is composed of a primary treatment basin (aeration chamber) where bacteria, organic matter, and effluent are mixed by the turbulence created by air injection. A second chamber (clarifier) provides quiescent conditions to allow biomass to settle. The two chambers may be separate tanks or combined into a single tank, as shown in Figure 25.
2. Sequencing Batch Reactors (SBR) - A sequencing batch reactor (SBR) provides treatment using one chamber. As the name suggests, processes occur in a particular order to provide aeration and biomass separation. These include filling the chamber, aerating the effluent, allowing the biomass to settle, pulling out the clarified effluent (decanting), and then denitrification in anoxic conditions. This is a batch operation, which means that storage must be provided for sewage that arrives while sequential operations are in progress. The SBR process provides some flow equalization and adjusts the quantity and strength of wastewater inflow, as shown in Figure 26.
3. Membrane Bioreactors (MBR) - Membrane Bioreactors include activated sludge components but use membrane filtration units to separate

biomass from effluent. First developed in the 1960s, MBRs have undergone significant modifications since the late 1990s, resulting in a more robust and practical membrane filtration unit. Unlike the suspended-growth configurations previously mentioned, MBRs do not rely on gravity (settling) to separate the biomass from the effluent. With membrane filtration, the time and space required for biomass separation are significantly reduced. MBR systems can thus treat a greater volume of water and occupy less space than conventional suspended growth systems. However, the increased treatment capacity is accompanied by higher electrical costs because greater aeration and pressurization are required to operate an MBR at its full potential (see Figure 27).

4. Fixed Film and Integrated Fixed-Film/Activated Sludge (IFAS) - When fixed film and suspended growth configurations are combined in the same aeration chamber, the configuration is referred to as an IFAS system. The aeration chamber contains media that serves as a substrate for biofilm development. The media is typically fixed in one location and is made of plastic or another synthetic solid material. The media that will support the attached growth of biomass on its surface and within its porous structure. Wastewater comes into contact with the film containing the fixed active biomass by being pumped past the media or by mixing within the tank. This biofilm will digest waste and slough off as it thickens, requiring periodic removal. Figure 28 shows an IFAS ATU.

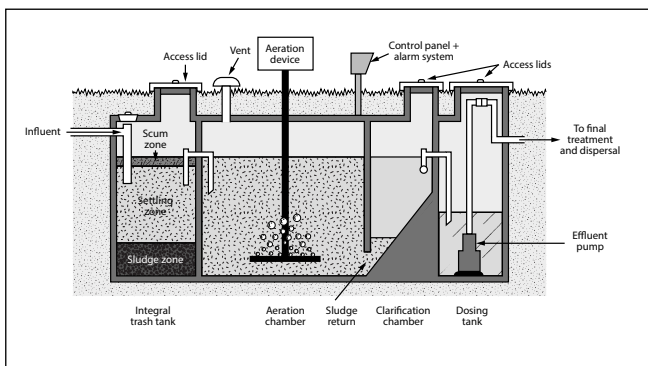


Figure 25. Suspended growth ATU with built in septic and dosing tank

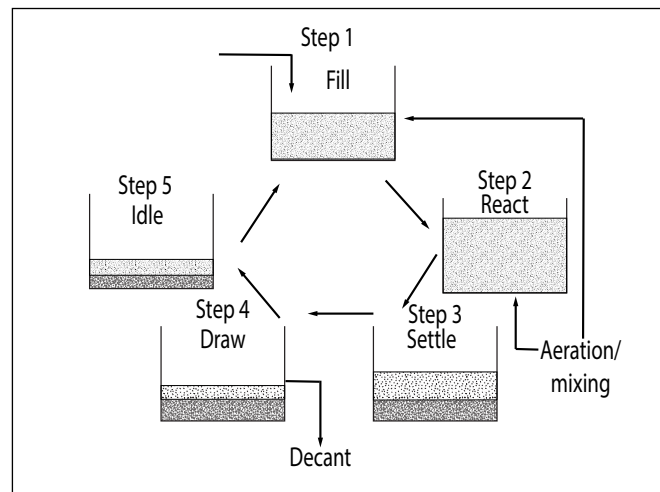


Figure 26. Sequencing batch reactor

In all cases, after aeration/mixing, the effluent enters a quiescent zone (clarifier), where the bacteria settle to the bottom. The clarified effluent then proceeds to the next phase of treatment or dispersal. As biomass accumulates, it is periodically removed (either automatically or manually). The removed biomass becomes a residual that can be taken to a landfill, applied to farmland, or subjected to further treatment.

Maintenance

The maintenance provider must understand the processes and equipment. With proper design and a rigorous maintenance program, an ATU will perform well and treat effluent reliably for an extended period. The frequency of maintenance provider visits varies with the volume of wastewater treated and the risk to the receiving environment. Residential systems typically require semi-annual maintenance, including solids removal as needed. Cluster development and community systems require more frequent visits. Many modern control panels support cellular telemetry, allowing maintenance providers to view system status remotely.

However, this does not eliminate the need for hands-on O&M at a reasonable frequency. A service provider performs a general assessment of the unit. These procedures include verifying that the air supply is operable and visually inspecting hoses and clamps, and observing bubbling action during the visit. A dissolved oxygen meter or kit is used to ensure that conditions are aerobic. During maintenance, an examination is performed to determine if the settled biomass needs to be removed. Biomass is typically

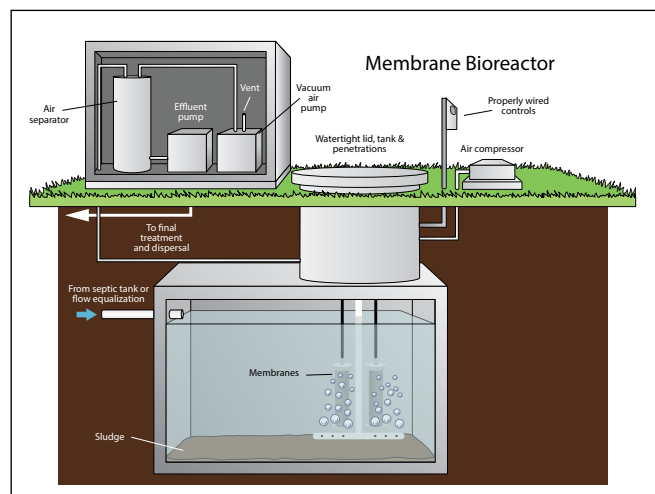


Figure 27. Membrane bioreactor

removed when the settling chamber is more than one-third full. This must be strictly observed to avoid excessive accumulation of residuals that could carry over to the next component. Filter cleaning and debris removal are also performed during a maintenance visit.

Media filters

Media filters use sand, peat, coconut husks, gravel, or a textile to provide a surface for aerobic bacteria to attach. This is a different configuration than the ATUs and the media is not submerged. Instead of mechanical aeration, media filters provide aeration by trickling water through the media, where oxygen, nutrients, and organic compounds diffuse through the biofilm formed by attached bacteria. Media filters provide excellent removal of organic matter, reduction of pathogens due to the hostile environment, and conversion of nitrogen compounds to nitrate (nitrification).

A media filter provides an environment with many attachment sites that allow microorganisms to grow and thrive. The media's porosity promotes the easy movement of effluent and air. As effluent flows past the attached microorganisms, they come into contact with the wastewater constituents. Because of the aerobic conditions resulting from 'dosing and resting' the porous media, conditions are favorable (aerobic) for the microbes to consume the dissolved organic matter in the effluent and convert ammonia nitrogen to the nitrate form through oxidation.

A media filter consists of a watertight container, an underdrain, filter media, a distribution network, and a control system. Frequently (one to twenty times per day), a small volume of wastewater is distributed across the top of the media. The liquid flows through the media, collects in the underdrain, and either proceeds to the next treatment component or is

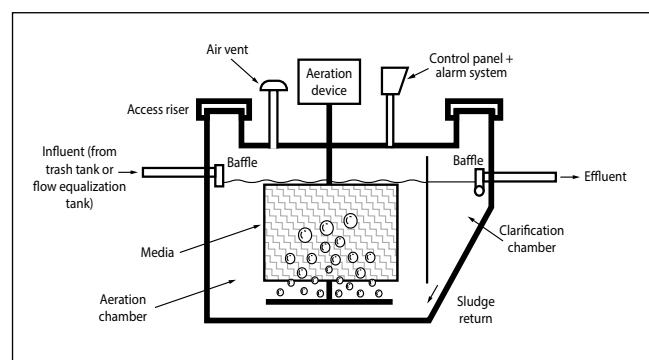


Figure 28. Integrated fixed film/activated sludge

recirculated for further treatment. In some cases, the media filter is placed directly over the dispersal area and effluent is allowed to weep out of holes in the bottom of the unit. This configuration is only used where soil conditions are appropriate for this application (i.e., well drained soils with sufficient depth to provide final treatment and disperse the liquid). In most applications the media in the filter is about 24 inches deep but can be as deep as 48 inches. Media filters can be constructed at the site or purchased as prefabricated units.

Media filters can be designed to operate in single-pass mode or recirculating mode. In single-pass media filters (SPMF) effluent trickles through the media one time before being transferred to the next treatment component. SPMFs provide excellent BOD and suspended solids removal as well as nitrogen oxidation. As the name suggests, recirculating media filters (RMF) re-circulate the effluent through the media and recirculating tank several times before it is conveyed to the next treatment component. RMFs utilize coarser media that allow for relatively high loading rates (three to eight gallons per square foot per day). A SPMF typically uses finer media and is loaded at a lower rate (one to two gallons per day per square foot). This means that a SPMF will have a larger footprint than a RMF. A RMF will include additional piping and tanks for effluent recirculation. A diagram of a generic RMF is shown in Figure 29.

The primary advantages of RMF include more complete BOD reduction, additional nitrification, and the potential for some degree of denitrification. After

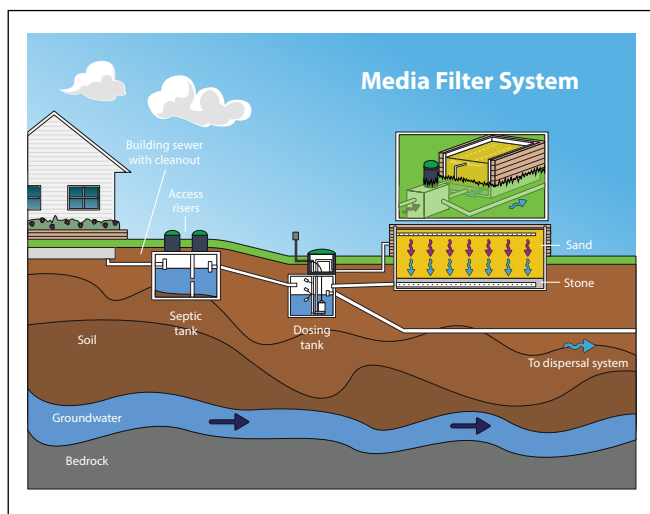


Figure 29. Recirculating media filter

the wastewater passes through the media, the flow is split. About 20-25% of the effluent flows to the next treatment component or to a dispersal component. The rest of the flow is directed to a recirculation tank and blended with wastewater that has received only primary treatment (liquid-solid separation). The nitrate-rich effluent from the media filter is thus subjected to conditions favorable for denitrification (low oxygen and an available organic carbon source). The nitrate is converted to nitrogen gas and released to the atmosphere. Removing nitrogen is important in environmentally sensitive areas or where nitrates may enter drinking water supplies and affect the health of young children and some adults. Many recirculation regimes are possible depending on wastewater characteristics and treatment goals.

This treatment technology is easy to scale up for higher flow rates and is commonly used in clustered housing developments and small communities. As wastewater volume increases, additional media or trickling filters can be added to the system. Whether built-in-place or modular, the components can be scaled in size or number to accommodate increased wastewater volume. Modular commercial systems offer several advantages over built-in-place systems, including a more straightforward installation process.

Typically, the effluent is discharged to a separate area, but in some applications it may drain out the bottom, as shown in Figure 30.

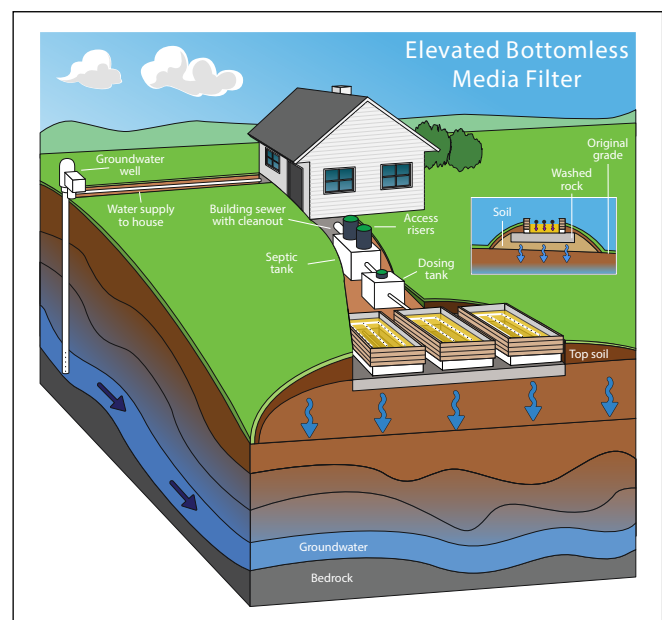


Figure 30. Bottomless media filter

Maintenance

Most fixed growth media filters incorporate one or more pumps and a distribution component. These components must be regularly inspected and serviced as needed. Control settings must be periodically verified and adjusted. Maintenance of the media container itself includes regular inspection for structural integrity and adequate ventilation. If multiple units are operating in parallel, the uniformity of distribution within and among units must be verified. Biosolid formation (bacterial overgrowth on the media) tends to be slower in media filters; however, accumulation will occur over time and can clog the media's pore space. Media filters must be regularly inspected to ensure that effluent is not ponding on the surface. If the media become clogged and rejuvenation methods are unsuccessful, the media must be removed and replaced. Natural media such as coconut husks or peat degrade over time and will need replacement. Professional service providers perform the necessary maintenance to keep the media filter operational.

Constructed Wetlands

As the name suggests, constructed wetlands (CWs) are small wetlands engineered for wastewater treatment. A gravel bed is built within a watertight liner (either a plastic membrane or highly compacted clay), and wetland vegetation is planted within the gravel bed. The water level is maintained at or just below the top of the gravel bed. Aeration is provided by atmospheric oxygen that crosses the interface between the air and water and by the release of oxygen via photosynthesis by algae and the roots of green plants submerged in the water. Reaeration is a slow process in constructed wetlands. This means the system must have a larger footprint than mechanical systems such as ATUs and media filters.

Constructed wetlands are passive wastewater treatment components used to produce secondary (and in some cases, tertiary) effluent. At a minimum, incoming effluent must have undergone primary treatment. There are two different types of constructed wetlands. Free-water surface (FWS) wetlands are wetlands with vegetation grown on the bottom sediments and flooded to a specific depth. Subsurface flow (SF) vegetated bed wetlands also use vegetation, but effluent flows beneath the surface of the bed rather than on top of it. Each configuration has its own advantages and applications. A SF wetland is shown in Figure 31.

Constituent removal in constructed wetlands occurs through a variety of processes. BOD is removed by microbial activity, and the emergent plants help to trap and settle particulate matter suspended in the wastewater. Nitrogen can be removed temporarily by plant uptake and permanently by providing optimal conditions for microbes that convert ammonium to nitrate (nitrification) and then convert nitrate to nitrogen gas (denitrification). A FWS wetland may be specifically designed for nitrogen removal if appropriately sized. Phosphorous will be removed during start-up through adsorption, and temporarily by plant uptake. Plant uptake of phosphorous during the growing season is rapid, but the phosphorous is released back into the water as soon as the plant dies. Phosphorous can also be released during other times of the year, usually in response to changing conditions within the system. Pathogenic bacteria and viruses are removed in constructed wetlands by adsorption, sedimentation, predation, and die-off from exposure to sunlight with FWS and unfavorable temperatures. Constituent removal is similar to any secondary treatment process if appropriate levels of maintenance are provided.

Constructed wetlands are generally not recommended for systems that treat large wastewater volumes due to the large land area required. Onsite, cluster, or small community scale systems are most appropriate. FWS wetlands are used for secondary treatment, polishing of secondary effluent, and providing wildlife habitat. Using parallel cells allows the operator to vary the flows and balance the loading on the individual cells to create appropriate treatment environments. The plants add little oxygen but do provide microsites

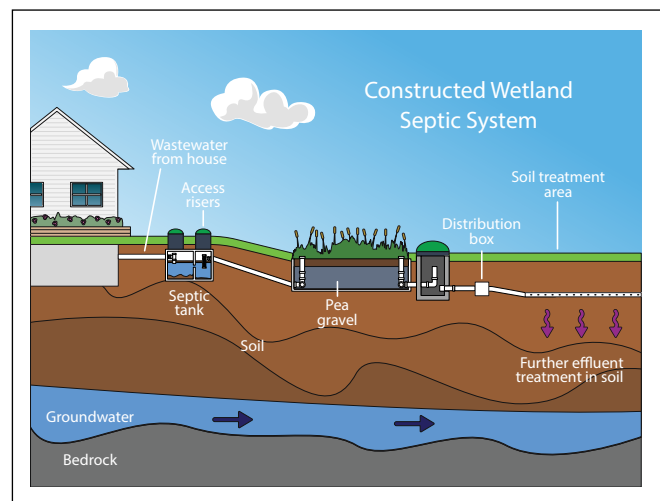


Figure 31. Free surface constructed wetland

which may assist in treatment. The plants also provide an aesthetically pleasing treatment unit but do require special maintenance.

Maintenance

Flows must be balanced, and water levels in the wetlands adjusted occasionally. In some climates the vegetation must be regularly harvested. Typical challenges in wetlands are caused by excess organic loading which turns the wetland anaerobic causing odors and potentially killing the emergent vegetation. Excess solids will create problems for emergent vegetation if allowed to settle in the FWS wetlands.

Lagoons

A lagoon is a passive method of providing secondary treatment of effluent. It is a constructed water body that is designed to receive liquid effluent and detain the effluent for 20 or more days as waste constituents are being removed. Some documents and regulations may refer to this treatment method as a pond.

Lagoons are used for residential (in some jurisdictions), small commercial and small community applications that have suitable, available land. If sufficient land is available, lagoon systems could service flows as large as a million gallons per day. Lagoon systems perform best when there are multiple (usually three or more) cells in series and some regulations require three cells.

Single cell lagoons are allowed in some states for single-family residential purposes as shown in Figure 32. Multiple cells maximize treatment by ensuring slower effluent progression through the system. Lagoons can produce effluent that approaches secondary treatment standards for BOD. TSS is less reliably removed. Lagoons can be a lower cost solution for treating wastewater generated by a small community.

Lagoons provide treatment through physical and biological processes. The rate at which aerobic microorganisms oxidize organic matter is limited by the concentration of dissolved oxygen in the water, so lagoons are typically shallow, with a large surface area (typically measured in acres). The surface area provides a large interface with the atmosphere, promoting oxygen transfer into the bulk solution (natural aeration). Because most lagoons are large, quiescent water bodies, liquid-solid separation (primary treatment) also occurs. However, for small single-family systems, it is strongly recommended that a septic tank be used

upstream of the lagoon to remove solids. A dispersal component is needed for the lagoon effluent.

There are several lagoon configurations. The differences among them primarily relate to their design depth, external inputs, and influent and effluent characteristics. Reducing total nitrogen is desirable in environmentally sensitive areas, and the chosen design will reflect that requirement where required.

Facultative lagoons are the most common configuration for small community applications. They are typically three to eight feet deep, with detention times greater than 30 days. "Facultative" means that both aerobic and anaerobic conditions are present. A facultative lagoon system forms three layers with respect to dissolved oxygen. The top layer is aerobic, the bottom layer is anaerobic, and the middle layer is facultative. Much of the organic matter is oxidized in the top layer. Dead bacterial cells and other materials that are difficult to degrade will settle and form a sludge layer on the bottom of the lagoon. This anaerobic layer allows for continuous, slow degradation. Anaerobic degradation processes produce odors due to volatile fatty acids formed under low-oxygen conditions. A particular advantage of facultative lagoons is that the aerobic layer can degrade many of these odorous compounds before they are released to the atmosphere, thus reducing the potential for odors. The three layers provide a very hostile environment for pathogens. Having both aerobic and anaerobic conditions encourages the die-off of microorganisms not adapted to this environment and enables nitrogen removal through nitrification/denitrification.

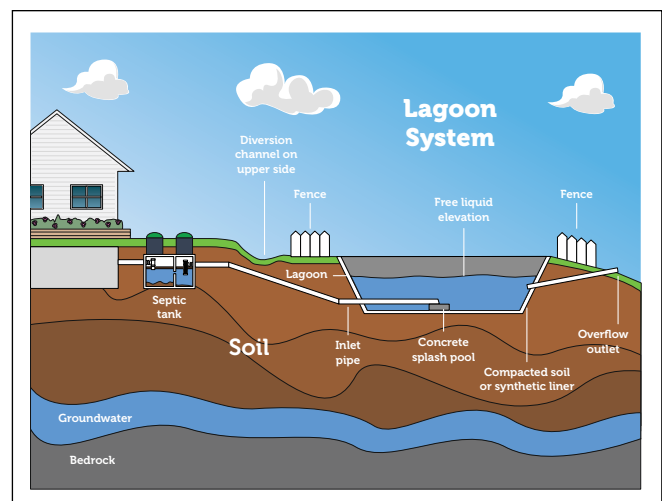


Figure 32. Single cell residential lagoon system

An aerated pond system is a lagoon with mechanical aeration. Aerated ponds are typically fifteen to twenty-five feet deep and have a 20–40-day detention time. In a two-cell system, the first cell is aerated and completely mixed. The second cell is only aerated for the first 2/3 of the cell length. The last 1/3 is quiescent to promote settling of solids before discharge. It is common for these ponds to produce a high amount of total suspended solids or TSS (in excess of 30 mg/L). Because of the mechanical aeration used, these types of lagoons can have a much smaller footprint.

Maintenance

Facultative lagoons have relatively low maintenance requirements since there are no moving parts. If they are loaded at recommended levels, they should not require solids removal for eight or more years. Anaerobic digestion slows the accumulation of organic solids. Aerated pond systems have aerators that must be maintained. Both types of lagoons require sludge removal.

In cold climates lagoons require extra care. Water depth is an important consideration in cold climates as having the water level too low may kill off the needed bacteria for treatment. Aeration methods cannot be used during winter months if the ponds are frozen at the surface.

A primary maintenance issue with all lagoons is related to the physical structure and the surrounding vegetation. Woody vegetation must be prevented from growing in the berms that support the lagoon. Roots can create a pathway for water that may cause the berm to fail. Commonly the vegetation growing along the water line is sprayed using a lagoon safe chemical. Vegetation allowed to grow impedes wind over the surface of the water resulting in lower natural oxygenation. For the same reason, burrowing animals must be excluded. Fencing and signage around a lagoon must be maintained to prevent unauthorized access. The rip rap (usually rock) must be maintained also. Over years, it can start sluffing down into the pond, exposing the berm. Maintenance should be performed to ensure rip rap is in the proper place to ensure longevity of the berm.

Tertiary Treatment

Treatment of nutrients and pathogens, and subsequent

treatment of organics and other contaminants, is referred to as tertiary treatment. The breakdown of organic compounds releases nitrogen and phosphorus. These two compounds are considered nutrients (fertilizers). When excess nutrients are discharged into a surface water body, excessive growth of algae and other photosynthetic organisms can occur, degrading water quality. Furthermore, the nitrate (NO_3^-) form of nitrogen is considered a human toxin when present at excessive levels in drinking water.

Large populations of (non-pathogenic) coliform bacteria live in the human intestinal tract, a portion of which are regularly discharged from the body during a bowel movement.

TERTIARY TREATMENT DEFINITION

Advanced treatment of wastewater for enhanced organic matter removal, pathogen reduction, and nutrient removal

Since it is impractical (if not impossible) to measure for the presence of all disease-causing organisms, water samples are often tested for fecal coliform bacteria to determine whether water has been contaminated with sewage. If coliform bacteria are detected in a water sample, it indicates that pathogens (from sewage) are likely present. Disinfection reduces the number of pathogenic organisms, thereby lowering the probability of disease transmission. If indicator coliform bacteria are present at low levels after disinfection, the water is considered safe. Note that disinfection does not make water sterile. It simply means that the number of pathogens are below a certain level and considered safe. Disinfection is generally the last treatment process before effluent dispersal.

Nutrient Treatment

Both nitrogen and phosphorus are essential elements for microorganisms. During treatment, some nitrogen and phosphorus is incorporated into new cells. When these cells are removed with other solids some nitrogen and phosphorus is also removed. If additional nitrogen reduction is required, other processes can be incorporated into treatment systems. Additional phosphorus can be removed through chemical precipitation using metals (such as aluminum or iron) which react with soluble phosphate to create an insoluble form that can be removed as part of the sludge. Many soils have the capacity to sequester (tie-up) phosphorous. The relative capacity for this is dependent upon the soil mineralogy.

Nitrogen Treatment

Wastewater can contain several nitrogen species: nitrate, nitrite, ammonia, and organic nitrogen. These nitrogen compounds result from the biological decomposition of proteins and from urea, which are discharged as human waste. Primary treatment can remove about 10% of the total nitrogen in wastewater through solids separation. The nitrogen that remains after primary treatment is primarily in the ammonium form.

In soil-based systems that receive septic tank effluent, nitrogen will undergo several transformations within and below subsurface soil dispersal components.

The ammonium nitrogen may be taken up by plants or volatilize to ammonia gas under high pH conditions in alkaline soils. Ammonium nitrogen may also be biologically converted to the nitrate form. The process of converting ammonium into nitrate is called nitrification.

Like ammonium, nitrate is plant available; however, it is also very water soluble and will tend to move downward to the groundwater and into nearby surface water. Denitrification is the process of converting nitrate into nitrogen gas, which is released to the atmosphere. This nitrogen reducing process can occur in treatment processes or in the soil if there is sufficient carbon present and if low oxygen conditions exist. Under these circumstances, microorganisms can convert nitrate to nitrogen gas.

In order for any treatment system to provide predictable nitrogen reduction, the system has to be carefully managed. From the perspective of biological processes, there are two limiting factors. The first is that the microorganism that convert nitrate to nitrogen gas need conditions with low (or no) dissolved oxygen. Secondly, these microorganisms need a source of organic carbon. Creating these denitrifying conditions is problematic because most of the organic carbon was removed during aerobic treatment, which also created the nitrate. A successful solution to this problem is to recirculate a portion of the nitrate-rich water back through a primary treatment component. This places the nitrate in a low oxygen environment with sufficient carbon to stimulate the organisms that conduct the denitrification process. Passive treatment components such as lagoons and constructed wetlands also provide conditions conducive to denitrification by having aerobic zones near the air-water interface and anaerobic zones near the bottom. In cases where organic carbon remains a limiting factor,

a medium containing bioavailable organic carbon may be placed in the anaerobic zone, or an external carbon source (e.g., methanol) can be added to the reactor.

