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Environmental Protection
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Region 5
Water Division
230 South Dearborn Street
Chicago, Illinois 60604

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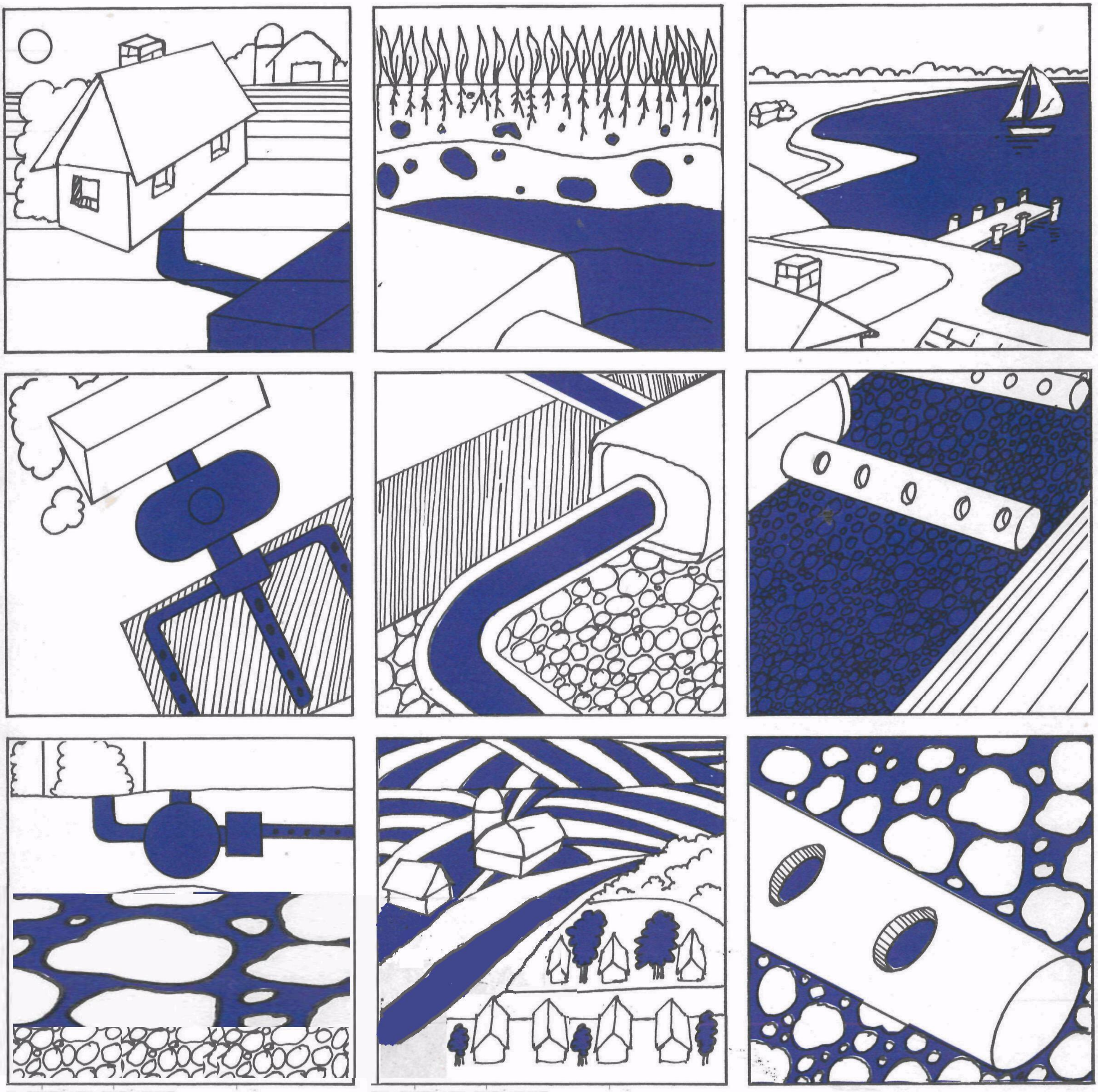
Water Division