Nitrogen uptake can occur in shallow systems such as low-pressure pipe, drip dispersal, or spray irrigation where the vegetation can utilize the nutrients. There are also mounded systems or systems with carbon buried in the soil which create the environment needed for nitrogen removal. Some systems can be designed to remove nitrogen by recycling effluent back to the septic tank or processing tank as shown in Figure 33.

Maintenance

Nitrogen reduction is a multiple-step biological process. Maintenance providers must ensure that environmental conditions are appropriate for these processes. The conversion of ammonia to nitrate (nitrification) requires aerobic conditions, and a by-product of this conversion is acid. Thus, maintenance providers need to frequently monitor dissolved oxygen concentration and pH. Converting the nitrate to nitrogen gas requires anoxic conditions and easily available organic carbon. In some situations, methanol or another carbon source is added. Alkalinity increasing compounds may be added to support biochemical reactions.

Phosphorous Treatment

Forms of phosphorus (P) include orthophosphate, polyphosphate, and organic phosphate. Organically bound phosphorus originates from human waste and food scraps. Upon biological decomposition, organically bound phosphorus is released as orthophosphate. Polyphosphates are used in synthetic detergents and often account for up to one-half of the orthophosphate in wastewater. In raw sewage, the concentration of phosphorus is usually between 5 and 15 mg/L as P. Acceptable levels in sensitive natural water systems may vary from 0 to less than 1 mg/L.

Because phosphorus is a component of many organic solids, liquid-solid separation reduces phosphorus. In

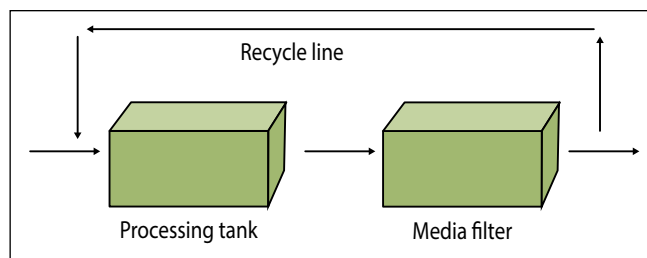


Figure 33. Recycling of effluent for nitrogen removal

soil-based dispersal systems, phosphorus is adsorbed by calcium, aluminum, and iron compounds as well as by clay minerals. These minerals are positively charged, and because phosphate is negatively charged, it will adsorb to these sites via electrostatic and chemical interactions. The capacity for P removal is based on the available surface area, soil mineralogy, and the pre-saturation soil depth.

With shallow application of effluent via low-pressure pipes, drip irrigation, or spray irrigation, vegetation may utilize phosphorus.

For systems with insufficient soil or that discharge directly to surface water, chemical treatment is standard. Phosphorus can be removed by chemical precipitation with metals (such as aluminum or iron), which react with soluble phosphate to form insoluble precipitates, producing a sludge byproduct rich in phosphorus that still needs to be managed. Large systems will require chemical storage, metering pumps, and control systems to ensure the proper dose of chemical is being added. On a smaller scale, technology exists where tablets can dissolve aluminum sulfate or electrocoagulation can release iron or aluminum all of which will bind with phosphorous. The phosphorus rich sludge will need to be periodically removed from the tank. The other option for phosphorus removal in decentralized systems is the use of reactive media which is designed to absorb phosphorus. Typically, iron or calcium is installed in a contained cell that can be replaced when saturated with phosphorus.

Phosphorus reduction through wasting of biomass from suspended growth systems (i.e., when solids are pumped from an ATU or activated sludge treatment component) can be improved through a process called luxury uptake. With modifications and proper management, the microorganisms in the treatment system can be 'tricked' into higher uptake levels of phosphorus than normal. This biological nutrient removal (BNR) process can reduce phosphorus to three-five mg/L but requires significant expertise and attention to be successful. Phosphorus reduction is unnecessary in most soil-based treatment systems.

Maintenance

Phosphorus removal through BNR is a viable option, but for small community systems, this is a complicated process to maintain. It is generally recommended that if a community has a phosphorus permit limitation, then

chemical methods should be investigated. Chemicals such as calcium, iron or aluminum coagulants can be added to the effluent on a continuous basis. This mixture reacts with the dissolved phosphorus and forms a solid known as a precipitant. Operation and maintenance of this system will require a person knowledgeable in setting chemical dosage, the purchase and handling of the chemicals, and management of the accumulated solids. If reactive media is used, it will need to be replaced when saturated. Sampling and analysis may be required to measure performance.

Disinfection

The goal of disinfection is to reduce the number of pathogens in the treated effluent thereby reducing the risk of disease transmission. Small wastewater systems tend to focus on filtration, predation and natural die-off in the soil, cell-wall destruction by chlorine, and disruption of reproduction by ultraviolet light radiation (UV). Soil has a significant capacity to disinfect effluent through filtration, adsorption and predation of pathogens. Chlorine is a very strong oxidizer and breaks down the cellular structure of microorganisms. Ultraviolet light is used to irradiate microorganisms and damage the DNA and RNA such that they are unable to reproduce.

Soil for Disinfection

For many human-based pathogens, the soil is a hostile environment. The body of a mammal is warm, moist, and contains the nutrients needed for pathogen survival. In contrast, soils are cool, have wet-dry cycles, and contain predatory organisms. As effluent moves through unsaturated, aerobic soil, most pathogens are removed by physical filtration and adsorption. They become attached to soil particles, become immobile in the environment, or die. Provided that soil-based dispersal systems are correctly sited and installed, pathogen disinfection is highly effective in the soil. The options and management for soil treatment are covered in the next part of this section – Final Treatment, Dispersal and Reuse.

Chlorine for Disinfection

Chlorine disinfects by diffusing through cell membranes and destroying enzymes that facilitate the organisms' bodily functions. Depending on effluent flow and mixing characteristics, this process generally requires 20 to 60 minutes of contact time to achieve typical chlorine concentrations. If adequately applied, chlorine

can be quite effective in the destruction of bacteria. However, six to seven times more chlorine is required to destroy viruses than that needed to destroy bacteria. Furthermore, the destruction of *Giardia* cysts and *Cryptosporidium* oocysts may require eight to ten times more chlorine due to their resilience. Chlorine can be used as a gas, a liquid, or in tablets. Gas and liquid forms are typically injected into effluent. Tablet chlorination passes the effluent through a chamber that contains the tablets. Regardless of the chlorine form used, there must be adequate mixing and contact time between the disinfectant and the effluent for disinfection to be effective (see Figure 34).

Depending on the effluent dispersal method (or permit requirements), it may be necessary to remove the residual chlorine that remains after disinfection. This dechlorination requirement is essential when effluent is discharged to surface water because of the potential negative impacts of chlorine on aquatic life. Dechlorination is a chemical process that uses sulfur compounds (typically either sodium bisulfate or calcium thiosulfate) to react with the form of the chlorine that could affect surface waters. Residual organic compounds and solids can interfere with the disinfection process. Since chlorine will also oxidize residual organic compounds, these compounds must be reduced to a reasonably low level through prior treatment so that the chlorine can act primarily upon the pathogens.

A routine operation and maintenance (O&M) schedule must be developed and implemented for any chlorine disinfection system. For individual residences, monthly O&M includes inspecting the feeder for damage,

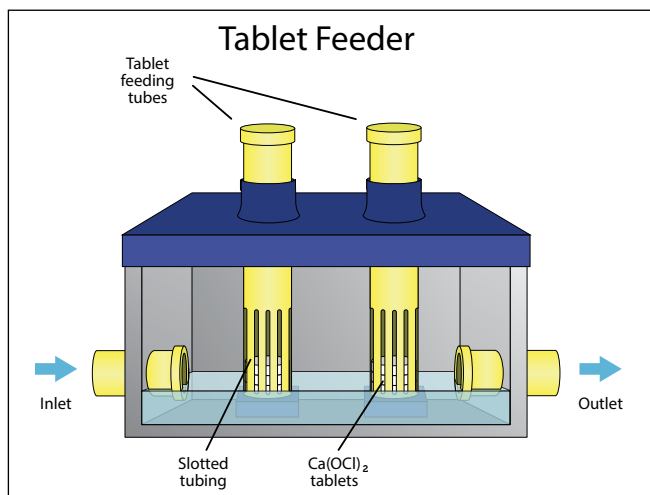


Figure 34. Tablet chlorinator

ensuring that tablets are present and in contact with the effluent and that contact time is sufficient for effective treatment. Chlorine residual in the effluent must also be measured. For larger treatment facilities, operation and maintenance activities for liquid and gas chlorination systems are significantly more complicated. Components such as meters and floats must be periodically disassembled and cleaned. Valves and springs must also be inspected and cleaned. Injector pump performance must be verified and maintained. Safe storage of liquid or gaseous chlorine is of paramount importance. If dechlorination is required, maintenance providers essentially have two chemical systems to operate and maintain. Sampling and analysis for indicator organisms is typically required to measure performance.

UV for Disinfection

Disinfection by UV radiation occurs when a specific band of electromagnetic energy from a source (e.g., a UV lamp) penetrates an organism's genetic material (i.e., DNA and RNA), retards its ability to reproduce and eventually causes death. UV radiation is generated by passing an electrical discharge through mercury vapor to produce light in the wavelength range of 250 to 270 nanometers (nm). This radiation range is optimum for pathogen inactivation. The electromagnetic waves are limited in how far they can effectively penetrate into water. UV systems are typically designed to pass effluent through a long narrow chamber, which has a UV source placed along the long axis. Wastewater

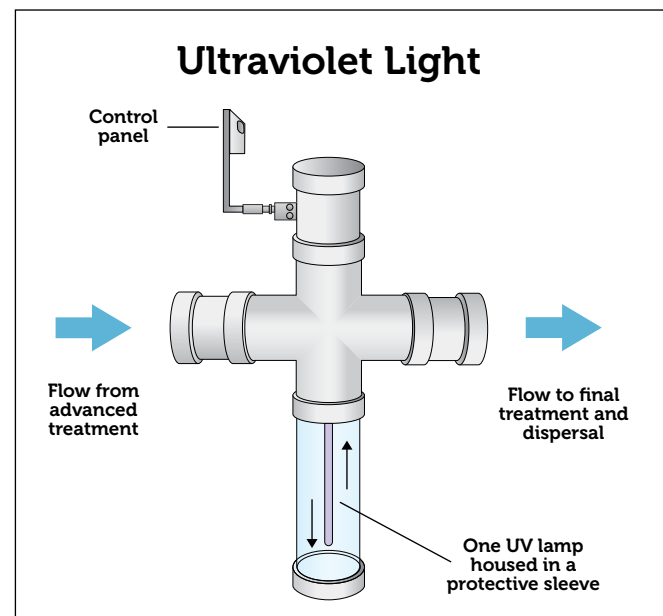


Figure 35. UV light for disinfection

flows around and close to the source (see Figure 35).

The length of the chamber and the flow rate through the chamber determines the length of time the effluent is exposed to the UV radiation (dosage). In order for UV disinfection to be effective, the influent must have low turbidity (be relatively clear) to allow the transmission of UV rays into the water. UV disinfection is only effective if effluent has received both primary and secondary treatment.

Over time, emissions from UV lamps begin to fade. Because of this strength degradation, lamps must be replaced regularly. Manufacturers provide UV meters that provide a read out of the emission strength, but these are somewhat unreliable. For residential applications, the replacement interval is typically one year. Larger units require lamp replacement about every 12,000 hours of use. This is typically an annual task. Ballasts and transformers must also be replaced every five to ten years and quartz sleeves that shield the lamps must be replaced every two-five years. Depending on mechanical cleaning arrangements, O&M visits may vary from one to four times per year. The protective sleeves (either quartz or Teflon) that separate the lamps from the effluent must be regularly cleaned. Inadequate cleaning is one of the most common causes of a UV system malfunction. Most manufacturers offer devices with mechanical wipers for this purpose. Depending on the degree of precipitation (scaling) that occurs, sleeves may need to be removed, and acid cleaned. Chemical cleaning is most commonly done with citric acid. Sampling and analysis for indicator organisms is typically required to gauge performance.

Final Treatment and Dispersal

With many decentralized wastewater treatment systems the effluent after primary, secondary and tertiary treatment is dispersed below the surface to prevent human contact although there are other options that disperse at the surface. The soil has a large capacity for wastewater treatment because of its physical, chemical, and biological properties. The potential to provide both dispersal and a certain amount of treatment

FINAL TREATMENT, DISPERSAL, AND REUSE DEFINITION

The method used to reintroduce the treated wastewater to the environment for final treatment, dispersal, and ultimate reuse of the effluent. Methods include subsurface dispersal, surface dispersal and direct stream discharges

means that less treatment may be required prior to soil based dispersal. This will depend upon the particular characteristics of the available soil. A professional with soils training and expertise must evaluate soil properties as well as site characteristics. From this evaluation, an effluent loading rate is determined, which is used to calculate the area required to safely disperse the anticipated volume of effluent. However, adjustment of the loading rate may be required on the basis of wastewater characteristics. If effluent has a high organic strength, aerobic degradation of organic compounds will require additional infiltrative surface area.

Subsurface

This section offers final treatment options below the ground surface for treatment and dispersal of wastewater.

Gravity Dispersal

Gravity distribution is a method of applying effluent to subsurface soil trenches backfilled with porous distribution media. At a minimum, the wastewater must have gone through primary treatment in a septic tank. Primary treated effluent is applied at one end of a trench and flows by gravity across the length of the trench. Gravity distribution is effective at providing treatment through oxidation and filtration when deep, well-drained soils with sufficient space for the installation exist. With septic tank effluent, a biomat will develop which assists with treatment as shown in Figure 36.

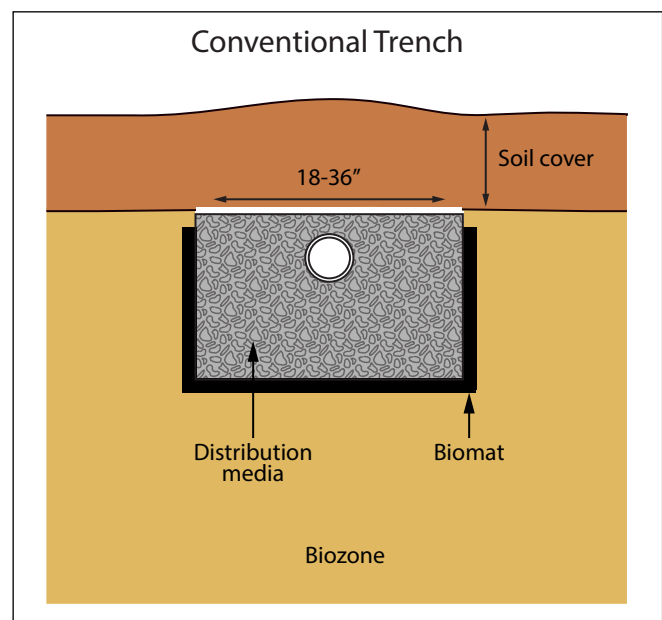


Figure 36. Cross section of a gravity trench

The site must provide sufficient vertical separation to limiting conditions (shallow groundwater, a rock layer or other restrictive horizon) in the soil beneath the excavation for treatment processes to be effective. This separation ensures that adequate aerobic soil is available under the trench for removal and/or renovation of the organic matter, nutrients and pathogens in the wastewater. Some wastewater constituents (including pathogens) are filtered out by the media and the soil. Others are consumed by soil microbes or taken up by vegetation. Eventually, almost all the treated effluent rejoins the hydrologic cycle through groundwater.

Septic tank effluent is applied to a series of trenches created in the subsurface soil. Trenches are shallow excavations placed on contours across the landscape (see Figure 37). Trenches are typically up to three feet wide and are partially backfilled with an inert media that provides void space. The void space provides short-term storage during high-flow events when more effluent is applied than can be immediately absorbed by the soil. The remainder of the backfill is the native soil that was originally removed. Wider trenches are sometimes installed and commonly referred to as bed systems.

Maintenance of gravity distribution systems includes a variety of activities. The area over and around

the dispersal area should be regularly inspected for damage (compaction, settling or erosion) and surfacing effluent. An appropriate, uniform vegetative cover (grass, sod or non-woody perennial plants) should be maintained to help assimilate water and nutrients and stabilize the surface. Septic tanks should be checked for accumulated solids and solids removed as needed.

Pressurized Dispersal

There are many methods to use a pump or siphon to distribute wastewater. These pressurized options have the benefit of uniform distribution over the area from initial startup which makes them more appropriate for sites that are a higher risk.

Low pressure pipe dispersal (LPD) uses low pump pressure to disperse effluent to subsurface soil trenches backfilled with porous distribution media. At a minimum, the wastewater must have gone through primary treatment in a septic tank. Secondary treatment may also be used before dispersal. Effluent is spread out over the entire trench or bed in contrast to the concentrated application that occurs in gravity distribution. Full utilization of the dispersal area can help to ensure the long-term success of the soil system (see Figure 38).

LPD is a modification of the conventional gravity

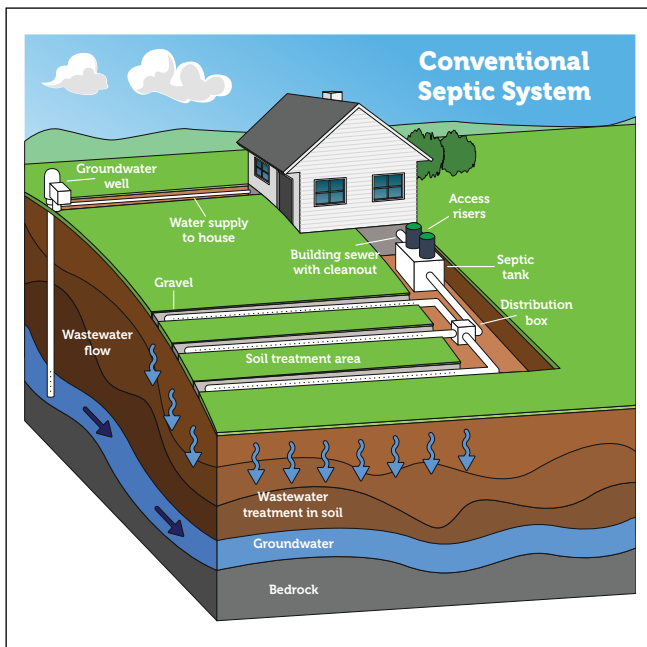


Figure 37. Trench system

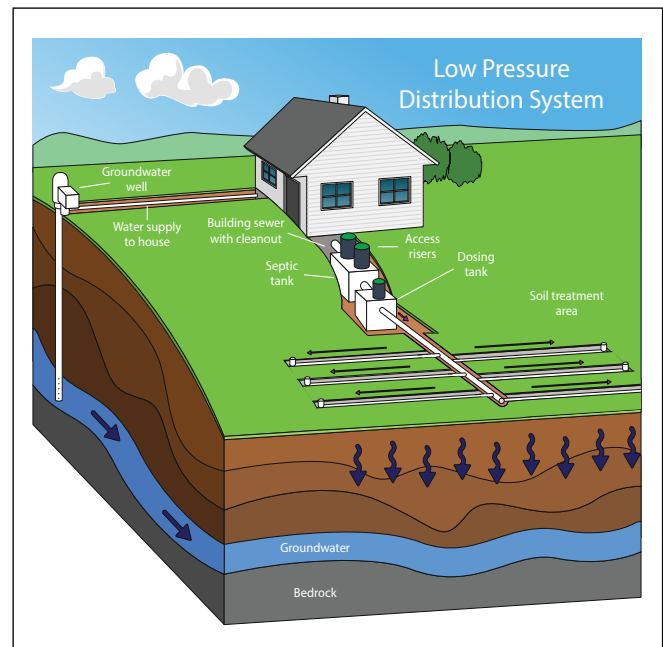


Figure 38. Low pressure pipe dispersal

distribution system. Like gravity systems, media-filled trenches are placed along the land contours. Small diameter PVC pipes with terminal cleanouts are installed within the media. Small diameter holes are drilled in the pipes at a predefined spacing. When the laterals are pressurized, effluent flows out of the orifices at an even rate. The distribution media is often washed rock, but (as with gravity distribution) other options include bundled pipe, chambers, polystyrene aggregate, or prefabricated permeable panel block configurations. Before placement of the final soil cover, a geotextile fabric may be placed over the media to prevent the infiltration of fine soil particles. The final cover supports vegetation growth, stabilizes the installation, and prevents erosion.

Effluent treatment in LPD systems occurs within the trench and in the aerobic soil beneath it, above the groundwater table or bedrock. Some wastewater constituents (including pathogens) are filtered out at the infiltrative surface and in the soil. Other constituents are metabolized by soil microbes or taken up by vegetation. Eventually, treated effluent that plants do not take up rejoins the hydrologic cycle through groundwater. LPD systems are less likely to develop a restrictive biomat, as typically occurs within gravity distribution systems, because effluent is evenly spread across the dispersal area. Additionally, because the area is fed via a pump system, there are periodic 'dose-and-rest' cycles that maintain aerobic (oxygenated) soil conditions, which are favorable to good effluent renovation.

In addition to the primary and potentially secondary treatment components, a complete LPD system includes a pump (or pumps) installed within a dosing tank, a supply line(s) from the dosing tank to a manifold, and the laterals within the field. The dosing tank collects and stores effluent from treatment components. A pump delivers effluent from the tank to the manifold. A control system regulates effluent delivery to the field. A time dosing configuration may be used (and is recommended) to apply effluent in even doses on a regular schedule. At a minimum, the wastewater must have gone through liquid-solid separation (primary treatment) before dispersal. Advanced effluent treatment should reduce the LPD system's maintenance requirements.

Maintenance for LPD includes inspecting the area around the system for damage (compaction, settling, or erosion) and for surfacing effluent. An appropriate, uniform vegetative cover (grass, sod or nonwoody perennial plants) should be maintained to help assimilate water and nutrients and stabilize the surface. Septic tanks will need to be evaluated and pumped as needed. Accumulated solids must also be regularly flushed from manifolds and laterals through cleanouts using pump pressure or pressure washed with a jetted nozzle. Performance of pump associated controls should be regularly assessed. When operational parameters are not met, the system needs maintenance. Pump screens and sensors must be cleaned as needed.

Drip distribution - Drip distribution uniformly places effluent into the subsurface soil (there are some limited applications where drip is applied directly on the surface). This dispersal method originated from crop irrigation in arid regions of the world where uniform water application results in efficient water use and nutrient uptake by vegetation. For wastewater dispersal, uniform application means that optimum conditions are created for final treatment of effluent. For most drip systems, the drip tubing is a polyethylene material that has a diameter of approximately one-half inch. As the tubing is manufactured, emitters are molded into the tubing wall on a typical spacing of two feet. Tubing is installed six to twelve inches below the soil surface and on two-foot centers, but local spacing variations are possible. This arrangement provides one point of effluent application for each four-square feet of dispersal area.

Emitters are the heart of a drip system because they control the rate of water discharge into the soil. Depending on the manufacturer, the emitters release approximately one-half gallon of effluent per hour. Emitters control the discharge by forcing water to travel through very small passageways. These passageways are smaller than most suspended solids in wastewater. Thus, a filtration system is required to remove larger suspended particles from the effluent to minimize the potential for clogging emitters in the drip tubing.

A complete drip system includes a means to accumulate effluent, a system to transfer the effluent to the field, and a distribution network to apply the

effluent to the subsurface soil (see Figure 39.) Effluent accumulates in a dosing tank. The tank contains one or more pumps that deliver effluent under pressure to the drip tubing in the dispersal area. The effluent then flows through the emitters and into the soil. The layout of the drip system varies according to the landscape features and soils presented on the site. A time dosing configuration is recommended to apply even doses on a pre-set schedule. Any pressurized water that doesn't make it out through the emitter during a dosing cycle is returned to the pump tank via a return manifold. At minimum, the wastewater must have gone through primary treatment and passed through a 100-to-120-micron filter prior to entering the drip tubing. It is generally recommended that dissolved organic carbon be removed, via an aerobic treatment process, before drip distribution. The inclusion of aerobic treatment may reduce the long-term maintenance requirements of the drip dispersal system.

The area over and around the dispersal area should be regularly inspected for damage (compaction, settling or erosion) and surfacing effluent. An appropriate, uniform vegetative cover should be maintained to help assimilate water and nutrients and stabilize the surface. Septic tanks, and other treatment devices must be maintained as needed. Performance of pumps and associated controls must be regularly checked to ensure the system is operating at design pressure and flow.

To prevent excessive biological growth that could clog

the tubing, filters are periodically flushed to remove the accumulated organic solids. This is accomplished by allowing the return side of the drip network to flow back to the primary treatment system. Most commercially available headworks are designed to automatically forward flush the tubing on a frequent basis

Imported Soil Dispersal

Mound - Mound systems are constructed when soil depth is insufficient to facilitate secondary treatment of wastewater. Fill material are used to provide additional unsaturated media depth for secondary treatment to occur. Mound systems are constructed above grade on the soil surface. The original soil surface is scarified and then a specified sand layer, twelve to twenty-four inches in depth is added. A pressure distribution system, LPD or drip, is constructed on the surface of the sand or may be embedded in a gravel layer placed on top of the sand. The distribution piping and the sand are covered with a geotextile cloth to keep soil from infiltrating into the sand layer. The mound is covered with six to twelve inches of topsoil and a grassed vegetative layer is established. See Figure 40.

Combined treatment and dispersal - Similar to a mound system, Combined treatment and dispersal combines treatment and dispersal proprietary products to treat septic tank effluent to secondary effluent levels in ground, at grade, or above grade. The products are comprised of a media core that is surrounded by a specified sand, generally with at least six inches of

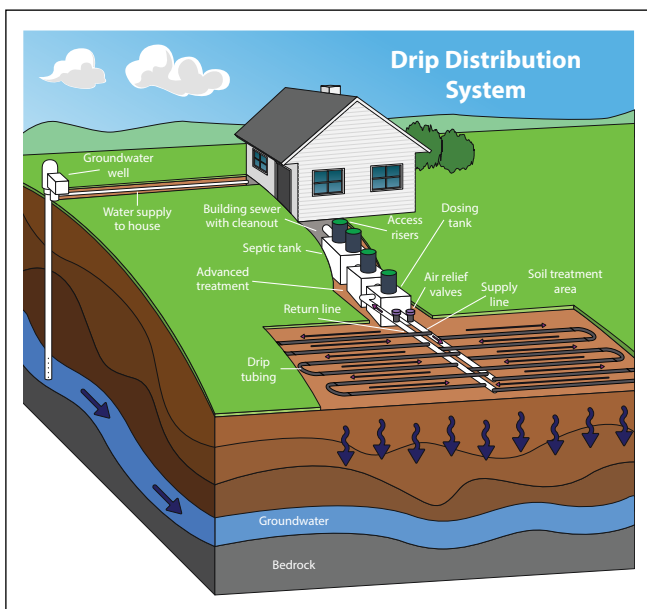


Figure 39. Drip distribution system

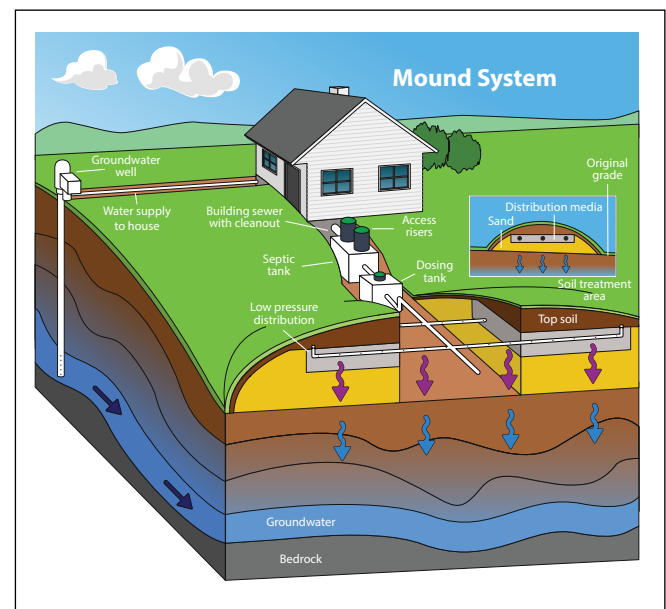


Figure 40. Mound system

sand beneath the media core. The products have been tested by a third party, to verify compliance with an NSF standard, to certify that they produce secondary effluent when septic tank effluent is applied. Effluent can be applied either by gravity or through pressure distribution. These are passive systems so they have little maintenance required except for the septic tank and pump tank, if used. See Figure 41.

Surface Dispersal

This section covers options where the effluent is applied to the surface.

Spray distribution is a means of dispersing effluent to the soil surface. This dispersal method originated from crop irrigation where uniform water application results in efficient water use and nutrient uptake by vegetation. Irrigation technologies may be used to apply effluent to the soil. A residential spray distribution system is shown in Figure 42. A similar application is allowed in some jurisdictions where drip irrigation tubing is laid on the surface. The first component of the spray distribution system is the dosing tank (or pump tank) that contains one or more pumps. A control panel activates a pump on a time-dose basis and pressurizes the distribution system with effluent. When the system is at operating pressure, effluent is distributed across the soil surface. In residential systems, the timer is often set to activate very early in the morning to minimize the chance of human contact.

Cluster and community-scale systems have

characteristics similar to residential systems but are larger in scale. Most larger systems are solid-set, meaning that the sprayers are permanently set at fixed locations. The sprayers may be pop-up heads which remain below the soil surface when not in use, or they may be mounted on risers. Common sprayers include rotors, impact heads or sprinklers. Community scale spray systems sometimes employ center pivots or traveling guns to apply effluent over much larger areas. For large scale systems, these devices are less expensive to install than solid set systems, but they require more operation and maintenance.

Surface application of effluent is a relatively high-risk dispersal method due to potential human contact with odors, contaminants, and pathogens. Large buffer zones, fences and signage are needed (and often required) to reduce this risk. At a minimum, wastewater treatment prior to dispersal must include primary treatment to minimize clogging of nozzles, some degree of organic carbon removal (secondary treatment) to reduce the strength of the effluent applied to the land surface, and disinfection (tertiary treatment) to reduce pathogen levels due to the risk of human contact. Chlorination or UV light is typically used for disinfection. Because effluent is surface-applied, spray irrigation promotes more evaporation than other dispersal methods. Effluent that does not evaporate eventually rejoins the hydrologic cycle through evapotranspiration (via plants), runoff to surface waters, and/or infiltration to groundwater.

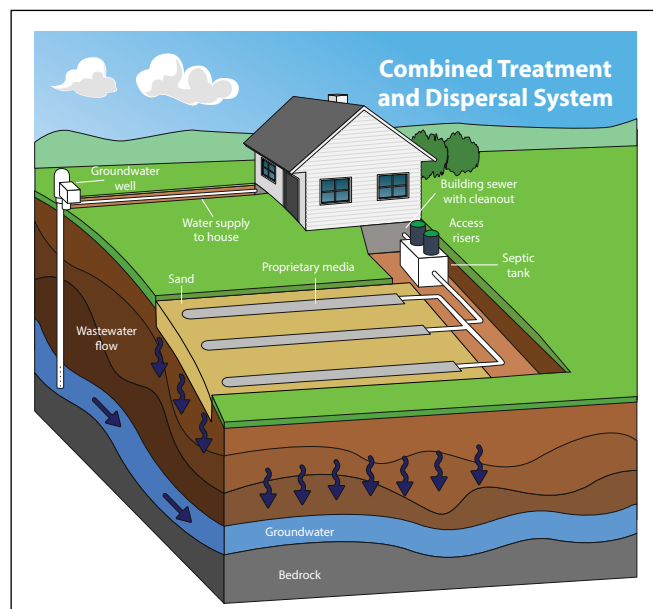


Figure 41. Combined treatment and dispersal

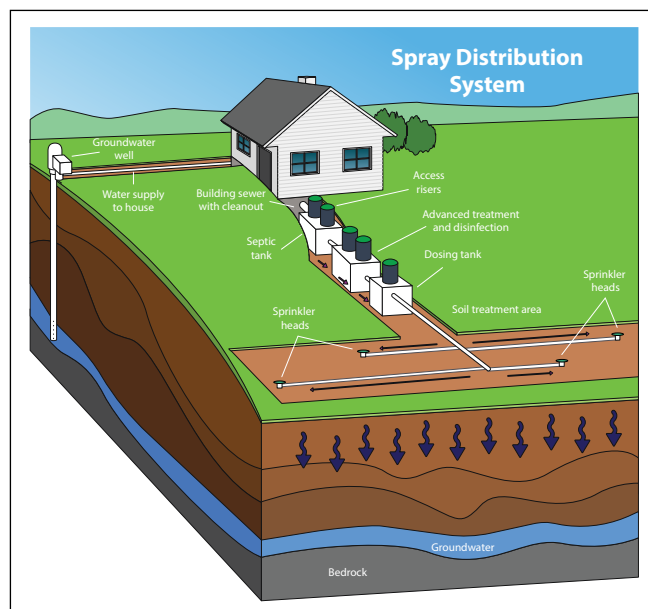


Figure 42. Spray distribution system

A uniform vegetative cover must be maintained to minimize effluent runoff and to increase infiltration. This vegetation should be mowed regularly and before spray application so as to avoid smearing and compacting the soil. The area over and around the dispersal area should be regularly inspected for damage (compaction, settling or erosion). Distribution heads and nozzles should be regularly inspected for uniform coverage patterns and disassembled and cleaned as needed. Integrity and performance of dosing tanks, pumps and controls should be regularly assessed and elapsed-time meter (ETM) and event counter (EC) readings should be recorded to track hours of operation and number of doses delivered. The effluent volume and wastewater strength applied to the site must be known. Application in excess of design may reduce the ability of the soil to accept effluent. Regulatory agencies will specify any monitoring and sampling requirements. Soil and vegetation must be regularly tested, and wastewater application should be adjusted in accordance with any applicable nutrient management plans.

Evapotranspiration (ET) systems are a method of dispersing effluent through evaporation (the change of liquid into vapor that passes into the atmosphere) or transpiration (the passage of water through a plant from the roots through the vascular system [stems and leaves] to the atmosphere). ET systems are designed for full water containment as all of the wastewater treated in the system is evaporated from the exposed surfaces of soils, ponds or plants.

ET beds apply effluent through a distribution network installed within a constructed soil bed. If no liner is used, the bed is often referred to as an evapotranspiration/absorption (ETA) bed which is designed to allow effluent to flow through the bed and into the native soil beneath it. The soil must have adequate capacity to allow the effluent to infiltrate. A gravity distribution system consisting of perforated pipes is typically installed in the shallow bed. Wastewater from a septic tank is applied through the perforated pipes. The sand bed is usually 24 to 30 inches thick, and covered with a shallow layer of topsoil, which can be planted with water and salt-tolerant, locally available vegetation such as grasses, bulrushes or reeds. Treated wastewater is drawn up through the sand by the plant roots and is evaporated, transpired to the atmosphere, or allowed to infiltrate into the soil (see Figure 43).

ET systems have large land requirements, but they require no direct energy input and have minimal O&M requirements. Communities with suitable climate, enabling laws and large tracts of open land for installation of ET beds can take advantage of this passive technology.

ET beds are low maintenance. Inspection ports located in the bed facilitate evaluation of the presence and depth of ponding in the ET bed. If ponding is excessive, the bed should be rested by using diversion valves to switch effluent flow to a rested bed. The service provider should walk the surface of the beds to note whether effluent is surfacing. The perimeter of the beds should be checked to insure that rainfall and stormwater are diverted around the system. The system is designed to handle normal rainfall entering from the top of the system, but excessive rainfall will overload the beds. The bed surface is sloped to help rain run off the bed. Erosion of the cover should be repaired to maintain a rainfall shedding condition. Vegetation management is critical to maintain the evapotranspiration rate. Overseeding of the beds during colder weather months cool weather vegetation is required if the vegetative cover has a dormant period due to colder weather.

ET ponds have relatively low maintenance requirements since there are no moving parts. If they are loaded at recommended levels, they should not require pumping over the life of the unit. Adjacent trees must be removed so that their roots do not create a pathway for water that may cause a dike failure. For the same reason, burrowing animals must be eliminated. Grazing

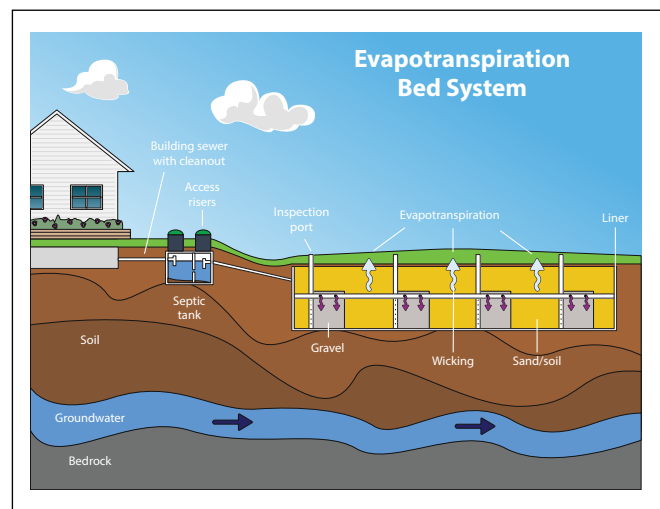


Figure 43. ET bed system

animals (goats and cattle) are a concern because they tend to leave trails that may promote erosion. Fencing and signage around an ET pond must be maintained to prevent unauthorized access. They must be irrigated during the dry season to protect the vegetation. No deep-rooted vegetation should be allowed on the banks or in the bed itself.

Direct Discharge

Many larger communities depend on surface water to receive treated effluent. A National Pollutant Discharge Elimination System (NPDES) permit is required for surface water discharges which are often referred to as point source discharges. Because of their direct effect on the receiving stream, these discharges are highly regulated. Prior to permit issuance, investigations are performed to determine the relative ability of the receiving water body to assimilate waste constituents present in effluent. System performance is regulated through permit limits.

Surface waters can assimilate a certain amount of pollution. However, excess pollution has a degrading effect on water quality that may render it unsafe for drinking, fishing, swimming, or use as a potable water source. The NPDES permit program (authorized by the Clean Water Act [CWA]) controls water pollution by regulating sources that discharge pollutants into surface waters of the United States. NPDES permits define limitations on the volume and strength of effluent that is discharged, describe monitoring requirements and spell out fines to be levied for non-compliance. Due to the cost and complexity of the NPDES program it may not be efficient or economical to pursue permits for individual or very small systems (flows less than 10,000 gallons per day). Surface discharge should not be considered unless soils are unusable and a community soil-based dispersal system is not feasible. The monitoring manpower required could overwhelm local resources. As seen in Figure 44 the typical layout of a discharging system is more complex.

NPDES permit requirements include sampling the effluent and reporting the results to EPA and the state regulatory agency. In addition, the permit will require the facility to notify EPA and the state regulatory agency if and when the facility is not in compliance with the permit requirements. EPA and state regulatory agencies also deploy inspectors to determine if the facility is in compliance with the conditions imposed under the permit. Point discharges generally require

a higher level of resources to operate and maintain relative to other options previously discussed because of the permit requirements. In general, the energy demand increases as the level of treatment provided increases. Each facility must be evaluated on a case-by-case basis.

Reuse

We continuously reuse water; this is the basis of the hydrologic cycle. However, we can shorten the cycle by reusing treated water rather than pulling more water out of the cycle. Reuse is a means of dispersing high-quality effluent back into the environment while simultaneously doing something productive with the water. Treating wastewater to the appropriate level for the particular reuse is of obvious importance.

REUSE DEFINITION

Reclamation process of collection and treatment of wastewater for the deliberate application of that treated wastewater for a beneficial purpose

Irrigation is the most common method of reuse and refers to a system specifically designed for reuse of treated wastewater for a 'value-added' purpose such as growing grasses, crops and/or trees. The second common use of reclaimed water is industrial reuse for cooling system make-up water, boiler-feed water, process water, and general wash down.

Wastewater reuse for other purposes has increased in the recent past. Urban reuse systems provide reclaimed water for a wide variety of non-potable purposes including irrigation for ornamental landscapes, use in decorative water features, dust control, concrete production for construction projects, fire protection through reclaimed water fire hydrants, as well as toilet and urinal flushing in commercial and

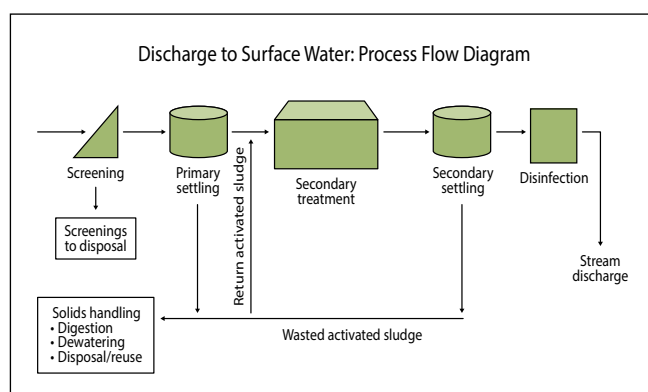


Figure 44. Process flow diagram for a discharging system

industrial buildings. In environmental reuse, reclaimed water is used to create manmade wetlands, enhance natural wetlands and sustain or augment stream flows. Recreational reuse allows reclaimed water to be used in impoundments for fishing, boating and (in some cases), human water recreational activities.

Reclaimed water for non-potable reuse must undergo some combination of primary, secondary, and tertiary treatment to meet reuse requirements. The number and choice of treatment steps will vary based on how the water will be used. However, most recycled water will undergo some form of disinfection for protection of public health. When disinfection is not used, the reuse area must be isolated from direct human or animal contact by fencing, signs, or other means. The most commonly used non-potable reuse applications are described below.

Irrigation Reuse

Irrigation reuse is the direct use of reclaimed wastewater by applying it to agricultural crops or landscaped areas. Irrigation is a value-added means of dispersing the water back into the environment. Spray distribution (described previously) uses similar equipment and methods to apply the water. Spray distribution is designed for dispersal of effluent and does not have the “value-added” component of crop production. It is important to remember that when a crop or landscape does not need irrigation, another means of reusing the reclaimed water must be identified. The two main categories of irrigation reuse are agricultural irrigation (crop irrigation, commercial nurseries) and landscape irrigation (parks, playgrounds, golf courses, freeway medians, landscape areas around commercial, office, industrial developments, and residential landscape areas). Both agricultural and landscape irrigation reuse may eliminate the cost of nutrient removal, which can be significant. Communities of all sizes can incorporate reuse of treated wastewater for landscape feature irrigation. Larger communities can produce sufficient water to make agricultural crop irrigation practical. Smaller communities or cluster-size systems only generate sufficient flow to satisfy smaller demands.

Industrial Reuse

Industrial facilities use reclaimed water primarily for cooling system make-up water (to replace water lost to

evaporation in arid climates), boiler-feed water, process water, and general wash down. It can also be used for concrete production on construction projects. Industrial re-users may require that the water undergo additional treatment. Softening (the removal of dissolved salts) is often done to protect the heat-transfer surfaces of industrial cooling towers. These additional treatment components are typically installed close to the point at which the reuse will occur.

Environmental/Recreational Reuse

Reclaimed water can be used to create manmade wetlands, enhance natural wetlands, and sustain or augment stream flows. An impoundment of reclaimed water in which recreation is limited to fishing, boating, and other non-contact recreational activities constitutes restricted recreational reuse. This form of reuse must be accompanied by appropriate signage. With unrestricted recreational reuse, reclaimed water is used in an impoundment of water in which no limitations are imposed on human recreational activities.

Urban Reuse

In urban reuse, reclaimed water is used for various non-potable purposes such as decorative water features, dust control, fire protection, and toilet and urinal flushing in commercial, residential and industrial buildings. Irrigation of ornamental landscapes, parks and golf courses can also be a part of an urban reuse system.

Traditional urban water reuse systems have two major components: water reclamation treatment facilities and a reclaimed water distribution system. Infrastructure is needed to bring wastewater into the treatment facility (sanitary sewers), and a distribution system is needed to take the reclaimed water back out to potential users. Non-potable recycled water goes through a separate pipeline (purple pipe) system, which is completely separate from the drinking water distribution system. This “dual distribution” of potable and non-potable waters is the most expensive component of a reuse system. The non-potable distribution must be constructed to prevent cross-connections with potable water lines and ensure that non-potable water is put to appropriate use. Periodic cross connection tests ensure that the non-potable recycled water pipelines are not accidentally connected to the drinking water system. In addition, there is ongoing monitoring and testing of the non-potable recycled water and drinking

water systems to protect public health. To avoid cross connections, all above-ground appurtenances and equipment associated with reclaimed water systems must be clearly marked.

Aquifer Recharge

Artificial aquifer recharge (AR) is the enhancement of natural groundwater supplies using manmade conveyances such as rapid infiltration basins or injection wells. Aquifer storage and recovery (ASR) as shown in Figure 45 is a specific type of AR practiced with the purpose of both augmenting ground water resources and recovering the water in the future for various uses. AR and ASR wells are found in areas of the U.S. that have a high population density and proximity to intensive agriculture; dependence and increasing demand on groundwater for drinking water and agriculture; and/or limited ground or surface water availability.

Toilet Flushing

One beneficial reuse of treated wastewater is to flush toilets. Numerous decentralized treatment facilities use treated wastewater to flush toilets. Some large urban buildings have installed wastewater treatment facilities on their premises and reuse the water for toilets and fire protection. The use of treated wastewater for toilet flushing, also known as recycled water or reclaimed water reuse, is a water conservation strategy that utilizes non-potable (non-drinking) water sources for indoor use. The wastewater used is typically graywater from non-toilet/kitchen sources like sinks, showers,

and washing machines. Graywater requires less intensive treatment than blackwater for non-potable reuse. Blackwater from toilets and kitchen sinks can be treated and recycled, but this requires a more rigorous, multi-stage treatment process to meet safety standards for non-potable indoor uses like toilet flushing. The wastewater must be treated and disinfected to meet strict public health and water quality standards for non-potable use. A typical treatment process will involve primary, secondary and tertiary treatment resulting in water that is clear, odorless, and safe for toilet flushing, but kept separate from the drinking water supply to reduce risk. A specialized plumbing system is required to safely deliver the treated water. Buildings using recycled water for toilet flushing must have two completely separate sets of pipes—one for potable (drinking) water and one for the non-potable recycled water. The non-potable pipes and fixtures are often color-coded or clearly labeled to prevent cross-connection with the potable water system. The recycled water is routed directly to the toilet tanks for flushing, an end-use that accounts for a substantial portion (often 30-40%) of indoor household water consumption.

Potable Reuse

The use of treated wastewater for drinking water, known as potable reuse, is a highly advanced and regulated practice. It involves purifying municipal wastewater to a standard that meets or exceeds all federal and state drinking water quality requirements. Potable reuse is generally implemented in two main ways, both relying on a multi-barrier approach to ensure safety – either indirect or direct potable reuse.

Indirect Potable Reuse (IPR)

IPR is the more common method and involves using an environmental buffer before the water enters the drinking water system. Wastewater is first treated at a municipal facility using primary, secondary, and tertiary treatment (removing solids, organic matter, and nutrients). The treated effluent then undergoes a rigorous purification process, often called Advanced Water Purification (AWP). A common “treatment train” includes:

1. Microfiltration (MF) or Ultrafiltration (UF): Removes suspended solids, bacteria, and protozoa.
2. Reverse Osmosis (RO): A high-pressure process that pushes water through a semi-permeable membrane to remove nearly all remaining dissolved

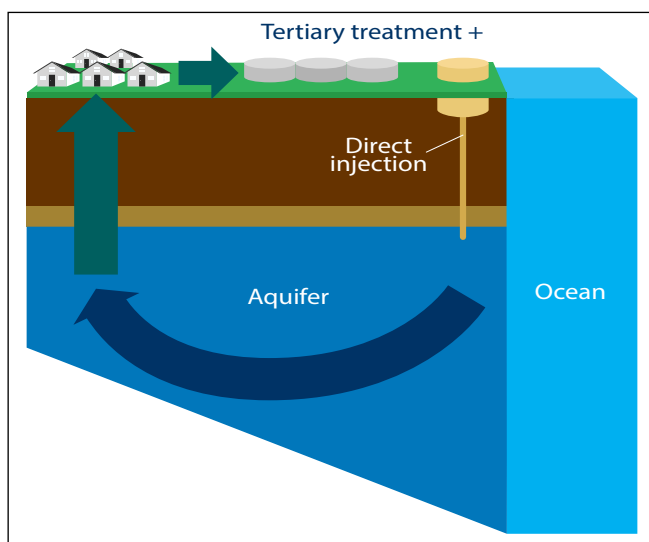


Figure 45. Example of an aquifer storage and recovery system

salts, viruses, pesticides, and trace contaminants (e.g., pharmaceuticals).

3. Advanced Oxidation Process (AOP): Uses UV light combined with hydrogen peroxide to destroy any remaining trace organic compounds that may have passed through the RO membrane.

The highly purified water is then discharged into a natural body of water, which acts as a buffer. This can be to groundwater where the purified water is injected into or percolated through a groundwater aquifer. A second option is Surface Water Augmentation where the purified water is released into a reservoir or river used as a source for a downstream drinking water treatment plant. The water is stored, blended with the native water supply in the buffer, and finally withdrawn and treated again at a conventional drinking water treatment plant before being distributed to consumers.

Direct Potable Reuse (DPR)

DPR is a newer, less common, and more sensitive method that introduces the purified water directly into the drinking water system without an environmental buffer. The initial stages are similar to IPR, involving conventional wastewater treatment followed by the same highly protective sequence of purification (microfiltration/ ultrafiltration, reverse osmosis, and advanced oxidation). The purified water is then immediately and intentionally added into the raw water supply line leading to a drinking water treatment plant, or directly into the distribution system after blending with other potable sources. DPR requires extremely robust, real-time monitoring and an increased regulatory focus on process control and redundancy to ensure public health safety given the absence of the natural buffer of time and dilution. The paramount concern in potable reuse is public health. Both IPR and DPR rely on a sequence of treatment technologies where each step is designed to remove different types of contaminants, providing redundancy in case one process fails. The final product water must meet or exceed the same federal and state quality standards (such as the Safe Drinking Water Act in the U.S.) that apply to all drinking water sources. The advanced purification processes are specifically designed to remove contaminants of emerging concern, such as trace pharmaceuticals and personal care products, to levels often undetectable by analytical instruments. Potable reuse is a rapidly growing strategy in water-stressed regions because it is an effective way to

create a reliable, drought-proof local water supply, thereby enhancing water security and sustainability.

Application and Management

Historically, few communities have pursued urban reuse programs. The main barrier has typically been cost of the non-potable transmission network described above. In a community where water is plentiful, these systems are very expensive compared to simply dispersing treated wastewater into the ground or into a receiving stream. Public perception of urban reuse systems has not necessarily been positive, which can be attributed to misconceptions regarding associated risks. Certainly, if they are not properly maintained, reuse systems can pose a significant odor nuisance and a health threat. The increasing commonality of drought is beginning to soften these attitudes. Provided that cross-connection can be prevented, reclaimed water can be used to replace potable water in any application that does not require human consumption. If the community is willing to commit to providing the money and manpower to do the job right, the system will function well, and all water brought to the community as potable water can be used at least twice prior to ultimate dispersal back into the environment. As state agencies see the potential value in adopting water reuse incentives, the number of such applications will dramatically increase.

Given the increased areas of water shortages, increased regulatory anti-degradation activities, and other constraints, all communities should consider the reuse of both treated wastewater and stormwater runoff in their overall community plans. One of the major advantages of reusing wastewater for irrigation is that nutrient removal is not required. Some arid states are requiring developers to assure an adequate water supply for 100 years. Irrigation reuse by the community, by commercial interests, and by the agricultural sector is certainly a means of maximizing water resources to meet such goals.

The reclaimed water distribution system is essentially an additional water utility. This makes a case for consideration of a single, combined water utility. Reclaimed water systems are operated, maintained, and managed in a manner similar to the potable water system. Water reclamation facilities must provide the required treatment to meet appropriate water quality standards for the intended use. In addition to

secondary treatment, filtration and disinfection are generally required for reuse in an urban setting. In cases where a single large customer needs higher quality reclaimed water, the customer may have to provide additional treatment onsite, as is commonly done with potable water.

Operation and maintenance (O&M) of urban wastewater reuse systems is very similar to any advanced wastewater treatment facility. In distributed or decentralized reuse systems, the O&M requirements are potentially lower owing to the use of more passive, non-O&M-intensive treatment technologies that are located closer to the reuse applications. However, if the reuse opportunities are primarily limited to a few large users, these innate advantages might be reduced. One of the positive aspects of decentralized systems is that they can always be sources of aquifer replenishment if other reuse opportunities are scarce.

Case Study

Utility: Mobile Area Water & Sewer System (MAWSS)

Governance: Board of Water Sewer Commissioners of the City of Mobile, five commissioners appointed by city council.