EPA

Rural Lakes Project Handbook



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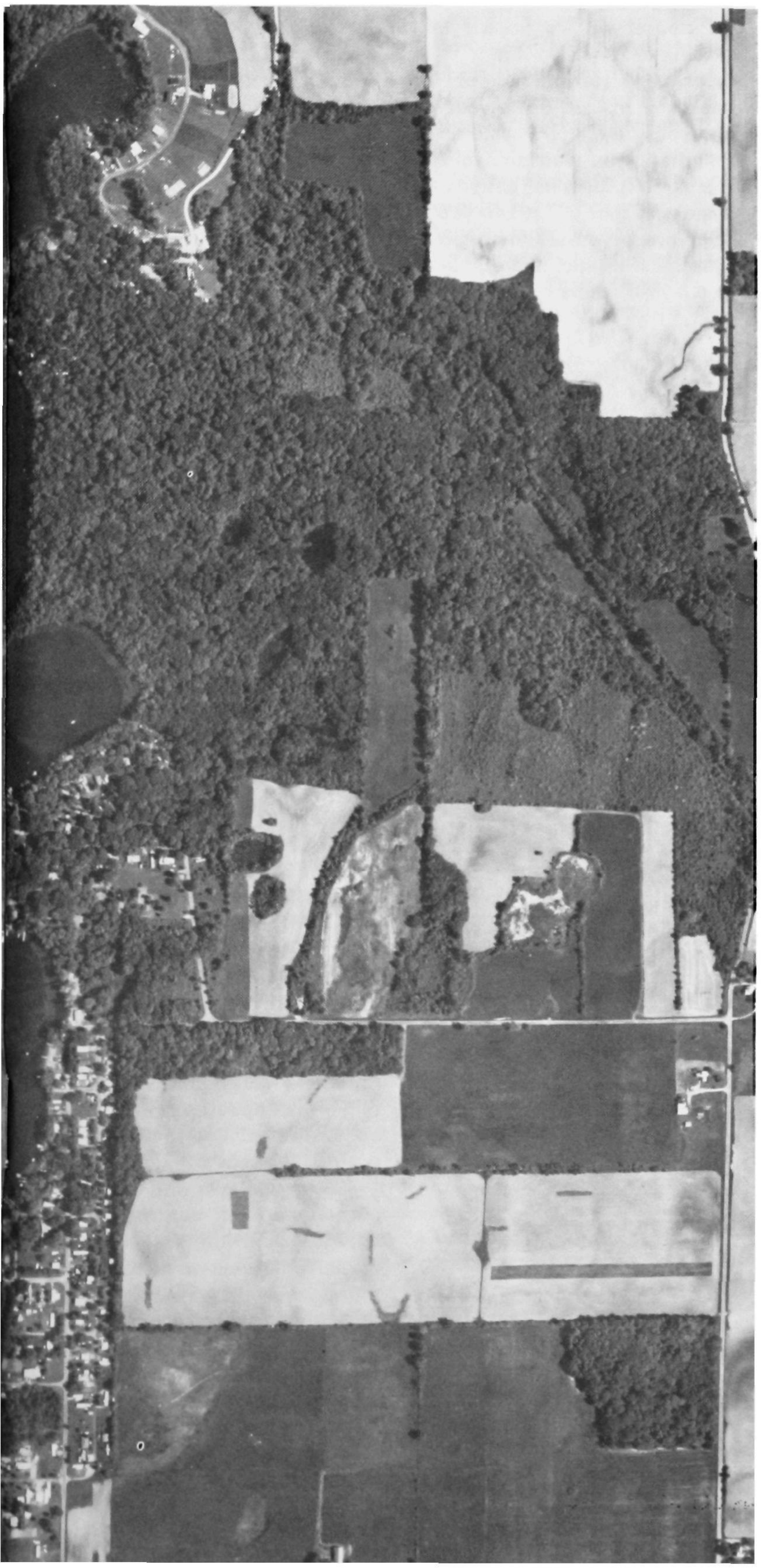


In 1977, Region V of the U.S. Environmental Protection Agency decided to prepare Environmental Impact Statements on wastewater facilities planning documents submitted by seven rural lake communities in Indiana, Ohio, Michigan, Wisconsin and Minnesota. Although each community was unique in many respects, they all had proposed sewers and centralized treatment facilities to serve low density development around lakes. All or large portions of the development was served by on-site sewage disposal systems at the time.