Existing Capacity – Discharge Systems

(green squares in Figure):

- 12.8 MGD.
- 28.0 MGD.
- 2.0 MGD.

Problem

- Development pressures west of topographic ridgeline (red line in Figure 1) and outside of existing service area.
- Pump stations and force mains required to move flow across ridgeline to existing systems.
- Existing sewer infrastructure in poor repair and subject to infiltration and inflow.
- Addition of flows to existing infrastructure will add to sewer overflows.

Solution Construct decentralized systems in phases to allow for growth.

Model Project Elements

System Components:

- Septic tank at each home – STEP or STEG collection system.
- Advanced secondary offsite treatment such as recirculating sand filter
- Effluent dispersal area – Spray irrigation has been used.

Developer Responsibilities:

- Developer donates land for both treatment and dispersal area – The area must be adequate for the full buildout of the project.
- Developer pays for and constructs on lot tanks, filters, and pump systems as well as the collection system to MAWSS specifications – The developer or homeowner owns the on-lot and collection system.
- Developer pays lump sum to MAWSS to offset costs..

Homeowner Responsibilities:

- Developer, builder or homeowner pays per lot fee and per connection fee.
- Homeowner pays MAWSS a monthly sewer fee to operate and maintain on-lot components as well as for wastewater treatment and dispersal.

MAWSS Responsibilities:

- MAWSS constructs, owns and operates treatment and dispersal system.
- MAWSS operates and maintains on-lot components and collection system. On-lot tanks are pumped periodically.



Existing WWTPs in green, proposed decentralized system as red dots, and ridgeline in red.

| | Hutchens | Copeland Is. |
|-------------------------------|------------------|----------------------|
| Serves | School, homes | homes |
| Initial capacity | 60,000 gpd | 20,000 gpd |
| Buildout capacity | 240,000 | 170,000 |
| Connections as of 2004 | 200 | 240 |
| Sewer type | STEP | STEP |
| Treatment | RSF | RSF |
| Dispersal | Chambers + spray | Vegetated gravelbeds |

Source: 2004. 'Case Studies of Economic Analysis and Community Decision Making for Decentralized Wastewater Systems', Rocky Mountain Institute, Colorado. National Decentralized Water Resources Capacity Development Project



Management, Structure, and Financing Options

Learning Objectives

- Describe the importance of different management programs.
- Identify O&M activities required with OWTS.
- Name key considerations when hiring a management professional or company.
- Describe responsible management of wastewater systems.
- List pros and cons of various ownership options.
- Delineate board roles when selecting an ownership structure.
- Describe the range of funding options available.
- List locations to find more information for your project.

This section reviews the key basic elements of management needed for wastewater treatment systems, namely monitoring, operation, and maintenance. Community-wide solutions must provide a management program that considers compensation, workforce, and planning for future needs. Organization is also needed for a wastewater project. Many landowners just want to get their system fixed and be done with it. However, when there are multiple landowners and properties involved, a legal and responsible entity is needed to work on behalf of the community. External funding is often needed to implement the project. Continuing financing is key for future inspections, operation oversight, maintenance, repair, and expansion of the system.

Wastewater Management Options

Over the years, many homeowners have followed the flush and forget philosophy. Others have thought of wastewater as a waste product that can easily be disposed of. Today, we know that neither of those approaches is valid. Forgetting about wastewater has caused premature failure of many wastewater treatment systems as well as produced threats to human health and the environment.

This chapter identifies some management needs and possible options to help your community implement its wastewater project. Management choices are very important. Many people do not realize that they need to manage their wastewater system and so, frequently, there is little or no management. Homeowners should be informed that just as with their cars, houses and other valued items, a little care goes a long way for their wastewater system.

Management simply means taking care of something. It is imperative that all homeowners provide proper management of their wastewater treatment systems, from the simple on-site systems to the more complex community systems. Management of all wastewater treatment systems involves inspection, monitoring, operation, and maintenance of the system.

Community managed systems need a management program that includes a comprehensive, life-cycle series of elements and activities that address issues critical to wastewater treatment systems. The program should include planning, education, maintenance, residuals management, training certification, licensing, inspections, monitoring, compliance, corrective action and enforcement, recordkeeping, inventorying, reporting, financial assistance, billing, and funding.

Management Is Important

The benefits of good management of your wastewater system include:

- reduced costs for repairs, maintenance, and replacement;

MANAGEMENT DEFINITION

Complete range of activities necessary to conduct operational services on wastewater treatment systems, including inspection, operation, maintenance, monitoring, and compensation

- longer system life;
- improved system performance; and
- increased reliability and overall satisfaction.

It is the responsibility of every homeowner to invest the time and money needed to provide a properly functioning wastewater treatment system. As was discussed in Chapters 1 and 3, a good wastewater treatment system must be properly designed—and properly managed. The homeowner's family, immediate environment and financial investment is at stake.

Professionals design and install wastewater systems. However, individual homeowners are responsible for the proper use and care of their onsite wastewater treatment systems (OWTS). Some new homeowners do not properly maintain their OWTS because they have not had this responsibility in the past. Others do not know where to begin. Many people who have lived in the country all their lives do not really understand their wastewater treatment systems and so have not taken care of them effectively.

To protect human health and the environment, communities must properly design, install and manage treatment systems. When a poorly maintained system fails prematurely, it costs more than just out-of-pocket dollars for the homeowner or community to replace it. There may be hidden costs of contaminated surface and groundwater, overall water quality degradation and reduced property values. In some cases, homeowners may find there is no place to put another new system. This is especially true with older developments, many of which were platted in the 1970s or earlier. While there are many reasons to take care of wastewater treatment systems, be it your own on-site system or your community's treatment system, the lesson is the same—Pay now or pay more later.

EPA Management Guidelines

The U.S. Environmental Protection Agency (EPA) issued a draft of Guidelines for the Management of Onsite/Decentralized Wastewater Systems in September of 2003 “to raise the level of performance of onsite/decentralized wastewater systems through improved management programs.” They proposed this set of voluntary national guidelines “to raise the quality of management programs, establish minimum levels of activity, and institutionalize the concept of management.”

Although these are draft guidelines and voluntary, they illustrate the concepts of management and accountability being discussed in the industry and by the government. Not everyone in the industry or at all levels of government agree on the guidelines and models proposed, but they provide a base for discussion and illustrate the range in possible management providers. In these guidelines, EPA proposes five models with objectives to increase system performance. These models can be used for new or existing infrastructure and include both subsurface and surface discharging systems. Appendix J has a summary of the benefits and limitations of the various models.

Model 1: System inventory and awareness of maintenance needs

Purpose: To ensure conventional decentralized systems are sited and installed properly in accordance with appropriate state/tribal/local regulations and codes and are periodically inspected, maintained, and repaired, as necessary.

To implement Model 1, the regulatory agency must be aware of the location of systems and periodically provide owners with operation and maintenance information. An accurate inventory and database of the system locations and assurances that the systems were properly sited and installed are critical to the success of this model. A reminder of needed maintenance is sent to property owners by the regulatory agency or other designated entity.

Typical application: Individual systems that are low maintenance, prescribed designs, non-sensitive environment.

Model 2: Management through maintenance contracts

Purpose: To allow the use of more complex mechanical treatment options in areas of higher density or environmental sensitivity through a higher level of assurance that the more complex systems will be maintained.

This model contains all the requirements of Model 1 but adds in the requirement that a maintenance contract be maintained between the owner and service provider/operator over the life of the system. Ideally, the maintenance contract status is tracked, and enforcement penalties can be levied for poor system maintenance.

Typical application: Individual systems that are higher maintenance.

Model 3: Management through operating permits

Purpose: To provide a higher level of oversight through operating permits for sites with more complicated characteristics than conventional systems.

Operating permits are especially important for decentralized community systems due to the larger flow and multiple residents served. In addition to the requirements of Models 1 and 2, Model 3 establishes specific and measurable performance requirements, renewable operating permits, and regular compliance monitoring reports, in addition to requiring maintenance contracts. The property owner, either individual property owner or legal entity owner of community system, retains responsibility for management. Enforcement powers are critical for the regulatory authority to mandate corrective actions.

Typical application: Individual systems in environmentally sensitive areas, large capacity systems, and specially designed systems requiring monitoring to meet prescribed performance criteria.

Model 4: Utility operation and maintenance (Responsible management entity)

Purpose: To allow the use of onsite wastewater treatment systems in areas of greater environmental sensitivity and/or systems of large capacity by requiring operations be provided by a professional third-party entity.

Model 4 ensures that decentralized treatment systems consistently meet their performance requirements through the creation of public or private utilities that are responsible for the performance of the systems within the service area. The utilities – referred to as a responsible management entity (RME) - are issued operating permits for the systems and maintain them, but system ownership remains with individual property owners. The requirements of Model 3 apply. Property owners are still responsible to pay directly for O&M and replacement costs to the RME. This model puts operation specialists in charge of maintaining the systems, creating potential conflict if owners do not want to pay for needed maintenance.

Typical application: Community scale management of individual and cluster systems in sensitive areas.

Model 5: Utility ownership and management (Responsible management entity)

Purpose: Establishes one RME as owner and operator of a system or group of systems. This eliminates the split in responsibility between ownership and operation that was evident in Model 4. This model is preferred for large community systems serving multiple properties and owners or where multiple individual systems are located in an environmentally sensitive area.

Model 5 provides professional management of the siting, design, construction, operation, maintenance, and ownership of decentralized systems through an RME that manages systems within a defined service area. The requirements of Model 3 and 4 apply, with the exception that property owners are not directly responsible for RME owned components on their lot.

Typical application: Areas of suspected impairment of critical water supplies and natural resources. Suggested for new, dense developments.

Management Begins in the Home

The residents of every household control the quantity and quality (contents) of the wastewater delivered to their treatment system. They operate the system every time they use water—flush the toilet, wash a load of laundry, or take a shower. All of the specific best management practices homeowners can use to improve the performance of their treatment systems are outlined in the *NOWRA Onsite Wastewater Treatment User Guide*. These include controlling water usage, disposing of household wastes properly, using appropriate cleaners, avoiding overloading the system, making needed repairs in a timely manner and scheduling maintenance at regular intervals.

Educating individual residents by providing information on best management practices is the quickest, least expensive, and most effective first step in managing individual or multi-household wastewater treatment systems. The owner of the system has the most at stake and will reap the greatest benefits. Homeowner education is a basic step managers of any treatment system should take. It is extremely difficult to control how individuals use their system, and no one wants big brother looking over their shoulder. Providing homeowners with information they need is the least expensive management strategy, but it provides huge benefits.

Managing Your Wastewater System

Understanding the basic operation and maintenance needs of your system is critical to assessing the level of management needed for your system. Section 3 described the basic components and operation and maintenance for collection, treatment, dispersal, and residuals options. Below is a brief review.

Collection system

For individual onsite systems, the collection system is simply the building sewer exiting the structure or there may be a grinder pump to lift the sewage to the septic tank.

For community decentralized systems, the collection system options include:

- Raw sewage
 - Gravity flow
 - Pumped flow
- Settled sewage (effluent)
 - Gravity flow
 - Pumped flow

Raw sewage – gravity flow: From a maintenance standpoint, these systems have the least amount of routine maintenance of any option. These are larger diameter pipes, minimum of eight inches diameter, and do not clog easily when designed and installed properly. Regular inspections to check for overflow and inflow/infiltration situations are needed. Clogs can occur due to inappropriate materials being tossed down the drain such as wipes and fats, oils, and greases. These two materials can combine to create large masses referred to as ‘fatbergs’ that block the flow of sewage. This type of gravity collection system is more prone to infiltration and inflow due to potential ‘weak points’ at connections to manholes and vented manhole covers. On an approximate ten-year rotation, each collection line should be visually inspected via a closed-circuit camera and repairs conducted as needed.

Raw sewage – pumped flow: A grinder pump at every structure or two transfers sewage through a small diameter force main to a downstream component such as a larger pump station or the treatment plant. The pump stations should be inspected annually or so to verify that all components are functioning properly.

The grinder pump station is small with little storage volume so if a pump goes down, it is an emergency situation to replace the pump and get the system back online. These pumps should last ten years at a minimum, and can be rebuilt, but if homeowners are not instructed on what should and should not be put down the drain, these pumps stations can fail. Grease, rags, wipes, bones, t-shirts, and diapers are not compatible with a drain, and they can shorten the life of the grinder pump. Standardization on the pump and station design are critical to efficient emergency response times. Given that these stations are on private property, the community must decide who is responsible for the pump stations at every home. Is it the individual property owner or the community system owner? If the community system owner is responsible, then appropriate easements and rights of access must be granted. The force main should require little attention except to check for line breaks or valve failures.

Settled sewage – gravity flow: A septic tank is placed at each structure and the settled effluent flows through a small diameter pipe (starting at four-inch diameter). Periodic maintenance is required to clean the effluent screen. The septic tank needs to be pumped when it is about a third full of solids, roughly every two to five years. A decision must be made as to who is responsible for maintaining the septic tank. Is it the community system owner or the individual property owner?

Settled sewage – pumped flow: A septic tank is placed at each structure, and the settled effluent enters an effluent pump vault. The effluent pump transfers the settled effluent downstream to the next component, either a pump station or a treatment plant. Periodic maintenance is required to clean the effluent screen. The septic tank needs to be pumped when it is about a third full of solids, roughly every two to five years. The effluent pump assembly and tank/vault should be inspected annually or so to verify that all components are functioning properly and clean the effluent screen. A decision must be made as to who is responsible for maintaining the septic tank. Is it the community system owner or the individual property owner?

Often there are no regulatory requirements that dictate how frequently these systems must be maintained or who can conduct maintenance. Regardless, collection is a critical step in the treatment process. Without proper collection, sewage is not delivered safely

to the treatment plant creating environmental and public health hazards. Select the level of inspection, operation, maintenance, and management that ensures that the collection system is functioning as designed and is not endangering public health or the environment.

Primary/Secondary/Tertiary Treatment

All sewage must be treated before being allowed to return to the environment. The three levels of treatment are primary, secondary, and tertiary treatment. The level of required treatment is determined by dispersal location in the environment. In evaluating the need for operation and maintenance, check the authorizing permit for any mandated effluent standards, monitoring requirements, and operator licensure.

Primary Treatment: Primary treatment is a passive step where gravity provides the force to separate solids from liquids. With few moving parts, operation and maintenance is minimal and infrequent. Effluent screens must be cleaned, and solids must be pumped when the tanks are about a third full of solids. These are simple systems that do not require a high degree of technical skill.

Secondary Treatment: Secondary treatment systems vary widely in complexity. Natural-based systems such as wetlands and lagoons have few moving parts and require only periodic removal of vegetation and inspection/repair of piping and valves. Aerated lagoons have blowers that require servicing. Media filters are the next step up in complexity, with a pump that doses wastewater to the media filter. Proper functioning of the pump and control systems are critical. Suspended growth and IFAS systems add blowers for aeration, and they include a sludge wasting system. Maintenance of the blowers, diffusers, and pumps for sludge are required. Secondary treatment is almost exclusively produced through a biological treatment process. Operators knowledgeable in the biological processes and the ability to trouble shoot are critical at this level. Required regulatory monitoring of some parameters is likely.

Tertiary Treatment: Tertiary treatment covers a lot of options that produce an effluent quality better than secondary effluent. Tertiary treatment includes nutrient removal, higher levels of BOD and TSS removal, disinfection, and the reduction of other emerging water quality parameters, such as turbidity and total

dissolved solids. These systems may add in chemical feed systems, filters, various return lines, and online process control monitoring. Required regulatory monitoring of some parameters is likely. Like secondary treatment, tertiary treatment systems require a high degree of technical skill from the operator not just to maintain physical systems, but to understand the biological and chemical reactions occurring and make appropriate adjustments to the system.

Final Treatment, Dispersal, Discharge, and Reuse

Once treated, the effluent is released to the environment where final treatment, dispersal, discharge, and reuse can occur.

Soil Treatment Areas: Onsite wastewater treatment systems end with dispersal to a soil treatment area (STA). In the STA, there is additional treatment of the wastewater through the soil column before it is finally dispersed to the environment. Maintenance of STAs varies depending on if there is a pump involved in discharge.

All STAs require periodic inspection to check for surfacing of effluent, evidence of uneven distribution, or cracked/clogged pipes. If there is a pump involved, the pump station should be checked annually for proper function. Pressure distribution dispersal systems can have additional filters and valves that may require a semi-annual frequency for maintenance. Spray fields and evapotranspiration beds do need vegetation maintenance to ensure that the vegetation remains active and growing.

In general, STAs are low maintenance components. Pressure distribution with pumps increase the level of technical skill required.

Stream Discharge: Stream discharge systems are more complex than a system that discharges to a STA. A stream discharge will require a secondary treatment level with disinfection. A stream discharge is a federal permit under the Clean Water Act and requires frequent routine monitoring and reporting of effluent quality. Failure to report monitoring or failure to comply with the required effluent standards can result in fines from the regulatory agency responsible. Operators of stream discharging facilities must be licensed. The level of licensure required depends on the size and complexity of the facility.

Reuse: The complexity of a reuse treatment system is dependent on the intended reuse. As the potential

risk of exposure to the general public increases, the level of treatment and monitoring required increases. The highest level of reuse – indirect and direct potable reuse – is a very complicated and highly monitored activity, requiring the highest level of technical competency from an operator. Online real time monitoring is used to ensure that all water that is released for consumption meets all applicable requirements. Any out of specification water is immediately shunted offline to protect public health.

Residuals Management

All waste constituents removed from wastewater must still be managed. Residuals management ensures that solids generated and retained in wastewater treatment components are properly managed. Solids accumulate in septic tanks, recirculation tanks, flow equalization tanks, trash tanks, and other primary treatment devices as a result of settling (sludge) and floatation (scum). Solids are also generated and accumulate in the clarifier within aerobic unit processes. In filtration units, solids accumulate on media surfaces. Chemical precipitation, such as for phosphorus removal, results in a solid material that must be removed. If a STEP or STEG system is used for collection in a community system, each property has a septic tank that will accumulate solids. Poor solids management will result in a failed system. All of these solids must be periodically removed so that components continue to properly function. The methods used to manage and dispose of residuals must be in compliance with regulations to protect public health and the environment.

The anticipated quantity of solids (septage) removed from septic tanks can be estimated based upon the expected pumping frequency and tank capacity. Required pumping frequency will vary on the basis of tank design, user habits, and seasonal temperature fluctuations. For basic planning purposes, the typical value of residuals generation is 60 to 70 gallons per person per year.

Common solutions to properly manage the residuals include land applications following Federal 503

The term “federal 503 regulations” refers to the EPA’s 40 CFR Part 503, which establishes comprehensive Standards for the Use or Disposal of Sewage Sludge, also known as biosolids and septage. These regulations set national minimum standards for the final use or disposal of sewage sludge when it is applied to land to condition soil or fertilize crops, placed on a surface disposal site, or fired in an incinerator.

rules along with local requirements or taking them to a wastewater treatment plant (WWTP) or residual management facility. Regardless of the method chosen, residuals haulers who will collect and transport solids must be trained and licensed or certified. Creation of collection, transport and delivery protocols and documentation procedures are essential for proper licensure. Many states have established licensing or certification programs in place.

If land application is the chosen dispersal method, areas must have the appropriate soil morphology and site characteristics to support this option. A soils professional must evaluate the soil and site to determine appropriate loading rates. Nutrient management plans must be formulated and implemented. Permits must be obtained from the local regulatory authority. If co-treatment at a wastewater treatment facility is chosen, adequate capacity must be verified. A receiving station must be established to receive the residuals from the pumpers. The necessary agreements among the plant and the haulers must be executed. If dedicated residuals treatment is chosen, the residuals management plant must be planned, designed, permitted, and constructed.

Management Provider Needs

There are many service providers for wastewater treatment systems. They range from informed individual homeowners arranging for the pumping of their conventional OWTS every three years to licensed operators doing daily monitoring, testing, and reporting for a complex community system. When choosing a system, be aware of how much care and management each option will require before making a final decision. While there is a lot of interest in new or alternative treatment systems, the standard systems are likely going to require the least maintenance.

Be sure to collect complete information on the management requirements from several sources, including the permitting agency. Whether you are considering a single homeowner system or a group system, help the designer or engineer understand how the system will be used so they can spell out what the management requirements will be. With this information, you can make the best final determination.

Management of multiple-household systems becomes more involved. Depending on the system's design, it may require minimal maintenance or much more involved attention. If your system uses mechanical

pumps and electrical time dosing, it will require a well-qualified service provider. Simple or complex, new system or a repair, be aware of the long-term management needs of the system you are considering. The system management activities should be a major factor in your final choice. Consider the following groups of professionals for management of an onsite wastewater treatment system.

Responsible Management Entity (RME)

Large capacity decentralized systems and multiple individual OWTS in environmentally sensitive areas benefit from an RME. An RME, required with Model 4 and 5, is an agency or organization tasked with professional management, oversight, and long-term assurance of decentralized wastewater infrastructure, such as individual septic systems or cluster systems. The core purpose of a RME is to ensure that OWTS function as designed over their entire lifespan to protect public health and the environment, especially water quality. With the application of a RME, management of OWTS transfers from a private owner responsibility into a professionally managed service.

Typical activities performed by the RME - billing/service charge fees, maintaining permits/licensing, ensuring adequate system performance, preventative maintenance, and system repairs. RMEs include public service providers (e.g., municipal, and private utilities), private agencies (e.g., community development corporations), and non-profit corporations. An RME can manage community, county, or regional systems.

Local cooperative rural electrical utilities have shown interest in working with the management of individual and cluster OWTS. This is logical because, first, the landowners usually receive their electrical power and their bills from the cooperatives and are therefore current cooperative members, and second, the cooperative usually works with the local township governing entity to collect unpaid service charges. The township can budget for repairs through a service district model if used. Third, the cooperative will try to keep costs down and be efficient for their shareholders. There is usually good communication with the utilities and minimal intrusion to the area's culture, as compared to bringing in an outside manager. Such arrangements can help projects go smoothly. The role of cooperatives in managing decentralized wastewater systems (like

clusters or advanced systems) is a recognized area of opportunity, especially in rural areas where conventional centralized sewer systems are too expensive or impractical.

Existing Municipal Utilities

Municipalities have been managing municipal wastewater treatment systems (WWTP) for decades. WWTP usually employ staff to maintain the pumps, lift stations and lines as well as to manage the plant operation. These operators may have experience with decentralized systems as well. Depending on the defined service area of the municipality, the municipal utility may be interested in owning and operating a decentralized facility. The utility may also be a source of operation professionals if properly licensed utility operators want to take on part-time work.

Installers/Contractors and Service Providers/Operators

Besides RMEs and municipal utilities, there are also private companies who do maintenance and management of systems. Some of these professionals are installers/contractors who are already familiar with systems they install and understand system maintenance protocol. Other options are service providers/operators who specialize in decentralized systems. Some treatment systems come with management contracts and warranties through the system manufacturer that can be extended. Be certain to review these types of contracts carefully, since you may get something you did not anticipate and may not be able to change in the future. Be aware of the costs to manage your system and the credentials and references of those that offer these services.

Records and Accountability

An important part of management is keeping records of pertinent data, which becomes valuable information for

use by management in the operation and maintenance of the system(s). It can be very useful to record such things as dates and status of septic tank pumping, pump inspections, alarm checks, and flow meter readings. It is often required to maintain regulatory required monitoring and other permitting information for specified time frames.

It is also necessary for the system manager to be accountable and responsible. The manager's first responsibility is to the owners of the system who depend on it and paying the management bill. Maintaining accurate records of billing, receipts, and expenses proves to the customers that rates are reasonable and necessary. Another level of responsibility is to the residents of the community who share the same aquifer as their water source. A third level of responsibility could be to reporting to a local unit of government that has an ordinance requiring regular evidence of prescribed management practices. Additionally, many states or their licensing authority have standards of practice they are required to adhere to.

Management Tips

With proper management tools for the type of system you choose, you will find that the life of the system will be greatly extended. The costs to replace your system, plus the hidden costs of possible contamination to your drinking water and groundwater supply, are good incentives to do proper management. The type of management you need depends on the type and complexity of the wastewater system, whether it serves a single homeowner or a group of landowners, the accountability needed, and the types of service providers that are available in your area. Continued long-term efficiency and accountability of your wastewater treatment system, whether by yourself or by professionals, will ultimately pay off when you and other landowners want to sell your homes. The saying, "An ounce of prevention is worth a pound of cure," really applies here.

Case Study

Background

- Mining community
- Population dropped by half to under 2,000
- Mining drainage, failing septic systems and straight pipes impacting streams and downstream Raystown Lake
- Increasing regulatory pressure to address
- Water supplies at risk

Goals

- Protect water supplies and reduce nutrient loading to Raystown Lake

Challenges

- Small lots limiting on-lot solutions
- Poor site conditions
- Low-income population
- Two governmental entities, neither of which had a utility department

Approach

- Create a Sewage Advisory Committee (SAC)
- Work with Planning Commission to identify service area
- Hire a consultant to assess the problem
- Engage the public and regulatory community
- Built consensus on solution

Project Elements

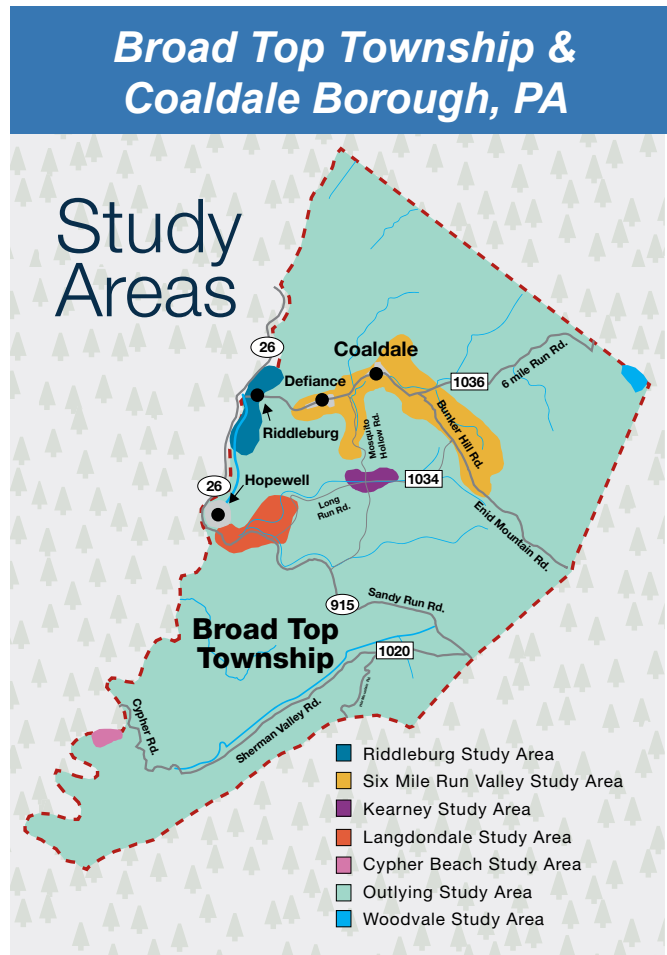
- Modified gravity sewer
- Four surface water discharges
- One decentralized system
- Individual on-lot systems elsewhere
- Treatment: aerated lagoons, sand filters, and UV disinfection

Funding

- 313 programs and Community Development Block Grant
- Special designation as demonstration of innovative solution for rural wastewater issues
- High percentage of grant funding

Management

- Intergovernmental agreement established Broad Top Township (BTT) as management entity for all community and on-lot systems
- \$30 monthly fee for on-lot and community systems
- Within 150 feet of a sewer main, structure must connect. Beyond 150 feet, may connect, but owner pays the extra cost for connection
- On-lot systems
 - Existing homes turn over ownership and control of on-lot system to BTT
 - \$6,000 connection fee
 - BTT inspects, repairs, replaces system
 - Owners sign maintenance agreement and provide easements
 - Non-participating owners must have system inspected annually
 - New homes – owner pays to construct system, then turns over to BTT
 - BTT specifies type of system installed



Results

- Surface waters recovering
- Groundwater supplies better protected
- Concerns over failing septic system eliminated
- Area is more appealing to residents and tourists

| Study Area | Existing Equivalent Dwelling Units (EDC) ¹ | System |
|----------------------------------|---|---|
| Riddleburg | 100 | Modified Gravity Sewer Collection to Aerated Lagoon; Sand Filter; UV Disinfection; Stream Discharge |
| Six Mile Run Valley ² | 305 | Modified Gravity Sewer Collection to Aerated Lagoon; Sand Filter; UV Disinfection; Stream Discharge |
| Kearney | 18 | Modified Gravity Sewer Collection to Small Flow Treatment Facility; Stream Discharge |
| Langdondale | 70 | Modified Gravity Sewer Collection to Lagoon; Sand Filter; UV Disinfection; Stream Discharge |
| Cypher Beach | 46 | Modified Gravity Sewer Collection to Septic Tank; Sand Filter; Subsurface Discharge |
| Outlying Areas ³ | 220 | On-lot systems as appropriate for site |

Final Solutions

Source: 2004. 'Case Studies of Economic Analysis and Community Decision Making for Decentralized Wastewater Systems', Rocky Mountain Institute, Colorado. National Decentralized Water Resources Capacity Development Project

Community System Organizational Structure Options

Someone must be responsible for inspection, operation, monitoring and upkeep of wastewater treatment systems. This may well be the homeowner for an individual system. However, for multiple-household and community systems, this important function requires an RME, with the legal authority and administrative capabilities to make maintenance arrangements and be accountable.

An organizational structure is necessary to set up the ownership and/or management of these more complex wastewater treatment systems. This section identifies some organizational tools to help a community implement a wastewater project. It discusses the need for an organizational structure, the kinds of organizational structures available, and the pros and cons of each kind.

Ownership of the System

The primary responsibility for a wastewater treatment system is always with the owner. Homeowners must manage their own individual OWTS, while community wastewater treatment plants are managed by the municipality. With more complex OWTS, management of these systems has become more complex as well. Today there is emphasis on managing systems through a RME to improve performance that also underscores the need for more accountability. More and more multiple-household cluster OWTS and community wide wastewater solutions are being used to provide effective wastewater treatment for communities. These systems offer new and more complex ownership and management challenges. Citizens expect accountability in the design and management of these systems because of the volume of wastewater treated and the potential for major problems. No matter who owns the system, one thing is definitely clear—it is in the best interests of the owners and the community to see that operations are properly overseen.

Why You Need an Organization

We all need organization in our lives. We may have fairly routine schedules for sleeping, working, eating, and raising our families, but we may also have more

When multiple landowners manage wastewater together, a legal and responsible entity is usually needed to work on behalf of the community members

complicated processes in our lives just to get things done—otherwise there would be chaos. Organization is also needed for a wastewater project. Many landowners just want to get their system fixed and be done with it. However, when there are multiple landowners and properties involved, a legal and responsible entity is usually needed to work on behalf of the community.

This entity, existing or new, can be used to:

- provide continuity and sustainability for the project;
- acquire property and easements where necessary;
- obtain and administer financing;
- negotiate contractual agreements;
- protect individual and community interests;
- develop ordinances, rules, and policies to protect property owner's rights and the project;
- enforce laws and rules;
- provide recovery of costs from damages to the system;
- budget and levy to plan, build, manage, repair, and replace the system;
- provide on-going evaluation and long-term accountability; and
- provide inspections/certificates when needed for property sales.

All of the above services are needed, in one form or another, depending on the number of landowners involved. Several organizational formats have been used for many years while others are new or variations of existing models.

Types of Structures and Selection

There are many different structures allowed across the US for owning and managing a utility. Much of the specifics of these structures is dictated by local statutes and rules. Some of these approaches still rely upon individual property owners to take the lead on managing their systems. More complex structures are more common when community solutions are being examined due to the system, funding, or management.

Many funding sources require the funds to be allocated to a governmental unit. Before deciding on an ownership structure, the funding source requirements must be known. There are three levels of financial assistance to be considered—local, state, and federal.

A community must understand the responsibilities associated with various funding programs, hoops to jump through and application formalities. One of the considerations is requirements related to structure ownership and funding. Tribal entities may serve in the role of government or non-governmental structures. Figure 46 shows the overarching options available which are discussed more in the rest of this section, be sure to confirm locally.

Another item to consider when evaluating structures are the project boundaries. Prior to choosing a structure, community education can convince residents that they need improved wastewater treatment before drawing project boundaries. Residents with compliant wastewater treatment systems included within a project’s boundaries may not support a new wastewater treatment system if it will cost them money. The scale of the project often impacts the need for and scope of a RME. The following section describes various structures used today and provide some information about the differences between them.

Structure #1 - Individual Landowners

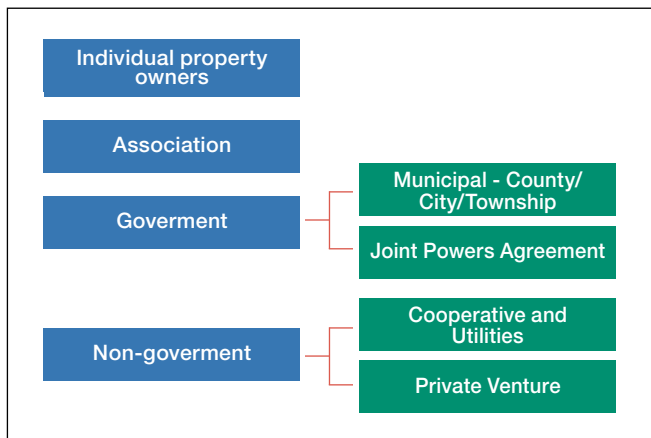


Figure 46. Wastewater management structures

The vast majority of OWTS across the US are owned and operated by individual property owners. This puts operational responsibility on the property owners who may be limited by time, financial resources, or lack of understanding about their system. For OWTS that are more complex due to marginal site conditions or proximity to an environmentally sensitive area, failure to maintain these systems can result in public or environmental health damage.

Structure #2 - Associations

Homeowner Associations (HOA) are sometimes created when parcels of land are subdivided, parceled out or can be created after the fact. HOA typically have mandatory association membership of the residents and other controlling conditions such as wastewater treatment which may be incorporated within the covenants of the subdivision. These stipulations are then agreed to when residents purchase properties covered by the HOA. HOA typically operate through a board of directors who manage and maintain the subdivision. A number of ownership associations are organized as nonprofit organizations or limited liability partnerships.

Associations can also be organized around a resource such as a lake/reservoir, river, or estuary. Like a HOA, they may cover part or all of a water body region and can be formally or informally created to take care of the water body and protect it. Sometimes they are formed as nonprofit organizations with some powers; however, these oversight groups may not have legal authority over wastewater. These types of associations can be a catalyst between the landowners near the water body and the local township, city, or county governments to get a project done. They may be able to assist with funding for initial planning or be the fiscal host for a survey of OWTS in the area. See Table 7 for the advantages and disadvantages of HOA.

Table 7. Association structure advantages and disadvantages

| Advantages | Disadvantages |
|---|---|
| Early catalyst for action: group already in place and can assist with education efforts | May lack ability to levy for funds, fee collection difficulties, and apply for public funds |
| Can provide some early funding, can apply for funding | Rule/ordinance enforcement difficult |
| Can play a role in the management of the system | New homeowners frequently lack the knowledge, interest, and incentives of the original organizers |
| Valuable in identifying the need for projects | May lack long-term accounting and management abilities/skills |

Structure #3 - Government Structures

Local Unit of Government (LGU) – A unit of government can own and manage decentralized systems. This can be a county, city, or special district. Eligible structures are dictated by state legislation, which will vary state by state. See Table 8 for the advantages and disadvantages of system governmental ownership.

Districts - Some areas have regional districts that have similar powers to a municipality commonly organized around a lake, watershed or other area needing improved wastewater treatment. Districts are typically formed at the request of citizens to focus on a problem such as water quality. Within a district, a board of managers representing the entities involved can be created to operate the district. The district typically has the ability to levy taxes and write and enforce ordinances, but not always. Districts can

often charge fees or borrow funds. Over time, the rules and authorities can help this model to become more efficient. This entity, either municipal or a district, can employ licensed staff trained on various wastewater treatment systems or contract out the maintenance activities. The district can be small or very large depending on the needs. See Table 9 for the advantages and disadvantages of district oversight.

Joint Sewer Authority/Powers Agreement - This structure is an agreement between governing entities that have similar powers to provide services outside of their normal jurisdictions. The terminology can vary locally – joint powers agreement or joint sewer agreement are commonly used. The joint powers agreement has everyone maintaining ownership of their pieces of the system, but they agree on who is doing what and how costs of joint pieces will be shared. In a joint sewer authority, a new independent entity is created. It does not fold if one entity drops out. The authority owns all of the

Table 8. Municipal structure advantages and disadvantages

| Advantages | Disadvantages |
|--|--|
| An existing unit of government with structure to provide services, collect fees, etc | Must have resources and staff to manage |
| Can cover a large area and plan for long-term population change | All residents are responsible financially |
| Municipalities can apply for most funding as they are a governmental agency | May add to the tax burden of the overall community |

Table 9. District structure advantages and disadvantages

| Advantages | Disadvantages |
|--|---|
| Created by the request of property owners within proposed area so the district is welcomed | Large size can be challenging |
| Focused on improving water quality and sometimes providing drinking water | All residents of district responsible financially |
| Can be formed quickly (some types) | May be created by small number of residents without broad support |
| Can change and evolve over time as the needs change with flexible boundaries | District must make sure that all costs are recoverable, and an accountable service provider manages the system. |
| Costs for services are borne only by those who use the services | Resources not available from larger tax base |

pieces of the system and all of the debt. The participating entities have representation on the board.

They require a defined agreement that spells out the powers and responsibilities for all entities involved. Normally a board is appointed to represent the entities and the group’s financial debt would need to be insured. These agreements have been used for Fire Districts, community halls, and so forth; however, they have been rarely used to implement and sustain wastewater or water projects. One reason that they might not be used as often in these instances is that either entity can undo the agreement by written notice and therefore this is not a reliable tool for a long-term project. Second, most entities do not want to bond these projects and have the debt considered part of their net debt. If there is a default by one member, the rest would be required to levy on their constituents for the recovery. See Table 10 for the advantages and disadvantages.

Structure #4 - Non-Governmental Structures

Cooperatives and Utilities

Cooperatives and utilities can manage electrical, water supply, wastewater, or other community infrastructure

for its members and shareholders. They may be an option to provide potable water or wastewater treatment and management services along with financing or refinancing the construction, operation and maintenance of treatment works, wastewater systems, storm sewer facilities, water pipelines, and related facilities. An existing wastewater utility could function as an RME, and homeowners with individual or community systems could be covered under that RME with a sewer bill.

This is logical because, first, the landowners usually receive their electrical power and their bills from them and are therefore current cooperative members, and second, the cooperative usually works with the local governing entity to protect themselves for the recovery of unpaid service charges. Third, the cooperative will try to keep costs down and be efficient for their shareholders. There is usually good communication with the utilities and minimal intrusion to the area’s culture, as compared to bringing in someone new. There typically needs to be a relatively large customer base to spread out the costs.

See Table 11 for the advantages and disadvantages of cooperative and utility management.

Table 10. Joint sewer agreement structure advantages and disadvantages

| Advantages | Disadvantages |
|---|---|
| Facilitate addressing issues that cross political/legal boundaries | Any partner can withdraw, leaving remaining partners with obligations |
| Agreements carefully spell out issues, powers, and responsibilities | Time consuming appointed board; multiple hearings; carefully outlined and detailed agreement |
| Are used frequently for special projects | Require an operating budget, bonding to finance may affect other entity’s financial obligations |

Table 11. Cooperative or utility structure advantages and disadvantages

| Advantages | Disadvantages |
|---|--|
| Organizational experience in managing projects, collecting fees and related activities | Service not available in many areas |
| Existing infrastructure can assist with project and may shorten timeline of implementation | Staff may not have wastewater treatment experience |
| Model includes existing 24/7 customer service accessibility & response structure to address service outages | Economy of scale may not work for small projects |

Private Venture Structure

Private companies can own the system and employ trained staff to manage the system. This structure is not well established in industry and therefore not widely available. This company structure may exist and have management capabilities in areas other than wastewater. The outside company can oversee all properly licensed management needs and make a profit as part of their business.

Finding the Best Fit

There are many reasons to consider an organizational model for your group projects. Some organizational structures have been successful for a long time and cover very large demographic areas, while others have been unsuccessful because they lack statutory powers for bonding, financing, enforcement, and ordinance work. Recently there has been an interest

in developing more flexible tools to help landowners in lake regions as well as in subdivisions and areas around cities. The most flexible model has been the Subordinate Service District, which uses the local utility to provide the final component in the picture—management and maintenance as well as long-term accountability.

It is important that as you review the different organizational models, you find one that fits your needs and that you can work with successfully. It is also important to realize that the system will be there for a long time, and therefore, your involvement throughout the project from beginning to end is also very important.

A final tip: When you have decided on the type of organizational model that will fit your needs, be sure to collaborate with an attorney familiar with the model to get it set up correctly.

Case Study

* Case study information based on <https://www.westernvawater.org/about-us/general-information/history-of-the-authority> and 'Getting past the politics to deliver water' by Gary Robertson and John Wilkes provided by WVA.

The Roanoke Valley is in Southwest Virginia and is surrounded by mountains. Four different governmental bodies operate in the Valley: City of Roanoke, City of Salem, Town of Vinton and Roanoke County. Each of these governmental entities addressed water and sewer needs within their jurisdictional boundaries independently with one exception. The City of Roanoke's wastewater treatment plant served multiple jurisdictions with the localities owning capacity within the facility and maintaining their own collection systems.

Drought conditions in the early 1980's prompted the jurisdictions to call for collaboration to address the lack of adequate water supply and interconnections within the distribution system. Over the next ten to twenty years there were multiple discussions, options to participate in a new reservoir in the County and consolidating the water systems but giving up independence and assets was not universally agreed upon.

It wasn't until 2002 when another major drought hit that talks began in earnest. One of the water treatment facilities was undergoing a transition to membrane treatment when the drought hit, compounding the City of Roanoke's lack of water. Bulk purchases from the County were the solution. Along with the drought, the wastewater water plant was facing upgrades to address wet weather flows due to leaky sewers in both County and City's collection systems. It became apparent to the City and the County officials that coordination of assets was needed to address the issues.

An Authority was the mechanism that was chosen to merge the City of Roanoke and Roanoke County's assets and staff. A steering committee was formed to facilitate the transition that included the County Administrator, City Manager, finance directors, attorneys, and utility directors. The three guiding principles of the negotiations were:

- "The County and City would have equal representation on the Board of Directors;
- The assets of both organizations would be combined for the common good of the citizens; and
- There would be equalization of rates for all customers over a reasonable period of the time" (Robertson & Wilkes).

Many meetings were held with officials, staff, and customers to provide accurate up-to-date information and to gain insight from attendees. Merging the staff between the two utility departments was accomplished by creating 23 employee teams that discussed and made recommendations on operations, benefits, and even uniforms.



Roanoke Valley. <https://virginia-map.com/wp-content/uploads/2022/11/city-of-roanoke-collaborates-with-community-partners-to-map-hot-test-2.jpg>

In early 2004, the formation of the authority was approved by both jurisdictions. On March 2, 2004, the Commonwealth of Virginia bestowed the state Articles of Incorporation on the Authority. The Western Virginia Water Authority became operational on July 1, 2004. The Authority's first year budget was \$1 million dollars less than the combined previous budgets of the City and County utility departments.

The original board had seven members: three from the City of Roanoke, three from Roanoke County and a seventh member was selected by the other six members and confirmed by Roanoke City Council and the Roanoke County Board of Supervisors. The City of Salem and the Town of Vinton remained bulk customers but did not enter into the authority.

Since then, two surrounding counties, Franklin County (2009) and Botetourt County (2015) have joined the Authority, and the Board has expanded to provide one representative from each County. The Authority purchased the Town of Boones Mill's assets in 2021 and the Town of Vinton's assets in 2022.

Currently the Authority serves 69,000 water customers and 60,000 wastewater customers. They also provide contract operations for several neighboring systems.

Funding

When cost estimates for a wastewater project become known, people start to wonder if there is a source of “free money” into which they can tap. This perception was created in the 1970s when federal construction grant funding was accessible. Money was abundant, especially for large projects to protect lake areas and clean up the environment. Congress passed the Clean Water Act and the Federal Pollution Control Act and authorized federal funding to get the job done. If a project received a high priority rating because of need and water quality problems, it may have been subsidized nearly 100 percent. In the 1980s, Congress began to cut grant funding and established 20-to-30-year low-interest loans for wastewater systems. Congress also required that federally funded projects set up a sinking fund—or depreciation fund—that would provide cash to replace equipment in the system when it wore out. Most projects showed that funding on paper, but when equipment needed repair or replacement, the money was not there. Today small communities in rural areas still face major wastewater problems because they were never rated as high priority in earlier legislation. Another issue is that some small communities that did receive funding did not adequately account for depreciation and O&M needs to sustain systems and are now facing major upgrade and replacement costs.

Today grant money is rarely available for wastewater treatment systems to fund the entire system. Grants are focused on planning and feasibility studies for large areas with multiple and complex issues, and to help low-income areas. Grants may possibly be used to buy down the initial costs of a project when the debt service and operation and maintenance costs exceed a prescribed percentage of the homeowners’ income levels.

This section provides a basic outline of the principals involved in financing wastewater projects. It discusses private and public grants and loans from local, state, and national funding sources. Since financing and grant/loan application rules are local and always evolving, this discussion does not go into detail. When applying for grants and loans of any kind, communities may want to use professionals: you may need the services of an attorney, accountant, a grant or loan writer, an engineer, and others.

Funding Concepts

There are many concepts and numbers to grasp as your community works through financing a project. If the project is very large, you will need a professional who has experience organizing finances and completing applications. Look for a grant writer with knowledge, skills, experience, and success with these kinds of projects. He or she must be willing to take the time to understand your situation and needs. Be sure to check references. There are no guarantees in applying for grants or loans, but a grant writer who understands your project and has sufficient information to build a good application can be more successful. See Section 2 of this manual under Working with Consultants for more information. Keep in mind that even when you hire someone to write your application, you may still not get the funding. Life cycle costs and capacity development are two terms homeowners should understand before starting to look for financing for a community wastewater project. These terms help you to understand concepts used by engineers and funding organizations.

Life Cycle Costs

The concept of life cycle costs is frequently used by engineering professionals but may be unfamiliar to landowners. Life cycle costing includes the capital or construction

LIFE CYCLE DEFINITION

The total cost of a project over its life, including design, construction, operation, maintenance, repair, and replacement

costs plus related expenses such as land acquisition, engineering, legal fees, etc., and also the operation and maintenance costs of the system over a specified period of time. Usually this is a twenty-year period (standard in the profession), but it can be done for a longer or shorter lifetime as desired.

Total life cycle costs help homeowners understand the project and how it might fit the community. As an example, after reviewing a project’s life cycle costs, homeowners may better be able to choose from one of these two solutions:

1. a solution that has a high initial capital cost with low operating and maintenance fees. This solution may be more appealing to people on fixed incomes who cannot afford high monthly costs; or
2. a solution with a low initial capital cost if they are willing to pay higher operating and maintenance

fees over the life of the system. This solution may be more appealing to young families with growing incomes.

Doing life cycle costing on a project helps the decision process. Be careful to consider any differences in the years of life and categories of costs when comparing proposals.

Capacity Development

Successful projects must have the following capacity:

- Technical - wastewater system adequacy or a plan for appropriate collection treatment and dispersal along with skills to implement the solutions.
- Financial - revenue sufficiency for repayment and operation and maintenance, credit worthiness to obtain grants and loans with fiscal management.
- Managerial - staffing and organizational development, ownership accountability with links to external partners and programs.

The overlap of these three capacities is critical for the project to be successful in the long term as show in Figure 47. The ultimate goal is to have both water and wastewater systems that are self-sustaining.

Life cycle costing and capacity are used when a project requests funding. Therefore, when considering an application, especially at the federal level, use these concepts to frame your request for financial assistance. A project may receive funding without a plan using these concepts but is more likely to get funded and

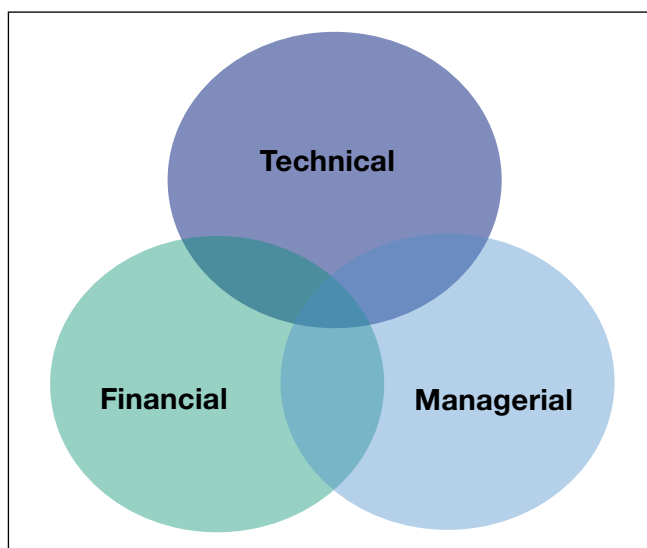


Figure 47. Capacity development needs

receive more money if the plan includes both initiative-taking approaches.

Funding Resources

There are three levels of financial assistance to be considered – federal, state, and local. As you go further up the funding ladder, there are usually more formalities to the application. Thoroughly review all of the requirements of the potential funding source being considered, because at times the reporting and work required to meet the contract requirements may cost more than the funds requested. Money is usually requested to do feasibility studies, planning, and construction of the project. Occasionally funds for project research may help with operation and maintenance costs for testing and analysis, but this is not common. It may take a combination of financing to help your community. If the community does receive a financial award, it will have added the responsibilities of reporting and fulfillment of the contract initiated between the community and the funding organization. You may wish to consider some staffing to do this depending on the requirements.

Eligibility

Many funding sources have requirements for funding application. It is critical to understand these requirements to determine if it is worth the time and resource investments. Common data needed to apply for funds include:

- Data about current systems failure - environmental and health impacts
- Proposed solution with rationale
- Structure of ownership – public or private
- Age and income of property owners
- Population including minority groups

Federal Funding

When you apply at the federal level for financial assistance, it is highly recommended that you work with a professional grant writer. Applications to the federal government have more formality and many legal implications attached to them. They also have strict reporting requirements that most often require knowledgeable staff to meet audit compliance. An accountant is important at this point. Homeowner income frequently determines eligibility for federal

loans or grants. The [Water Finance Clearinghouse](#) is an easily navigable web-based portal that helps communities locate information and resources that will assist them in making informed decisions for their community. The site includes a step-by-step guide with information and examples geared toward homeowner and small communities. There is an online module focused on local, state, and federal options to finance septic system repair or replacement. Below is a list of potential federal sources.

Environmental Protection Agency (EPA)

- **EPA Clean Water State Revolving Fund (CWSRF)**
 - Loans (with forgiveness options) available in some states to cover upgrading OWTS. Under the CWSRF, EPA provides grants to all 50 states plus Puerto Rico to fund state CWSRF loan programs. The CWSRF programs function like environmental infrastructure banks by providing low interest loans to eligible recipients for water infrastructure projects. As of 2024, eleven out of fifty states have funded septic system projects. **States** are responsible for the operation of their CWSRF program and for selecting the projects that receive assistance. CWSRF-eligible decentralized wastewater treatment projects include:
 - upgrade (e.g., nutrient removal), repair, or replacement of existing systems;
 - construction/installation of new systems; costs associated with the establishment of a responsible management entity (RME) (e.g., permitting fees, legal fees, etc.); and
 - septage treatment works and pumper trucks to support the proper maintenance of decentralized systems.
- **EPA Nonpoint Source Section 319 Grants** - Under section 319 of the Clean Water Act, EPA provides grants to states to control nonpoint sources of pollution from a variety of sources such as agricultural runoff, mining, and malfunctioning onsite septic systems. Some, but not all, states use these grants to construct, upgrade, or repair onsite systems. Depending on your state's NPS management program, grants may be available to construct, upgrade, or repair individual septic systems. Please note that individual homeowners are not eligible to directly receive grant assistance through this program, as the grants are typically

provided to watershed organizations that are actively implementing watershed-based plans to restore impaired waterbodies.

United State Department of Agriculture (USDA)

- **Rural Home Loans Program** - Offers loan assistance to low and very low-income applicants. The amount of assistance is determined by the adjusted family income. Funds can be used to build, repair, renovate, or relocate a home, or to purchase and prepare sites, including providing water and sewage facilities.
- **504 Single-Family Housing Repair Loans and Grants Program**
 - Offers grants and low-interest loans to repair, improve, or modernize rural single-family homes or grants to elderly low-income homeowners to remove health and safety hazards, including septic systems. Loans may be used on repairs and improvements and grants must be used to remove health and safety hazards. The maximum loan amount is \$20,000 and the maximum grant amount is \$7,500.
- **Rural Decentralized Water Systems Grant Program**
 - The Decentralized Water Systems Grant Program helps qualified nonprofits create a revolving loan fund for eligible individuals who own and occupy a home in an eligible rural area (those with population of 50,000 or less). The fund may be used to construct, refurbish, or service individually owned septic systems. The nonprofit must contribute at least a ten percent match and may offer grants to rural homeowners. Grant funds may be used to help a nonprofit create a revolving loan fund for eligible individuals who own and occupy a home in an eligible rural area. The fund may be used to construct, refurbish, or service individually owned household water wells and septic systems. Terms for the loans include a one percent fixed interest rate, a 20-year maximum term, and a \$15,000 maximum loan per household.
- **Water and Waste Disposal Predevelopment Planning Grants** - This program helps eligible low-income communities plan and develop applications for proposed USDA Rural Development water or waste disposal projects. State and local government, non-profit organizations and federally recognized tribes can apply in areas with populations under 10,000 that have a median household income below the poverty line or less

than 80 percent of the statewide non-metropolitan median household income.