In the preparation of those statements we used new research tools and evaluated many alternatives and innovative techniques for wastewater management. We gained important insights into the problems that on-site systems cause, and we learned much about the economics of wastewater management for low and moderate density development. The most basic lesson we learned was that continued use of existing on-site systems is cost-effective when compared to any centralized alternative as long as adverse water quality and public health impacts of subsurface waste disposal can be controlled.

This handbook relates the major findings of our studies in a format intended to be useful to the interested citizen. The homeowner who wants to prevent or correct problems with his on-site system will find Chapters 1 and 4 useful. Homeowners and civic leaders should benefit also from the community-wide perspective presented in Chapters 2, 3 and 5 through 8.

If you wish to explore this subject in more detail, another Region V document, the *Final Generic Environmental Impact Statement for Wastewater Management in Rural Lake Areas,* is recommended. Also, U.S. EPA, the states and others have prepared a number of excellent reports related to small community wastewater management. Selected references are listed at the end of this handbook.

Introduction

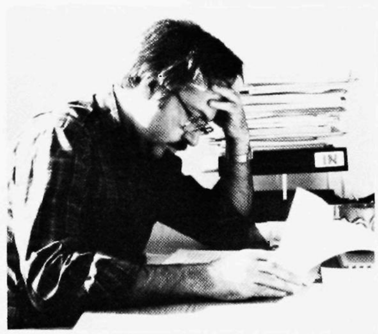
Do You Really Need Sewers?

Chances are, you've never really considered this question in much detail before. You've probably never spent much time debating the relative merits of sewers and on-site septic-tank systems. But now, for any one of a number of reasons, you need to consider that question.

Perhaps you are moving to a rural, unsewered area after a lifetime in an urban area where wastewater treatment means the Metropolitan Sewer District and you never give wastewater another thought as long as it disappears down the appropriate drains. But septic tanks aren't like that, are they? Don't they smell and back up? You can't use washing machines, can you? And only one shower a week, right?

Perhaps you are constructing a second residence in a rural area, a summer place on the quiet shores of a placid little lake, and you want to know what your building contractor is talking about when he discusses mound systems and drainage fields and depth to bedrock. You don't want to stand there nodding as if you read up on septic systems as a hobby, but where do you go for information? And how much are all these mounds and trenches going to cost? What's wrong with blasting through that bedrock and putting in a sewer like everyone else?

Perhaps you are already well acquainted with on-site systems—have one in your backyard, in fact. But a year ago your neighbor's system failed and you want to avoid the same fate. What causes a system to fail? What can you do to preserve the life of your system? If it fails, do you have to put in a whole new system?



Perhaps you are a local official involved in solving the wastewater treatment problems in your community. You are faced with a number of seemingly equally feasible alternatives and you want to choose the alternative that will adequately serve the community's residents without undue disruption of their lives or a staggering price tag. Moreover, you have to consider how your community can finance costs for new systems. Can the government help? Who ought to pay for services? Are the problems really serious enough to make centralized collection and treatment necessary?

Whether you are a prospective resident, a current homeowner, or a local official, if you are concerned about improving wastewater management in your unsewered community, this handbook is designed for you. You will find answers here to many common questions about waste treatment technologies for small communities. You will also be introduced to some recent ideas about how your community can ensure adequate wastewater management at affordable costs.

Partly because the subject of this handbook is wastewater management in unsewered communities, we have emphasized existing wastewater facilities, what makes them fail, and what can be done to detect, prevent and correct failures. But, as you will see, the high costs of new sewer construction are another reason for emphasizing on-site and other low-cost alternatives. These alternatives to new sewer construction seldom have been considered objectively when grants were available to help pay the high initial cost of sewers. Failure to define actual wastewater problems and to seek the least-cost remedies has resulted in millions of dollars spent for elaborate facilities that were not really needed.

As the taxpayer and the person who will pay the user charges, your interest in effective, low-cost wastewater management should be at least as keen as the federal government's. This handbook is intended to add understanding to your interest.