- WEP** - The Water and Waste Disposal Loan and Grants Program provides funding to eligible rural areas with populations of less than 10,000 for drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage projects. The program provides low interest loans with a grant potential of 45 percent or up to 75 percent. The program can provide up to 75 percent grant funding if the median household income (MHI) is below the poverty line, or 80% of the statewide MHI and the project alleviates a health or sanitation issue (includes failing septic systems). Financial audits are required for USDA-RD loans and grants, as well as a commitment to revenue collection during the life of the loan. The loan periods are up to 40 years with fixed interest rates. The grant recipient typically owns and maintains the system that is funded. Applications are accepted year-round through RD Apply.
- Search Grant** - The program helps very small, financially distressed rural communities with feasibility studies, design and technical assistance on proposed water and waste disposal projects. State and local government entities, nonprofits, and federally recognized tribes may apply. The area to be served must be rural, with a population of 2,500 or less, and have an MHI below the poverty line or less than 80 percent of the statewide MHI. Applications are accepted year-round through RD Apply.

Other Federal Programs

Department of Housing and Urban Development (HUD) - Provides funds to states through community development block grants. The grants fund various projects, including rehabilitation of residential and nonresidential structures, construction of public facilities, and improvement of water and sewer facilities.

Economic Development Administration (EDA) - Administers various funding programs to promote collaborative regional innovation, public/private partnerships, national strategic priorities, global competitiveness, and environmentally sustainable development.

Federal Emergency Management Assistance (FEMA) - Has resilience grants to plan before a disaster and recovery grants for after a disaster. Can be used to update OWTS.

Sanitation Facilities Construction Program (IHS) - The Indian Health Services (IHS) provides grant funding for sanitation facilities for American Indians and Alaska Natives. These funds are administered through the twelve IHS area offices.

Clean Water Indian Set-Aside Program (EPA) - EPA works with IHS to fund wastewater projects for American Indian and Alaska natives that are not picked up by the IHS grant fund program. Communities with a native population should consider these funds to help offset costs. EPA funds projects from the IHS list of projects, so the application is through IHS. Table 12 below has a summary of the federal funding programs and eligibility criteria.

Table 12. Summary of federal funding programs and criteria

| Eligibility Criteria | EPA CWSRF* | EPA NPS 319 | USDA Rural Home | USDA Single Family (504) | USDA Rural Decentralized | USDA WEP | USDA Search Grant ** | HUD CDBG | RCAP | EDA | IHS Sanitation Construction | EPA Indian Set Aside |
|------------------------------|------------|-------------|-----------------|--------------------------|--------------------------|----------|----------------------|----------|------|-----|-----------------------------|----------------------|
| Age >65 | X | | X | X | | | | X | X | | | |
| Low Income | X | | X | X | X | X | X | X | | | | |
| Tribal | X | X | X | X | X | X | X | X | | X | X | X |
| Non-government organizations | X | X | | | X | X | X | | | X | | |
| States | X | X | | | | X | X | X | | X | | |
| Local/County Government | X | | | | | X | X | X | | X | | |
| Population | | | | | <50,000 | <10,000 | <2,500 | | | | | |
| Other | Need | | | | | | | | | | | |

*Lower income communities may qualify for loan forgiveness

** Is only for feasibility, design and technical assistance

State Funding

At the state level, there may be several opportunities for grants or loans. Below are examples of state level funding programs:

- State Revolving Loan Funds (SRF funds) are low-interest loan funds available for municipal wastewater and non-point source projects. To be eligible for funding, projects must be publicly owned, but all types of systems, including individual septic systems, can be funded if they are publicly owned, managed and maintained under a centralized management structure. These are federal funds administered at the state level.
- Wastewater Infrastructure Funds (WIF funds) are state grant funds used in connection with the SRF loan program and with USDA Rural Development grant and loan funds.
- Drinking Water State Revolving Funds are available for municipal and nonmunicipal drinking water projects and may assist when a water system needs to be upgraded when a wastewater system is being constructed. These are federal funds administered at the state level.
- Department of Agriculture Best Management Practices Loan Program is funded in part by the SRF and was designed to help on-site systems and to encourage the use of agricultural best management practices. Some states allow the funds to be used for OWTS.

With all state funding programs, it is extremely important to meet all application deadlines. Most of them have only one or two deadlines each year. If you miss a deadline, you may miss an entire construction season. Even when the deadlines are met, if your project needs grant funds, you may find the process takes several years or more until funds are available so the project can start construction. To find out more about these funding resources, contact the agency or department for each program.

Local Funding

The local level has many resources to consider. Several are described briefly below; however, keep in mind that not all are available statewide and funding varies from region to region. Seek out those in your area and discuss criteria and timelines with their local contacts before beginning the application. Local contacts are

extremely valuable resources; using the information they provide will pay off with a much better application. Below are examples of local funding options:

- Local lending agency (bank, credit union, etc.)
- You may already be their client, and they may consider it a public service to help a group by offering a lower interest rate when it could help local economic conditions. They may also have a program to help low-income groups promote economic development in their communities. Group income levels must be documented.
- Watershed districts - May consider financing certain projects such as on-site wastewater surveys and/or feasibility studies and planning.
- Local water quality associations - Usually will consider the same projects as watershed districts and may help with education and survey work.
- Local water plans - County water planning agencies identify water quality problems and may allocate money for remedial actions. Contact the county offices to find the County Water Planner for information on this possibility. Although it may be a small funding source, it can get you off to a good start. Your County Soil and Water Conservation District may also be helpful, especially if you need help in land restoration.
- Corporate stewardship funding - Many large corporate groups make a financial commitment or annual allocation to their communities for protection of the local environment and economy.
- Regional Development Commissions (RDC) - may know of specific sources or be able to direct you to other possible contacts. They may also be helpful with some technical assistance.
- Local septic loan programs - Check with the local Environmental Services, Planning and Zoning or Health Department. Some have implemented local loan programs from permit proceeds, special taxes, or special state loan funds. Keep in mind that they may have some criteria for giving out these funds.
- Economic Development Authority (EDA) - Local EDA sometimes contribute funds if economic development benefits can be demonstrated.
- Endowments - Occasionally a private party will endow a project, but this is rare.

- RCAP – Some regions have access to limited amounts of direct project funding, often supported by philanthropic funding entities.

To find out more, contact local county and township people as well as the local economic development authorities. You may need to go directly to the financial contact in some entities. Remember that your project must have merit and be an asset to the area, with a goal of protection of human health, the environment and groundwater quality.

Tips for Applying for Financial Assistance

1. Do your homework so you know your community's situation, strengths, and weaknesses. Turn the weaknesses into strengths.
2. Get information from funding contacts while applying and be respectful of their time.
3. Attend any workshops offered regarding the application; they will provide ideas and beneficial networking as well as an opportunity to gauge your competition.
4. Set up a timeline to get work completed.
5. Break the application into working portions.
6. Write and rewrite; have others review your application narrative.
7. Schedule and make sure all necessary formal resolutions are completed on time.
8. Consider comparing and contrasting. A cost-benefit analysis that shows and justifies need is usually requested.
9. Be realistic in the amount of the grant or loan you are requesting.
10. Submit your application as requested and meet deadlines early; this reflects interest.
11. Consider expectations of the lender or grantor: What do they want in return?
12. If the project dollar amount is too large, consider staging the project over a period of years.
13. Leverage a very large project; do not go to just one source. Apply to multiple funding sources and show a percentage of funding coming from those to meet the project's needs. Ownership and willingness

to pay your own portion is one way to show that commitment.

It is important to accurately identify your project's goals, resources and the amount of money needed to complete the project. There are many sources of funding from private and public money at the local, state, and national level. The larger the project and the higher the level of funding, the more details and information you will need to provide up-front, and the more oversight and reporting will be required at the end.

Successful Funding Applications

Before you accept any type of financial assistance, read materials carefully to know what you are getting into and what is expected from the community. Repayment of loans is usually required. In the case of a homeowner association, the HOA will collect sewer fees to repay the loan. Repayment funds collected through property taxes helps homeowners avoid high upfront costs by allowing the lender to secure the loan using a lien against the property when the system is being installed. The loan is repaid through incremental increases on the property owner's property tax bill. If the system is owned by a cooperative, the utility will use collected fees as a Responsible Management Entity.

Rate setting must evaluate all the costs included with the solution. Planning, installation, inspection, operation, maintenance, repair, replacement, and administration are all costs that must be budgeted for. Administration costs include collection fees, reporting, record keeping, loan repayment, and education.

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Selection and Implementation

Learning Objectives

- Describe the data needed to select a system.
- Evaluate the options presented to determine which is most appropriate for your community.
- Describe the critical steps required during implementation.
- List the benefits of proper management.

In this section the selection and implementation of a successful wastewater treatment plan will be covered. It requires commitment and endorsement from the entire community to ensure the most appropriate option is chosen and the correct steps are followed to build and manage the system.

Criteria for Choosing a System

With so many options available, it is important your community follow a good decision-making process using all of the information you can get and evaluating it against the criteria identified by the community as important. Many communities that have dealt with sewage treatment issues have found the basic criteria below to be important.

- Source and site - Every wastewater treatment system design must evaluate source and site limitations. Many solutions are not feasible due to the requirements of the source(s) or the site characteristics.
- Treatment requirements – depending on location of the community and sensitivity of the environment permitting requirements may be more stringent than some technologies can meet.
- Life cycle costs - Life cycle costing includes the capital or construction costs plus related expenses such as land acquisition, engineering, legal fees, etc., and also the operation and maintenance costs of the system over a specified period of time.
- Complexity - Generally, as systems get more complex you will find increased costs for O&M requirements, replacement, greater knowledge, skills, and abilities of the operator/service provider, and increased permitting requirements (effluent standards and monitoring). There are situations where a complex system is the best/only solution; the community must understand the impacts.
- Appearance - Appearance and aesthetic considerations are extremely important for decentralized wastewater treatment systems, especially since they are located near homes, businesses, or in community spaces. The goal is often to make the infrastructure as unobtrusive or even beneficial as possible. Acceptance is influenced by the perceived annoyance (odor, noise, visual impact). Technologies that integrate with the landscape (like Constructed Wetlands) or are physically small/out-of-sight are generally better accepted. Conversely, a prominent treatment plant can be perceived as an undesirable eyesore, affecting local property values and social harmony.
- Reliability - A decentralized wastewater treatment system must consistently produce effluent of the required quality under all operating conditions and throughout its service life. While modern decentralized systems can be as reliable as centralized systems, their reliability hinges on different factors, particularly management and site-specific conditions.
- Longevity - The longevity of a decentralized wastewater treatment system is complex and highly dependent on a combination of factors, ranging from component materials to user behavior. The useful lifespan of a OWTS is often determined by its most vulnerable components, particularly the soil treatment area. Some designs provide secondary treated effluent to the soil which should extend the STA life expectancy.
- Ease or difficulty of management - The ease or difficulty of managing a decentralized wastewater system is highly dependent on the scale and the technology used. Generally, the complexity scales with the level of treatment required and the number of moving parts.
- Space required - Space considerations are a major factor in the design and selection of decentralized wastewater treatment systems, and they vary significantly depending on the chosen technology.
- Flexibility to manage changes in flow and wastewater contents - The flexibility of a decentralized system is heavily dependent on the technology selected and the incorporation of equalization measures.
- Impact on community culture and values - Decentralized systems strongly align with a community culture that values self-sufficiency and local control. Advanced decentralized systems incorporating reuse can transform wastewater to a valuable resource, altering the community's perception of water. Residents must trust the management entity (private or public) to properly operate and maintain the shared system. They also need to feel that maintenance costs and service quality are equitable among all users. A lack of trust can lead to non-compliance or system failure. The system choice can reflect and influence the community's approach to finance and affordability.
- Consistency with long term land use goals - The selection of a wastewater treatment system must

be thoroughly evaluated for its alignment with a community's long-term land use goals, as it can either support or undermine the desired pattern of growth. Consistency depends on the type of decentralized system chosen and the planning that accompanies it.

Making an Informed Decision

There are many ways to properly treat and recycle wastewater while protecting human health and the environment. As you make an informed decision for your community, it is prudent to consider all of the treatment options available. You need to consider both categories of treatment options:

- Decentralized individual or multiple-household on-site systems
- Collection and centralized treatment systems

The discharge point is a significant difference between systems: decentralized systems disperse back into the ground and centralized systems discharge to a surface water body. The on-going management of the system(s) chosen must play a key role in the

decision of how wastewater will be managed in your community.

Each community situation is unique, and all treatment options have their advantages and disadvantages. The number of new treatment options in the market make the choice of system more challenging than ever. You and your community have the opportunity to make the best choice. In choosing the right solution for your community, you must have a clear definition of the community's goals and identify all the criteria that will determine your choice in a crowded marketplace.

Implementation: What, When, Who, How?

All the planning in the world does no good without implementation. This final section discusses implementation beginning with a true story of how one community implemented a wastewater treatment project. The Otter Tail Lake case study provides community process ideas and a list of specific steps a community can take to move through the five distinct stages needed to implement a project.

Case Study

Problem Defined

The community around Otter Tail Lake in western Minnesota saw a decline in lake water quality. An environmental assessment revealed that substandard wastewater systems, untreated sewage discharges to surface waters, and intensive shoreline development contributed to high levels of phosphorus in the lake, causing elevated algae growth and an overall decline in water quality.

Process followed

A group of concerned citizens formed a task force which first identified that proper sewage treatment was critical to the future of their community. There were up front educational programs which lead to 85% of the owners agreeing with the formation of the District. The District was then formed to assure proper treatment at an affordable long-term cost which would maintain the rural character of their community. Approximately 75% of the residents are seasonal users of their homes.

Capacity Development

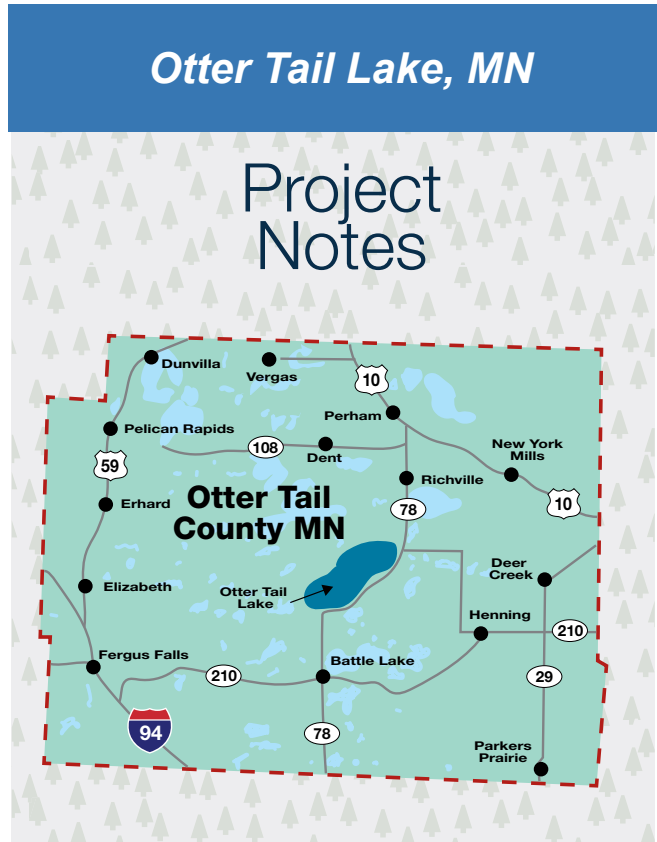
In this case, a Board of Managers representing the District was created to operate the District. The District has the ability to levy taxes and write and enforce ordinances fitting in EPA Model Management Program Areas 4/5. The Board is an independent entity that has the responsibility to oversee operations, hire a manager, set yearly operating budgets and user fees. It is a non-profit.

Implementation of the Project

In 1982, the final environmental impact study was completed, followed by final project and public hearings through 1984. Construction of 850 new individual onsite and cluster systems began in 1984 and was completed in 1985. The Otter Tail Water Management District was formed in 1984 as a mechanism to assure the proper onsite treatment of wastewater in a 55 square mile service area. Initially, the District served 1200 homes, cabins and businesses and expanded to cover over 1700 connections.

Evaluation

Water quality of the lakes within the District has improved in all measured parameters including a decrease in level of phosphorus and chlorophyll-A and an increase in Secchi disk readings (an indication of water clarity). The Otter Tail Water Management District is a success story for proper management of onsite systems with an effective yet modest level of inspection and maintenance. The District has documented a 5% failure rate over 30 years. System improvements and management occur at affordable costs resulting in improved lake water quality, improved property values while maintaining the rural character of the community despite moderate growth.



How Long Will Implementation Take?

To implement a community process that will be able to move the project to completion, the community team must collaborate with the entire community, including the naysayers and those who have the legal authority to make official community decisions. As can be imagined, there can be many barriers to face and hurdles to overcome throughout the process. Luckily, there are also many things that can be done to make the process move more smoothly.

Every community would naturally like to skip all of the struggle and go right to the solution. It does not work that way. It is the struggle that stimulates the people in the community to learn, to understand and negotiate their differences, and come to a solution that everyone can live with.

Finding a viable solution to community wastewater issues can take three to seven years from inception through implementation. Each stage has a range of time needed to accomplish its goals. Some stages will take more or less time because of the differences in the situations, people and processes used. Below is a typical timetable for assessment, implementation, and evaluation of wastewater treatment options. The entire process from start to finish breaks into five distinct stages:

- Stage 1 — Understanding the situation
- Stage 2 — Exploring the options
- Stage 3 — Making informed decisions
- Stage 4 — Implementing decisions
- Stage 5 — Managing the system

The following outline provides stage details. It suggests potential answers to the questions of what, when, who, and how, and your community must provide your community-specific answers.

Stage I: Understanding the Situation: Defining the Problem, Collecting, and Interpreting Community Information

Often a community becomes aware of a wastewater or water system problem because of a violation, inability to transfer a property title, wastewater surfacing, a contaminated well or a green lake. When one or more homeowners identify a wastewater problem, they can alert the community to the situation and define the

problem. The typical timeline for this Stage is six to twelve months with the following steps:

1. collect relevant community data – current sewage treatment method by parcel;
2. collect individual community member data;
3. interpret the data and develop a vision for the community; and
4. communicate the resulting information to citizens.

The key to success is involving residents and government officials in the project through informational meetings, social media, posting updates to a website, and discussions. They must be a part of formulating the community's vision, including the plan for managing wastewater, and in outlining the mission of the wastewater team. To buy in, they need basic information about wastewater, the problems created by wastewater and the many factors that need to be considered in finding solutions. All stakeholders are instrumental in interpreting the data and developing a community process plan. Working together is necessary and will happen through meetings and personal and mass communications.

Stage II: Exploring the Options: Treatment, Management, Organizational Structures, and Funding

Once community members complete Stage I, they are motivated to find the solutions to the problems. Making an informed decision involves having knowledge of all potential solutions. This investigative Stage is an opportunity for all the people with interest or skills in the various categories to participate. Involving a larger group than the steering committee will prevent burnout, bring diverse views to the table, facilitate a thorough investigation of the options, and provide a broader base of involved residents. Teamwork and leadership skills are important.

The typical timeline for this Stage is 18 to 36 months. The following steps are part of this phase:

1. Study options for your community in wastewater treatment, management, structure, and funding
2. Inform residents via newsletter, newspaper, social media
3. Acquire professional engineer/designer assistance

4. Develop a list of potential solutions with recommendations

Community members must be involved in this Stage by attending meetings of professionals, evaluation of the options, providing initial funds that might be necessary for this work (through organizations, taxes, others) and staying informed via newsletters and mass media sources.

Stage III: Making Informed Decisions: Sorting Out the Options

Stages I and II provide complete information to enable your community to begin making informed decisions in Stage III. Creating an organizational structure comes first. This structure is often necessary to enable the community to acquire funds and make legal commitments. In this Stage, attorneys and engineers enter the picture. There will be a lot of details to work out and negotiations with service providers, regulators, and funding sources.

The typical timeline for this Stage is three to twelve months and includes the following steps:

1. Identify collection, treatment, and dispersal/discharge technology options for the project
2. Establish organizational structure for the community
3. Authorize preliminary engineering report
4. Inform residents via newsletter, newspaper, social media

As decisions are made, community involvement is vital. If residents have been included in Stages I and II, they can continue to stay informed by attending informational meetings and using multiple media outlets. They can influence official decisions by discussing the options with authorized people. Make sure the community stays in charge. The resource people, engineers, consultants, and others should provide information, not make decisions for the community. Continue to provide information to the entire community, not only on decisions but also on the status of the project.

Stage IV: Implementing the Decisions: Final Plans and Construction

Stage IV puts Stage III decisions into action. Implementation of decisions is always exciting, but following legal processes is important. If residents have been informed and involved, they will support and legitimize the decisions. However, if they have not been

informed and involved, this Stage can be subject to significant community unrest and turmoil.

After the community decides on a system, the engineer or designer must draw the final plans and specifications and prepare a bid packet for installers. The community should review these plans to ensure they match the community decision. These plans will need approval from the permitting authority and should not be sent out until the approval has been granted. The project cannot start until all required permits are obtained.

The final cost can then be estimated but will not be 100% known until it goes out for bid. At this time, the plans can be shared with the community at a meeting, if possible.

In this phase Technical Assistance Providers (TAPs) can be helpful. Frequently the communities do not have the technical capacity to fully understand engineering reports or designs, or treatment option evaluations. TAPs can assist the communities through the process. Potential funding sources shall be considered for the type of engineering report or system required. Typically, federal agencies will require a preliminary engineering report and environmental report before approving funds or going to final design.

The typical timeline for Stage IV is one to twenty-four months. Stage IV includes the following steps:

1. Form organization structure (legal entity) and get required insurance
2. Develop and implement ordinance governing wastewater treatment
3. Review preliminary engineering report/design
4. Authorize design of the community system
5. Construction of the selected alternative
6. Legal entity begins operation
7. Continuously inform community via newsletter, newspaper, social media

During the authorization of the design, the community will hire an installer/contractor to build the system. When advertising the position, request a list from your county or state of licensed professionals. Determine if the company has experience installing the selected design. Some technologies require installation training from the manufacturer. If the system is large in scale, has the installer/contractor done similar projects? Look at the contractor's bid for cost-saving measures that will not compromise quality. The design engineer

should lead this review for cost saving. The community leaders should ask the contractor for a list of similar jobs and interview the community/owner and the system operators at these job sites. The installation company should have insurance, but the community may need its own as well. Throughout the process be sure to keep the community in the loop.

After the installation company has been selected and the final cost estimate is available, money needs to be available for the project. If easements are needed for the project either during construction or permanently, they need to be obtained. If a construction permit is required, now is the time to apply. Prior to construction, a walkthrough of the construction area should be conducted to document current conditions, identify impacts to properties, and finalize staging of the project and timeline. Owners impacted by construction should be informed of the schedule, how traffic may be impacted, how their property may be affected and how impacts will be mitigated. The oversight entity (inspector or construction administration) should be documenting the construction progress and reporting back to the engineer and community on a routine basis. Any deviations from the original design must be approved by the designer, permitting authority, and the community. Deviations may result from unknown site conditions or the lack of availability of a specified product. At completion, the oversight entity should do a walk through with designer/engineer and the community representative to assure everything was installed and completed as required. The permitting authority will likely also conduct an inspection and upon completion issue a certificate.

Stage V: Managing the System: Inspection, Monitoring, Operation, Maintenance and Administration

Stage V begins when the wastewater system(s) become operational: systems are operating, the management plan/operation and maintenance manual is being followed, and citizens are paying for the services they are receiving. Everyone is fulfilling their responsibilities and is accountable for them. Periodic review of the plan is important, and community leaders are aware of how wastewater needs may change in the future. The timeline for this stage is ongoing, until changes need to be made to address repairs, expansions, or upgrades.

The organizational structure:

1. Completes construction
2. Secures a management service provider
3. Performs administrative functions

The hiring of a service provider/operator is critical. The skills needed are based on system and permit requirements. Unless an RME already has someone on staff who meets the requirements, interviews should be conducted, a company chosen and a contract signed. The service provider may need training from the engineer/designer, installer, or product manufacturer.

Stage V lets community involvement take over. Homeowners begin using the system(s) and paying the costs. Residents are pleased with the service provided and feel that the payment and fee schedule are affordable and fair. Keep homeowners informed about the operation and performance of the systems. They should also attend meetings, use information provided by the organization and support needs as they arise.

Communication is critical throughout the process. Determine what method(s) will work best in your community. With larger projects, the local government staff may not be involved with the project permitting but it is wise to keep them in the loop. The system is operating, the management plan is being implemented, and citizens are paying for the services they are receiving. Everyone is fulfilling their responsibilities and is accountable.

Ongoing accountability is needed. Develop maintenance and management logs. Post the system's financial status. If monitoring is required, post the results. Annual meetings are a great way to keep the system top of mind for residents and provide an educational opportunity.

Whenever possible, an in-person or virtual meeting should be held with the community to describe the system, rules, and best management practices. Free training materials that can be customized can be found at:

- www.nowra.org/resources/homeowner-training-materials/
- online.flippingbook.com/view/162468359
- Free online course (under Homeowner): www.pathlms.com/nowra

Summary

Water use comes with responsibility for recycling it. Healthy communities work together to address what matters to them. They depend on properly functioning wastewater treatment systems to protect human health and preserve environmental quality. When your community addresses wastewater treatment issues, a successful outcome may depend more on the planning process than on sewage treatment technologies. People need to have a shared community vision and clear mission, leadership that will help them turn plans into action, and human, financial, and social resources to produce an outcome that meets everyone's needs and behaviors.

Solving your community's wastewater problems is not an easy, quick task, but taken one step at a time it is doable. Property owners will need to be involved in identifying current and future wastewater treatment problems, evaluating options, and making appropriate and informed decisions about financing, monitoring, operating, and maintaining cost-effective sewage treatment systems in the community.

To be successful in finding a viable solution to wastewater issues, community members need to clearly understand their current situation before they start looking for solutions. A steering committee creates a clearly defined mission and examines all options before making decisions. The committee will gather information from as many sources as possible and keep everyone involved and informed all along the way.

Every community has to decide which type of organizational structure will best make, implement, and manage a wastewater treatment decision. Your community needs to find funding for the project and will hire professionals and seek assistance from other resource people to make informed decisions. If your community group is informed and fully prepared to address wastewater issues, the decision making will be easier and will result in a viable solution that is a socially, economically, and environmentally responsible method to safely recycle your community's wastewater. Improving the overall management of a community's wastewater can be a challenging but rewarding goal.

Key Steps

- Communication
- Define the problem
- Collect data
- Hire a design professional
- Evaluate options
- Implement an organizational structure
- Identify funding sources
- Select an option
- Develop construction and permitting documents
- Secure funding
- Construction
- Implementation

Case Study

Background

- Established in 1715
- Coastal community at junction of Chesapeake Bay and Rappahannock River
- Dwindling population
- Public water to downtown area, but no central sewer
- Businesses could not expand and homeowners were faced with expensive repairs due to limited area
- Concern over sewage impact on health of water ecosystem
- Chesapeake Bay is impaired for N, P, and sediment

Goals

- Provide central sewer as part of the revitalization effort to improve economic growth and protect public and environmental health
- Build community by extending that offer of central sewer beyond the Town Boundaries

Challenges

- Small lots in Town limiting on-lot solution options
- Old on-lot systems required expensive repairs to continue
- Population at 60% of Virginia MHI
- No current public works department

Management

- Town of White Stone to be management entity
- Proposed to extend sewer to neighboring county lots
- County participated in meetings, Town Halls, and public events
- \$40/month residential; two non-residential tiers at \$100 and \$200/month
- Town owns and maintains on-lot components

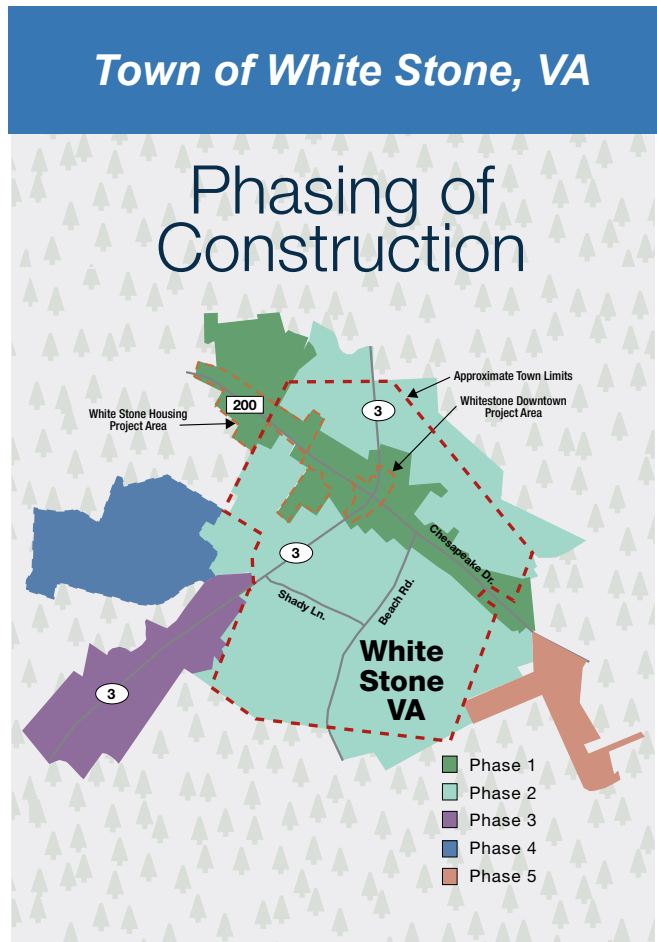
Approach

- Hired engineering firm to define project
- Project split into five phases
- Ultimate buildout design flow 80,000 gpd
- Selected low pressure sewer with individual grinder pump stations for collection due to flat terrain, low impact construction, and could be phased easily
- Permitting options:
 - Discharge system – rejected due to high cost to access stream discharge point and stringent limits due to Chesapeake Bay TMDL
 - Decentralized onsite system – selected due to good soils; effluent limits reasonable, monitoring and permitting costs much less than discharge system
- MBBR selected for treatment and drip irrigation for dispersal system

Funding

Phase 1:

- Included collection system through main part of town and installed 40,000 gpd treatment and dispersal system
- USDA provided bulk of funding with the rest from DHCD, Virginia SRF, Virginia Water Quality Improvement Fund, and SERCAP
- 75% in grant of \$6.8 M project



Phasing of construction

Phase 2:

- Adds more collection system and adds second treatment train and additional drip fields to bring total capacity to 80,000 gpd
- Funding from Virginia SRF, 60% in grant and the rest in low interest loan

Results

- Businesses can expand
- Population is growing again
- Concerns over failing systems eliminated
- Decentralized community system is operating well

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Appendix

Learning Objectives

- Appendix A: Homeowner Survey.
- Appendix B: How to Use the Web Soil Survey to Find Information about Your Land.
- Appendix C: OWTS Assessment.
- Appendix D: Community Wastewater Assessment & Solution Report Template.
- Appendix E: Request for Qualifications (RFQ) for Services.
- Appendix F: Request for Proposal (RFP) for Services.
- Appendix G: RFP Ranking System.
- Appendix H: Interview Questions.
- Appendix I: Reference Questions.
- Appendix J: EPA Management Model Summary.

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National Onsite Wastewater Recycling Association

Homeowner Survey

Please fill out this survey to the best of your knowledge.

Property Owner Information

| | |
|------------------|--|
| Name | |
| Property address | |
| Parcel ID | |
| Mailing address | |
| Phone | |
| Email | |

Home/Use Information

| | |
|---|--|
| Seasonal or full-time occupancy | |
| Square footage of home | |
| Number of people living in home | |
| Number of bedrooms | |
| In home business (if yes, indicate what) | |
| Washing machine (yes/no) | |
| Garbage disposal (yes/no) | |
| Water treatment device (if yes, indicate what and discharge location) | |
| Public water or private well | |
| If private well, depth of well | |

Onsite Wastewater Treatment System Information

| | |
|--|--|
| Year of installation | |
| Number/capacity of septic tank | |
| Date of last septic tank pumping | |
| Manholes to grade for service (yes/no) | |
| Type of system after septic tank | |
| Distance from septic system to well | |
| Distance from septic system to surface water | |

Please indicate any problems or concerns you have about your onsite wastewater treatment system:

Please provide a sketch of the home and property with any surface water or well locations on the back of this form.

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How to Use the Web Soil Survey to Find Information about Your Land¹

Mary G. Lusk²

Introduction

Many decisions about how you use and manage your land depend on soil properties. For example, the conditions of your soil can influence how it holds water and nutrients, which in turn influences how your soil can support plants including vegetable gardens, turfgrass, and ornamentals. Likewise, soil properties related to water-holding capacity (how fast the soil drains) have implications for building and construction activities, including the placement of foundations and septic systems. Because of the connections between soil properties and land management decisions in multiple areas of life, it is important to know how to find and interpret soil information. The United States Department of Agriculture's Natural Resources Conservation Service (USDA-NRCS) maintains a web-based tool for quick and easy access to soil data in the United States. The tool is the Web Soil Survey, and it contains helpful information, management descriptions, and cautions about potential limitations of soils in more than 95% of US counties. The Web Soil Survey is accessed at <https://websoilsurvey.nrcs.usda.gov/app>. The purpose of this publication is to provide step-by-step guidance on how to find soil data about a given parcel of land in the Web Soil Survey. This publication can be used by residents, growers, gardeners, construction personnel, landscape managers, septic system installers and inspectors, and many others.

Note that this guide is most applicable for using Web Soil Survey on a desktop or laptop computer.

Access the Web Soil Survey

1. Go to <https://websoilsurvey.nrcs.usda.gov/app>.
2. Click on the large green button that says "Start WSS."



Figure 1. The Start WSS button will lead you to the online version of the Soil Survey.

Credits: Web Soil Survey (2024)

Find Your Area of Interest

After clicking the green button, you are taken to a page that looks like this (see Figure 2):

1. Notice the **Quick Navigation** links on the left-hand side of the page.
2. You can enter an address, state and county, latitude and longitude, or other identifying information to find a place of interest. If you are interested in your home property,

1. This document is SL530, a publication of the Department of Soil, Water, and Ecosystem Sciences, UF/IFAS Extension. Original publication date February 2025. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication. © 2025 UF/IFAS. This publication is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/).
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it may be easiest to use the Address link and enter your home address.

3. In this case, click on **Address** and enter the address of the property you are interested in. Then click **View**.



Figure 2. Area of Interest (AOI) Interactive Map.
Credits: Web Soil Survey (2024)

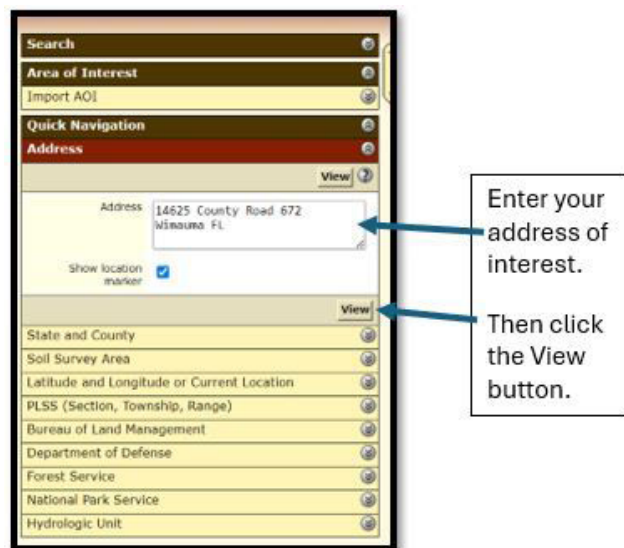


Figure 3. Quick Navigation links.
Credits: Web Soil Survey (2024)

Zoom in to a More Defined Area of Interest

1. After you click View, you will be taken to an aerial image of your area of interest. In this example, the area of interest is a farm in Hillsborough County, Florida.
2. Notice the buttons on the top left of the aerial image. They allow you to zoom in, zoom out, pan the screen (move left, right, up, down), measure distances between points, and other actions.
3. You can click on the second-to-last button that has a picture of a rectangle and the letters **AOI** under it. This will allow you to then use your mouse cursor to **draw a**

rectangle around a specific area on the map that you are interested in. For example, you may be interested in siting a septic system for wastewater treatment from your home and want to check soil properties of a specific location on the map, such as your backyard, etc.

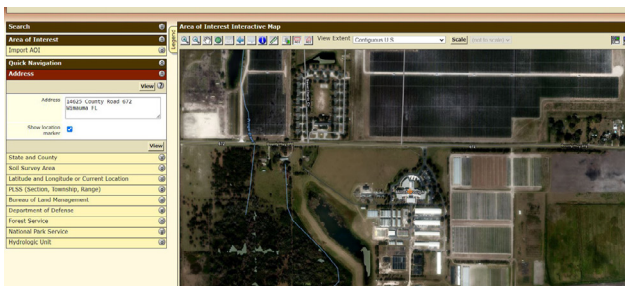


Figure 4. Aerial image of an example area, a farm in Hillsborough County, Florida.
Credits: Web Soil Survey (2024)



Figure 5. Buttons on the top left of the aerial image, including options to zoom in, zoom out, pan the screen, measure distances between points, and other actions.
Credits: Web Soil Survey (2024)

4. After drawing the rectangle on the map, the screen will zoom in to that area.

Learn about Your Area of Interest

1. Notice the **yellow navigation tabs at the top of the map** that say Soil Map, Soil Data Explorer, etc.
2. Click on **Soil Map**.
3. A legend will appear on the left of your map that lists the soils in your Area of Interest. In the case of the example here, there are two soil types: the Seffner fine sand and the Zolfo fine sand.
4. At this point, you can click on any of the **Map Unit Names** in blue to get basic information about each soil, or you can get more detailed information about soil uses if you go to the next step.

| Map Unit Legend | | | |
|--------------------------------------|--|--------------|----------------|
| Hillsborough County, Florida (FL057) | | | |
| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
| 47 | Seffner fine sand, 0 to 2 percent slopes | 0.2 | 3.2% |
| 61 | Zolfo fine sand, 0 to 2 percent slopes | 6.2 | 96.8% |
| Totals for Area of Interest | | 6.4 | 100.0% |

Figure 6. Legend displaying the soils in the example area (Seffner fine sand and Zolfo fine sand). Credits: Web Soil Survey (2024)

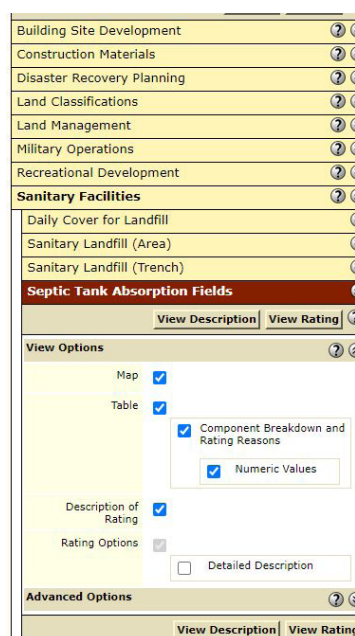


Figure 7. Categories of potential land uses. Credits: Web Soil Survey (2024)

The Soil Suitabilities and Limitations for Use

1. Click on the **yellow Soil Data Explorer** tab.
2. Click on the **yellow Soil Suitabilities and Limitations** tab.
3. Notice all the options to explore in the left-hand navigation box. These are categories of potential uses for your land (Building Site Development, Construction Materials, etc.). Clicking on one of the options will show the suitability and limitations of each soil in your area of interest for a given application.
4. In this example, we clicked on Sanitary Facilities and then Septic Tank Absorption Fields.
5. At this point, you can click on **View Description** to read text about that given soil use and how soils are rated for that use. You can then click on **View Rating** to see how your soils rate for that use.
6. After you click on View Rating, **scroll down** and see how each soil in your area of interest rates for the use category you chose (septic system absorption fields in this example).

7. In this example, we see that the Seffner fine sand has a rating of **Very Limited** for septic system absorption fields. The reasons for this are given in the table and include things such as depth to saturated zone, filtering capacity, and seepage. The numeric values given in the rating reasons can range from 0.0 to 1.0, with values closer to zero meaning the soil is well-suited for a use and values closer to 1.0 meaning the soil is poorly suited for a use. In this example, the Seffner fine sand has a value of 1.0 in almost all cases, meaning it is poorly suited for septic tank absorption fields.

| Map unit symbol | Map unit name | Rating | Component name (percent) | Rating reasons (numeric values) | Acres in AOI | Percent of AOI |
|-----------------|--|--------------|--------------------------|---|--------------|----------------|
| 47 | Seffner fine sand, 0 to 2 percent slopes | Very limited | Seffner (85%) | Depth to saturated zone (1.00) Filtering capacity (1.00) Seepage, bottom layer (1.00) | 0.0 | 0.2% |
| | | | Ona (4%) | Depth to saturated zone (1.00) Seepage, bottom layer (1.00) Filtering capacity (1.00) | | |
| | | | Pompano (3%) | Depth to saturated zone (1.00) Filtering capacity (1.00) Seepage, bottom layer (1.00) | | |
| | | | Smyrna (3%) | Depth to saturated zone (1.00) Filtering capacity (1.00) Seepage, bottom layer (1.00) | | |
| | | | Adamsville (2%) | Depth to saturated zone (1.00) Seepage, bottom layer (1.00) Filtering capacity (1.00) | | |
| | | | Florahome (2%) | Filtering capacity (1.00) Seepage, bottom layer (1.00) Depth to saturated zone (0.97) | | |
| | | | Spart (1%) | Depth to saturated zone (1.00) Slow water movement (0.47) | | |

Figure 8. Example Summary by Map Unit for Hillsborough County, Florida. Septic Tank Absorption Fields table. Credits: Web Soil Survey (2024)

Learn about Soil Properties and Qualities

1. Click on the top **yellow navigation tab that says Soil Properties and Qualities**. Many other soil properties are found here, and you can click through some of the tabs to see examples. For example, you can click on Soil Chemical Properties to see the pH of soils in your area of interest. This may be helpful if you are planning a vegetable garden or want to know how to select plants for your yard. Additionally, you could click on the Water Features tab to see information about the depth to the water table and how frequently the soil is expected to flood.
2. In this example, we clicked on Water Features and then Depth to the Water Table and saw that both the Seffner fine sand and Zolfo fine sand have 76 cm to the water table.

Figure 9. Example list for Soil Chemical Properties and Water Features. Credits: Web Soil Survey (2024)

| Map unit symbol | Rating (centimeters) | Acres in A01 | Percent of A01 |
|---|----------------------|--------------|----------------|
| 47 Seffner fine sand, 0 to 2 percent slopes | 76 | 0.0 | 0.2% |
| 61 Zolfo fine sand, 0 to 2 percent slopes | 76 | 0.0 | 99.8% |
| Totals for Area of Interest | | 0.0 | 100.0% |

Figure 10. Depth to Water Table example — Summary by Map Unit. Credits: Web Soil Survey (2024)

Conclusions

There are many types of data about soils in the Web Soil Survey that have not been shown by the brief examples here. By exploring the navigation tabs shown in these examples, you should be able to get a good idea of many

types of information that can be found. Soil uses include those related to agriculture and horticulture, engineering, construction, sanitary features, wildlife management, and others. Information on how the soils in your area can be used in these various ways can be found by exploring the navigation tabs in the Web Soil Survey.

As you navigate through the Web Soil Survey, you will sometimes see the question mark icon. You can click on that at any time for tips about how to use certain features.

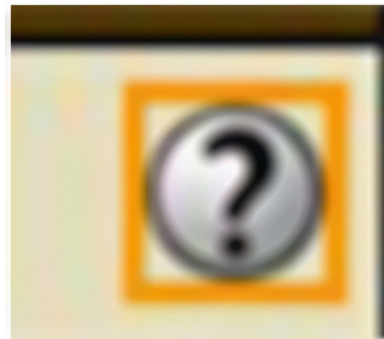


Figure 11. Question mark icon for tips about how to use certain features.

Credits: Web Soil Survey (2024)

For more information, consult the USDA's guidance document at <https://www.nrcs.usda.gov/sites/default/files/2022-09/How-to-Use-WSS.pdf>, which provides more detailed examples of the many uses of Web Soil Survey.

Reference

Web Soil Survey. 2024. "Web Soil Survey." United States Department of Agriculture, Natural Resources Conservation Service. <https://websoilsurvey.nrcs.usda.gov/app/>

ONSITE WASTEWATER TREATMENT SYSTEM ASSESSMENT

| |
|-------|
| Date: |
|-------|

OWTS Assessment Only Well and OWTS Assessment

| SECTION 1: ASSESSOR INFORMATION | |
|---|---|
| Name: | Affiliation: |
| Email: | |
| Phone: | <input type="checkbox"/> Mobile <input type="checkbox"/> Home <input type="checkbox"/> Work |
| SECTION 2: OWTS PARTICIPANT/OWNER CONTACT INFORMATION (SITE LOCATION) | |
| Name: | Physical OWTS Address: |
| Email: | |
| Phone: | <input type="checkbox"/> Mobile <input type="checkbox"/> Home <input type="checkbox"/> Work |
| Alt. Phone: | <input type="checkbox"/> Mobile <input type="checkbox"/> Home <input type="checkbox"/> Work |
| Mailing Address (if different): | Owner Name (if different): |
| Owner Mailing Address: | |
| Owner Phone: | <input type="checkbox"/> Mobile <input type="checkbox"/> Home <input type="checkbox"/> Work |
| Send Copy? | |
| SECTION 3: GENERAL OWTS INFORMATION | |
| Reason for assessment: | |
| OWTS Location (latitude/longitude preferred): | |
| <input type="checkbox"/> Legal Description <input type="checkbox"/> GPS <input type="checkbox"/> Google Maps / Google Earth | |
| Description/Comments: | |
| OWTS Discharge Location (latitude/longitude preferred): | |
| <input type="checkbox"/> Legal Description <input type="checkbox"/> GPS <input type="checkbox"/> Google Maps / Google Earth | |
| Description/Comments: | |
| Permit/Sizing Information | |
| Permit Number(s)/ID(s): | Date(s) of Permit(s): |
| Issued to: | Physical Address: |
| If permit is not available, please answer the following questions: | |
| # of Bedrooms: | # of Bathrooms: |
| # of People using the system: | # of Loads of Laundry per week: |
| Is home used: <input type="checkbox"/> Year Round <input type="checkbox"/> Seasonally | Garbage Disposal: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Other Sources for Information | |
| Installation Contractor: | Address: |
| Telephone: | |
| Service Provider: | Address: |
| Telephone: | Contract? <input type="checkbox"/> Yes <input type="checkbox"/> No |

| | | |
|--|--|----------|
| Pumper: | | Address: |
| Telephone: | Contract? <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| Agency/Agencies who issued permit(s) (if available): | | |
| Address: | | |
| Telephone: | | |
| Other Sources (ex. Previous Homeowner, neighbor, etc): | | |
| Address: | | |
| Telephone: | | |
| SECTION 4: WATER USAGE | | |
| Water Source: <input type="checkbox"/> Well <input type="checkbox"/> Spring <input type="checkbox"/> Public Water Supply <input type="checkbox"/> Other: | | |
| If on a public water system, what is the average monthly water meter reading? | | |
| Does the home have any of the following: <input type="checkbox"/> Water Purification System <input type="checkbox"/> Hot Tub <input type="checkbox"/> High Flow Shower | | |
| <input type="checkbox"/> Other large water use devices: | | |
| SECTION 5: LANDSCAPE PROPERTIES | | |
| Location on the landscape: <input type="checkbox"/> Upland area, uphill of any potential sources and runoff | | |
| <input type="checkbox"/> Floodplain for stream, creek, river <input type="checkbox"/> No flood risk, but below some potential sources | | |
| <input type="checkbox"/> Other (in woods, near a stream, vegetation, etc.): | | |
| How is the OWTS affected by surface water? <input type="checkbox"/> It is not affected. <input type="checkbox"/> Surface water flows across that area. | | |
| <input type="checkbox"/> Surface water accumulates in that area. <input type="checkbox"/> Water is always standing in that area, even during dry spells. | | |
| What is the vegetation like? <input type="checkbox"/> Green and lush, even during dry spells <input type="checkbox"/> Same as the rest of the yard <input type="checkbox"/> Nothing will grow | | |
| What kind of traffic goes over the area? <input type="checkbox"/> None <input type="checkbox"/> Foot traffic only | | |
| <input type="checkbox"/> Small equipment such as lawnmowers, ATVs, etc <input type="checkbox"/> Large equipment such as tractors | | |
| <input type="checkbox"/> Other: | | |
| Anything else to mention regarding landscape (ex. new building built near area, recent digging, etc.)? | | |
| SECTION 6: GEOLOGY/SOIL PROPERTIES | | |
| Information from: <input type="checkbox"/> System permit <input type="checkbox"/> Other: | | |
| Soil Classification/Perc Test performed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | | |
| If yes, do you have a final report? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | | |
| Was the soil: <input type="checkbox"/> Highly permeable <input type="checkbox"/> Average permeability <input type="checkbox"/> Low permeability <input type="checkbox"/> Very low permeability <input type="checkbox"/> Don't know | | |
| Additional factors: <input type="checkbox"/> Karst <input type="checkbox"/> Shallow water table - ft from surface | | |
| <input type="checkbox"/> Limited infiltration <input type="checkbox"/> Bedrock at surface | | |
| <input type="checkbox"/> Other: | | |

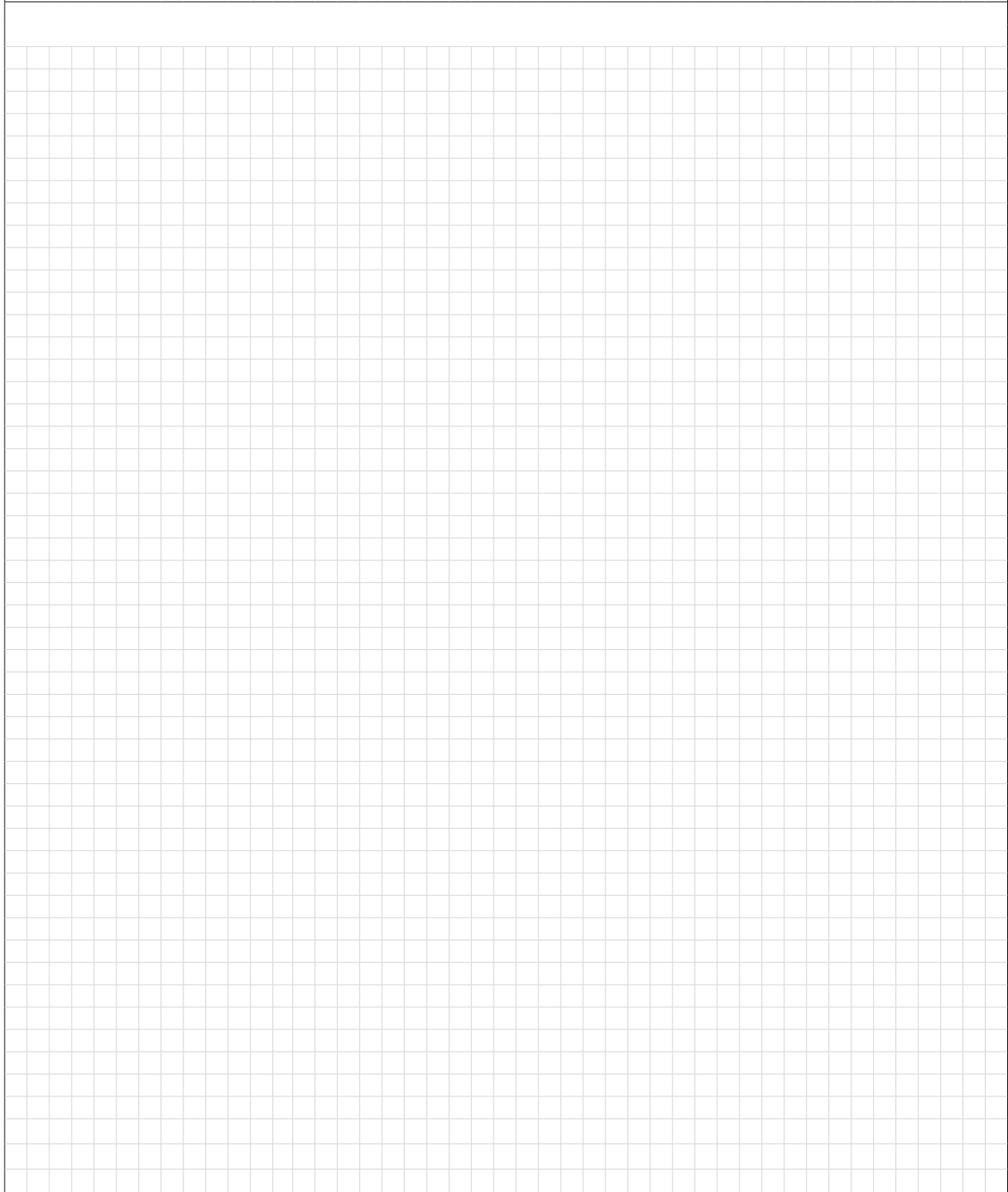
| | |
|--|---|
| SECTION 7: ONSITE WASTEWATER TREATMENT SYSTEM | |
| <i>Please locate on diagram</i> | |
| What year was the home/building built? | |
| Do you have the as-built records (drawings) of the onsite system? <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| What year was the system installed? | Was it a replacement OTWS? <input type="checkbox"/> Yes <input type="checkbox"/> No |
| What kind of OWTS system? <input type="checkbox"/> Conventional Septic System <input type="checkbox"/> Low Pressure Pipe System <input type="checkbox"/> Drip Distribution System <input type="checkbox"/> Spray Field <input type="checkbox"/> Mound Septic System <input type="checkbox"/> Sand Line Trench <input type="checkbox"/> Evapotranspiration Septic System <input type="checkbox"/> Lagoon System <input type="checkbox"/> Other: | |
| Year of last service: | What was done? |
| Has the system been dyed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | If so, what were the results? |
| SECTION 8: OWTS PRETREATMENT TANK (SEPTIC TANK) | |
| Tank Material Type: <input type="checkbox"/> No tank <input type="checkbox"/> Concrete <input type="checkbox"/> Steel <input type="checkbox"/> Polyethylene <input type="checkbox"/> Other: | |
| If buried, how deep? | Describe: |
| Size of tank: _____ gallons <input type="checkbox"/> Don't know | Age of tank: _____ (or year installed) <input type="checkbox"/> Don't know |
| Tank distance from home? _____ feet | Tank distance from well/spring (if applicable)? _____ feet |
| Is septic tank accessible with a manhole or an inspection pipe to grade? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | |
| What year was the septic/trash tank last pumped? | |
| How was the tank last pumped? <input type="checkbox"/> Manhole <input type="checkbox"/> Inspection Pipe <input type="checkbox"/> Don't know <input type="checkbox"/> Other: | |
| Was the tank dug up when the last maintenance was done? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | |
| Have there been any problems with the septic tank? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, please describe: | |
| Does the OWTS system have any of the following? Pretreatment: <input type="checkbox"/> Pump or siphon <input type="checkbox"/> Effluent screen <input type="checkbox"/> Distribution box or Drop box <input type="checkbox"/> Control Panel with audible/visible alarm <input type="checkbox"/> Other: If pump is present, how old is it? _____ years <input type="checkbox"/> Don't know | |
| SECTION 9: ADVANCED PRETREATMENT | |
| Type of advanced pretreatment: <input type="checkbox"/> Aerobic Treatment Units (ATUs) <input type="checkbox"/> Media Filters <input type="checkbox"/> Constructed Wetland <input type="checkbox"/> UV <input type="checkbox"/> Other: | |
| <i>If ATUs marked, please complete this section:</i> | |
| What year was the aeration/mixing tank last pumped? | |
| When was the air pump filter last cleaned? _____ | months ago |
| When were the diffusers last checked/cleaned/replaced? _____ | months ago |
| When was the last time amps were checked to ensure pumps were working at capacity? _____ | months ago |

| SECTION 10: FINAL TREATMENT | | |
|--|------------------------------|-----------------------------|
| Type of soil configuration: <input type="checkbox"/> Trench or bed Number: <input type="checkbox"/> Dispersal Media (e.g. rock/gravel, fabric-wrapped pipes, chambers) | | |
| <input type="checkbox"/> Drip Dispersal <input type="checkbox"/> Spray Irrigation <input type="checkbox"/> At-Grade Mound <input type="checkbox"/> Lagoon <input type="checkbox"/> Discharge to lake/river | | |
| <input type="checkbox"/> Other: | | |
| Are any other treatment utilized? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know | | |
| If yes, treatment device name and brand: | | |
| If yes, treatment purpose: <input type="checkbox"/> BOD ₅ reduction/removal <input type="checkbox"/> Nitrogen reduction/removal <input type="checkbox"/> SAS reduction <input type="checkbox"/> TSS reduction | | |
| <input type="checkbox"/> Other: | | |
| SECTION 11: OWTS SITE OBSERVATIONS | | |
| <i>Septic Tank:</i> | | |
| Are risers visible? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| If yes, are risers watertight with no visible leaks? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| If yes, are there any cracks or damages to the risers? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <i>Pump Tank:</i> | | |
| Is the riser watertight with no visible damage? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the control panel free of leaks, corrosion, or loose wires? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Has the OWTS alarm ever gone off? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| If yes, did the homeowner know what to do? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are floats or a transducer present? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <i>Sand Filter:</i> | | |
| Is the junction box free from corrosion and wire damage? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there effluent visible over the filter? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there standing water in the inspection port(s)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <i>Advanced System Panels:</i> | | |
| Is it clear around the panel so completely visible? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Can you see the alarm light? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the alarm sound connected (easy to disable)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there a sticker on the panel with emergency contact information? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Does homeowner understand what alarm means and how to respond? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <i>Drainfield (gravity or pressurized):</i> | | |
| Are there any noticeable odors? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there any effluent at the surface (soft, mushy areas)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the vegetation more lush and green? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |

| | | |
|--|------------------------------|-----------------------------|
| Gravity Drainfield: | | |
| Is there a distribution box? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the distribution box accessible? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Does the distribution box appear intact (no cracks or leaks)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is the distribution box level or have speed levelers? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Pressurized Drainfield: | | |
| Is there standing water in the inspection ports? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Mound System: | | |
| Are there any noticeable odors? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there any effluent at the surface (soft, mushy areas)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there any noticeable erosion? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are there sinkholes in the mound? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Spray Irrigation: | | |
| Is system disinfected as recommended? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Does the irrigation have an offensive smell? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Miscellaneous Questions: | | |
| Are additives used in the system? (not necessary or recommended) | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| is there an emergency power source (generator)? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Is there an identified reserve area for your drainfield? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Does a home business/cottage industry use the OWTS? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| If yes, specific type: | | |
| Have there been any recent plumbing leaks? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are there any old appliances or fixtures? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are any sump pump discharges connected to system? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are any greywater systems not going to the septic? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Are there any sewage backups/clogging into the house plumbing? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Has anything been added to the system since the OWTS was installed? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| Please describe (garbage disposal, hot tub etc.): | | |
| Any other issues with the Onsite Wastewater Treatment System worth noting? | | |

SECTION 12: DIAGRAM

Please make an accurate scaled drawing of the onsite system, site, and property. Please include location of all possible components, septic tank, mixing tank, pump tank/clarifier, sand filter, distribution box, drainfield, etc. Also include other relevant site attributes, like water well, spring box, garden, property lines, water features, water lines, livestock feedlot and enclosures, roadways, driveways, overland flow direction (arrow), chemical storage and mixing, fuel storage, burn pile, animal or waste burial, animal waste storage, etc. Should be able to look at this property in google maps and be able to identify the property with features.

A large grid area for drawing the onsite system, site, and property. The grid consists of 30 columns and 40 rows of small squares, providing a space for a scaled drawing.

SECTION 13: RECOMMENDATIONS, SUGGESTIONS, OR OTHER ISSUES WORTH NOTING

Areas that you should consider asking a professional installer/pumper, a professional plumber, or your local health authority for more information about include:

- Leaking/broken plumbing/backflow
- Maintenance needs performed
- Biomat buildup
- Additions to home, use, or number of people served
- Improper design/construction/installation
- Pump/alarm not working
- Electrical issues
- Ponding or atypical ground color
- Other:

SECTION 14: PHOTOS OF SYSTEM AND PROPERTY

A large, empty rectangular box with a thin black border, intended for the user to upload or paste photos of the system and property. The box occupies most of the page area below the section header.



Community Wastewater Assessment & Solution Report *Template*

- I. Title page; Table of contents with page references

- II. Introduction and project area description
 - A. Location, town or city, county, state
 - B. Information about the town: population and population trends, demographic information, potential and existing growth areas, potential and existing business and industrial zones, areas of declining population.
 - C. General statement about existing systems and statement of the problem goals,
 - D. Environmental resources in the area: geology, soils, aquifers, land-uses, impaired waters, water tables, existing sensitivity analyses and other environmentally sensitive resources
 - E. Current septage/biosolids management method
 - F. Any special conditions/features of this project; any previous work
 - G. Overview of work performed

- III. Existing conditions
 - A. Introduction
 - B. Description of methodology
 - C. Findings - List of all site parcels and site information. This is ideally an accounting of the parcels investigated, with specific parcel by parcel data. Determine if parcels with no current structure should be included. Map the parcels evaluated and all parcels to be included in the solution. Note if all parcels cannot be individually evaluated.
 1. Drinking water source
 2. Occupancy status
 3. Types of parcel (residential, commercial, industrial) and wastewater systems
 4. Compliance/status of systems
 - D. Summary of field work
 1. Number of parcels assessed
 2. Types of systems found
 3. Compliant vs. non-compliant
 4. Reasons for non-compliance

- IV. Alternatives analysis
 - A. Design flow(s) discussion for individual, cluster or community-based approaches
 - B. Identify regulatory criteria and possible compliance issues, permitting options, and concerns (local vs. state)
 - C. Describe potential solutions for each property in community and describe components of each option:
 1. Individual solutions
 2. Cluster solution(s)
 3. Regionalization solution

4. New centralized wastewater treatment plant solution
- D. Discuss recommendations for future service of empty lots and buildings and unoccupied homes and businesses
- E. For each alternative provide:
 1. Total budgetary project cost for each alternative
 - a. Design
 - b. Permitting
 - c. Equipment
 - d. Easements/property acquisitions
 - e. Construction
 2. O&M/permitting requirements
 - a. Minimum qualifications of maintenance professional
 - b. Annual operation and maintenance costs (staffing, monitoring, chemical, electrical, equipment maintenance/repair/replacement)
 - c. Septage/biosolids management
- V. Summary and recommendations
- VI. Appendices (provide all that that apply)
 - A. Summary spreadsheet
 - B. Wastewater maps
 1. All parcels in the project and existing OWTS status
 2. Parcels and their individual (on lot) options including all relevant setbacks
 3. Location of proposed cluster(s) and participating parcels with proposed routing of collection system
 - C. Soil survey information
 - D. Topography of service area
 - E. Flood plain map
 - F. Mapping of access restricted areas such as geologic, archaeological or historical protected areas
 - G. Homeowner surveys
 - H. Soil observation logs
 - I. Compliance inspection reports
 - J. Photographs
 - K. Land-use, geology, sensitivity and other natural resource-related maps
 - L. Any comprehensive planning maps or reports completed



REQUEST FOR QUALIFICATIONS (RFQ) FOR SERVICES

Instructions: Underlined areas need to be filled in, italicized portions need to be updated by the community.

The (City/Area) is seeking assistance for assessment/design/inspection/engineering services for evaluating options for wastewater treatment and subsequent implementation for (Program/Project name).

The type of project involved is: (Provide detailed description to give Respondents enough information to identify the required skill sets described in this RFQ including the required license(s))

Questions should be addressed to (community contact) at (phone number). Responses to this RFQ can be :

1. hand-delivered to: (community contact), at (mailing address)
2. mailed to: (community contact) at (mailing address)
3. emailed to: (community contact) at (email address)

Responses to this RFQ must be received no later than (date).

PART ONE: SCOPE OF SERVICES

The (City/Area) is soliciting qualification statements for services to assist the (City/Area) with (list of the general project services needed). The agreement will be on a *lump sum, fixed price basis (or cost reimbursement "not to exceed" basis)*, with payment terms to be negotiated with the selected offeror.

The services to be provided will include, but not be limited to:

1. List of services needed
2. List of services needed (add as many lines as needed)

PART TWO: REQUEST FOR QUALIFICATION STATEMENTS

The following information should be included:

1. Name of Respondent
2. Respondent address
3. Respondent telephone number
4. Related licenses of company/firm
5. Name, title address, telephone number, and email address of contact person authorized to contractually obligate the Respondent on behalf of the Respondent.

Contents of RFQ

Respondents should number and letter responses exactly as the questions are presented herein. Interested Respondents are invited to submit RFQs that contain the following information:

1. Introduction (transmittal letter)
2. Background and Experience
3. Specialized Knowledge
4. Personnel/Professional Qualifications

1. Introduction (transmittal letter)

By signing the letter, the Respondent certifies that the signatory is authorized to bind the Respondent. The RFQ response should include:

- a. A brief statement of the Respondent's understanding of the scope of the work to be performed.
- b. Confirmation that the Respondent meets the appropriate state licensing requirements to practice in the (city/state/jurisdiction).
- c. A confirmation that the Respondent has not had a record of substandard work within the last five years.
- d. A confirmation that the Respondent has not engaged in any unethical practices within the last five years;
- e. A confirmation that, if awarded the contract, the Respondent acknowledges its complete responsibility for the entire contract, including payment of any and all charges resulting from the contract;
- f. Any other information that the Respondent feels appropriate;
- g. The signature of an individual who is authorized to provide information of this nature in the name of the Respondent submitting the RFQ

2. Background and Experience

Respondents should:

- a. Describe Respondent's firm by providing its full legal name, date of establishment, type of entity and business expertise, brief history, current ownership structure and any recent or materially significant proposed change in ownership.
- b. Describe any prior engagements in which Respondent's firm assisted a small community with a related wastewater treatment project. Respondent should include all examples of work on similar projects as described in Part One. Respondent should provide the names, phone numbers, and emails of contact persons for these past projects.
- c. Describe the firm's workload and current capacity to accomplish the work in the required time.
- d. Describe any issue the characteristics of which would be uniquely relevant in evaluating the experience of Respondent's firm to manage the proposed project(s).
- e. Describe Respondent's firm's presence in and commitment to the area.
- f. Provide current information on professional errors and omissions coverage carried by Respondent's firm, including amount of coverage.

3. Specialized Knowledge

Respondents should:

- a. Describe their knowledge and experience in the particular types of projects described in Part One.
- b. Describe their knowledge of data and tools needed and available for successful completion of the project.



REQUEST FOR PROPOSALS (RFP) FOR SERVICES

Instructions: Underlined areas need to be filled in, italicized portions need to be updated by the community.

Project Overview - *Describe why the community is requesting proposals and give background on the project. Indicate what community data is already available.*

Sample Overview: The Community of (X) requests proposals to evaluate the current condition of 50 homes on Beaver Bay and provide recommendations to improve the wastewater treatment and reduce impacts to the Bay. The county is the permitting authority and has installation records for 40 of the homes. Homeowner survey data will be collected by the community prior to start date of the project.

Goal - *Give the outcome of the work you are advertising.*

Sample Goal: It is the goal of this project that residents will have the opportunity to be informed on current status of onsite wastewater treatment and potential options for improvement and so that they may participate in informed discussions about the recommendations.

Tasks - *List the tasks to be completed and the specific outcomes expected*

- Task 1
- Task 2

The contractor will work closely with the task force and other community members/ personnel. The contractor can add additional tasks if needed clearly delineating the costs for these items separately.

Project Term – *Provide the time period for the work to be completed.*

Sample Term: The term of this contract is anticipated to run from July 1, 2028 to June 30, 2029. The contract will begin on the date stated in the contract or upon full execution of the contract, whichever is later, and will be completed by (DATE).

[You should/must add a statement that issuing the RFP doesn't require the state to select a vendor or start the project]

This request for proposal does not obligate the (community) to award a contract or complete the project, and the (community) reserves the right to cancel the solicitation if it is considered to be in its best interest.

Project Questions: *There is a good chance that responders will have questions about the content of the RFP or the project; you should have them put their questions in writing and submit them to the contact person. The contact person should answer all questions in writing making sure that everyone who requested a copy of the RFP receives a copy of the answers. To assure that answers to the questions are received by all the potential responders at the same time, you should issue the responses to the questions via an addendum to the RFP. You might want to set a date by which all questions must be received and provide the answers with enough time left so the responders have opportunity to review the answers when writing the proposal. Remember all answers must be sent to all firms requesting proposals. Everyone must be on a level playing field with the same information.*

Sample Project Questions:

Prospective responders who have any questions regarding this request for proposal may contact:

- Person, title
- Address
- City, State, Zip
- email@email.com
- Telephone 555-555-5555

Other personnel are **NOT** authorized to discuss this request for proposal with responders before the proposal submission deadline. Contact regarding this RFP with any personnel not listed above could result in disqualification.

Proposal Content *[You have to determine what you want to evaluate in the proposal and then tell the responders what they must include in their proposals. Remember, if you don't ask for it, you may not get the information and this will create a problem when you begin the evaluation process.]*

Sample Proposal Content: Responders must submit the following information:

1. Contact information for individual and firm seeking the job
2. A statement of the objectives, goals, and tasks to show or demonstrate the responder's view and understanding of the nature of the contract. Indicate and Limitations, conflict, or exception in their offering.
3. A description of the deliverables to be provided by the responder along with a detailed work plan that identifies the major tasks to be accomplished and be used as a scheduling and managing tool, as well as the basis for invoicing.



RFP RANKING SYSTEM

These general topics may be discussed when interviewing a consultant about a variety of the tasks necessary to develop new wastewater treatment systems. The search committee should review these issues before the interview, agree on the total number of points you want to assign to each category, and provide clear guidance on the scoring scale. For example, you might rank each on a scale of 1 to 5, where:

- 1 = No experience/clueless;
- 2 = Subcontractor on project similar to ours;
- 3 = Active participant in project similar to ours;
- 4 = Designed, installed or managed project similar to ours; and
- 5 = Clearly expert on this issue or situation

Evaluating companies is similar to interviewing new employees. To the extent possible, ask for specific experiences and examples that address the issues described below. If an answer is unclear or not specific, ask the same question in a different manner. If a group is interviewing the consultant, rotate the role of questioner so that everyone has the opportunity to interact with the interviewee. Review insights or reactions immediately after the interview while impressions are still fresh. Take notes during the interview so that you can explain your ranking to the others.

Evaluation Criteria for Assessing Consultants

| Topic | Consultant #1 | Consultant #2 | Consultant #3 | Consultant #4 |
|--|---------------|---------------|---------------|---------------|
| Understands the problem | | | | |
| Experience in communities of similar size | | | | |
| Experience with financial institutions and funding agencies | | | | |
| Experience with state and county agencies | | | | |
| Willingness to work with and for our community | | | | |
| Meeting time and budget requirements | | | | |
| Staff capabilities | | | | |
| Soundness of approach | | | | |
| Technique of analysis | | | | |
| Sequencing of project | | | | |
| Method of project management | | | | |
| Location/home office (proximity to and familiarity with our community) | | | | |
| Success with similar projects | | | | |
| Total Points | | | | |

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Interview Questions

1. What successful experience do you or your firm have in working with communities such as ours? Please discuss similar projects you have worked on in the last year or two.
2. Do you have the necessary licenses or other requirements to work in the state/county? What are they? Do you know other professionals in the area who will be needed to complete the project, such as a pumper, installer, etc?
3. Are you familiar enough with our situation and the local area to know some of our particular needs?
4. What is the design philosophy of your company? Are you willing to look at innovative and/or alternative designs? What examples of this can you provide from past projects?
5. Are you familiar with various funding programs within our state for wastewater as they relate to communities or wastewater districts? What has your experience been working with these funding agencies? Has your company assisted communities with grant writing or funding applications? What has been the success rate of the applications?
6. If we told you that our goal is to keep the costs of treatment methods below \$25,000 per user, do you feel your company could produce a solution to meet this requirement?
7. Who specifically in your company would be working directly with our community? Who are the team members who will be working on this project, and what company do they work for if they are sub-consultants?
8. Will the lead consultant be willing and able to attend public meetings to discuss the project?
9. What other projects are you currently working on that could take precedence and time away from our project? Is your firm under any time constraints for this year?
10. How much of the work on our project would be subcontracted?
11. Do you offer to “carry” communities for the cost of the study until funding is obtained, or is partial payment expected?
12. What time schedule does your company propose for completing the scope of work? What challenges do you envision by meeting these timelines?
13. Are there specific itemized services that your firm cannot provide?
14. Does your company typically utilize a specific technology or a variety of technologies? What is it/are they? Do you sell equipment or have a commercial interest in any specific technology or agreement with a vendor?

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Reference Questions

Below are some questions to ask a reference regarding a consultant your community is considering hiring. May need to be adjusted based on your project

1. What services did the firm provide for your community? (for example, feasibility study, funding application, design, construction)
2. Were you satisfied with the quality of the work? Were they able to provide you with a cost-effective system?
3. Was the firm able to meet the time frame and schedules agreed upon in your contract?
4. Did the consultant have other projects scheduled that caused time delays in your project?
5. Were the costs and charges reasonable in relation to the work actually performed?
6. Who was the consultant assigned to your project, and was he/she knowledgeable about the funding program and its requirements?
7. Did the firm assist you with your application to your funding source? Was that application successful?
8. Was the consultant willing and able to work closely and effectively with your community and/or district board?
9. Did you experience any problems that would discourage you from hiring this firm again?
10. If you could start over with the knowledge you have gained during your experience in working on this project, what would you do differently?

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Appendix J –EPA Management Model Summary

| TABLE 1: SUMMARY OF MANAGEMENT MODELS | TYPICAL APPLICATIONS | PROGRAM DESCRIPTION | BENEFITS | LIMITATIONS | |
|---|--|--|--|---|--|
| | MODEL 1 - HOMEOWNER AWARENESS MODEL | | | | |
| | <ul style="list-style-type: none"> Areas of low environmental sensitivity where sites are suitable for conventional onsite systems. | <ul style="list-style-type: none"> Systems properly sited and constructed based on prescribed criteria. Owners made aware of maintenance needs through reminders. Inventory of all systems | <ul style="list-style-type: none"> Code-compliant system. Ease of implementation; based on existing, prescriptive system design and site criteria. Provides an inventory of systems that is useful in system tracking and area-wide planning. | <ul style="list-style-type: none"> No compliance/problem identification mechanism. Sites must meet siting requirements. Cost to maintain database and owner education program. | |
| | MODEL 2 - MAINTENANCE CONTRACT MODEL | | | | |
| | <ul style="list-style-type: none"> Areas of low to moderate environmental sensitivity where sites are marginally suitable for conventional onsite systems due to small lots, shallow soils, or low-permeability soils. Small clustered systems. | <ul style="list-style-type: none"> Systems properly sited and constructed. More complex treatment options, including mechanical components or small clusters of homes. Requires service contracts to be maintained. Inventory of all systems. Service contract tracking system. | <ul style="list-style-type: none"> Reduces the risk of treatment system malfunctions. Protects homeowner investment. | <ul style="list-style-type: none"> Difficulty in tracking and enforcing compliance because it must rely on the owner or contractor to report a lapse in a valid contract for services. No mechanism provided to assess effectiveness of maintenance program. | |
| | MODEL 3 - OPERATING PERMIT MODEL | | | | |
| | <ul style="list-style-type: none"> Areas of moderate environmental sensitivity such as wellhead or source water protection zones, shellfish growing waters, or bathing/water contact recreation. Systems treating high-strength wastes or large-capacity systems. | <ul style="list-style-type: none"> Establishes system performance and monitoring requirements. Allows engineered designs but may provide prescriptive designs for specific receiving environments. Regulatory oversight by issuing renewable operating permits that may be revoked for noncompliance. Inventory of all systems. Tracking system for operating permit and compliance monitoring. Minimum for large-capacity systems. | <ul style="list-style-type: none"> Allows systems in more environmentally sensitive areas. Operating permit requires regular compliance monitoring reports. Identifies noncompliant systems and initiates corrective actions. Decreases need for regulation of large systems. Protects homeowner investment. | <ul style="list-style-type: none"> Higher level of expertise and resources for regulatory authority to implement. Requires permit tracking system. Regulatory authority needs enforcement powers. | |
| | MODEL 4 - RESPONSIBLE MANAGEMENT ENTITY (RME) OPERATION AND MAINTENANCE MODEL | | | | |
| | <ul style="list-style-type: none"> Areas of moderate to high environmental sensitivity where reliable and sustainable system operation and maintenance (O&M) is required, e.g., sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters. Clustered systems. | <ul style="list-style-type: none"> Establishes system performance and monitoring requirements. Professional O&M services through RME (either public or private). Provides regulatory oversight by issuing operating or NPDES permits directly to the RME. (System ownership remains with the property owner.) Inventory of all systems. Tracking system for operating permit and compliance monitoring. | <ul style="list-style-type: none"> O&M responsibility transferred from the system owner to a professional RME that is the holder of the operating permit. Identifies problems needing attention before failures occur. Allows use of onsite treatment in more environmentally sensitive areas or for treatment of high-strength wastes. Can issue one permit for a group of systems. Protects homeowner investment. | <ul style="list-style-type: none"> Enabling legislation may be necessary to allow RME to hold operating permit for an individual system owner. RME must have owner approval for repairs; may be conflict if performance problems are identified and not corrected. Need for easement/right of entry. Need for oversight of RME by regulatory authority. | |
| | MODEL 5 - RESPONSIBLE MANAGEMENT ENTITY (RME) OWNERSHIP MODEL | | | | |
| <ul style="list-style-type: none"> Areas of greatest environmental sensitivity where reliable management is required. Includes sole source aquifers, wellhead or source water protection zones, critical aquatic habitats, or outstanding value resource waters. Preferred management program for clustered systems serving multiple properties under different ownership (e.g., subdivisions). | <ul style="list-style-type: none"> Establishes system performance and monitoring requirements. Professional management of all aspects of decentralized systems through public/private RMEs that own or manage individual systems. Qualified, trained, owners and licensed professional owners/operators. Provides regulatory oversight by issuing operating or NPDES permit. Inventory of all systems. Tracking system for operating permit and compliance monitoring. | <ul style="list-style-type: none"> High level of oversight if system performance problems occur. Simulates model of central sewerage, reducing the risk of noncompliance. Allows use of onsite treatment in more environmentally sensitive areas. Allows effective area-wide planning/watershed management. Removes potential conflicts between the user and RME. Greatest protection of environmental resources and owner investment. | <ul style="list-style-type: none"> Enabling legislation and/or formation of special district may be required. May require greater financial investment by RME for installation and/or purchase of existing systems or components. Need for oversight of RME by regulatory authority. Private RMEs may limit competition. Homeowner associations may not have adequate authority. | | |

From EPA’s “Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment System”, EPA 832-B-03-001, March 2003.

https://www.epa.gov/sites/default/files/2015-06/documents/septic_guidelines.pdf



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