The Existing Situation

Today, the most common on-site system in unsewered areas is the *septic tank/soil absorption system,* often called a septic system or septic tank system. This system is described in Chapter 4. Septic tank systems chiefly serve detached, single-family houses. Densely developed single-family houses and multi-family housing may be served by off-site systems such as conventional gravity sewers and treatment plants or *cluster systems.* These systems are also discussed in Chapter 4. Older buildings may be served by *cesspools,* and dwellings on properties unsuitable for standard on-site systems are typically served by *holding tanks.*

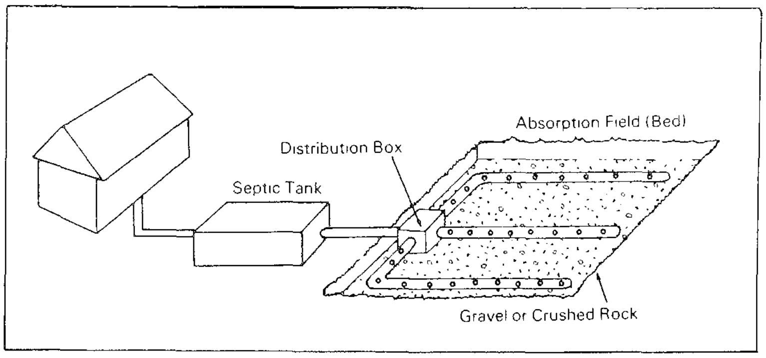
Septic tank systems have only been used in large numbers since the end of World War II, when widespread electrification programs made rural areas more attractive. When septic tank systems first made their appearance as a modern alternative to pit privies, few local jurisdictions set standards for determining appropriate sites and designs, for supervising installations, or for operating and managing the systems.

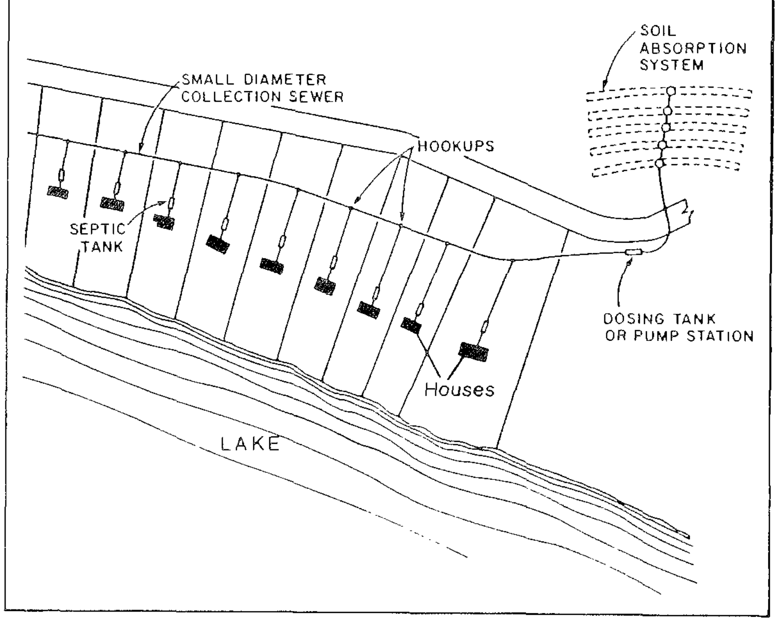
Many early septic tank systems were constructed poorly or were installed in places where they would not work. As they failed, our knowledge of what makes them work increased. Design codes were adopted to reduce future failures. These codes have become increasingly conservative through the years and the systems have become larger, or in many instances, not allowed at all. Many older systems that do not meet existing code standards are functioning satisfactorily nevertheless. Established, unsewered communities are likely to have an elaborate mix of on-site systems, old and new, properly used and abused, working and not working.

As rural populations have grown, it has become increasingly necessary for communities to deal with problems arising from construction and failure of on-site systems. The involvement in wastewater management of most communities can be seen as a path that begins with advice, leads to regulation, and comes to a fork leading one way to sewers and the other way to expanded public involvement with on-site systems. We call this second path *"small waste flows management"* If you and your neighbors asked "Do we need sewers?", you are at this fork.

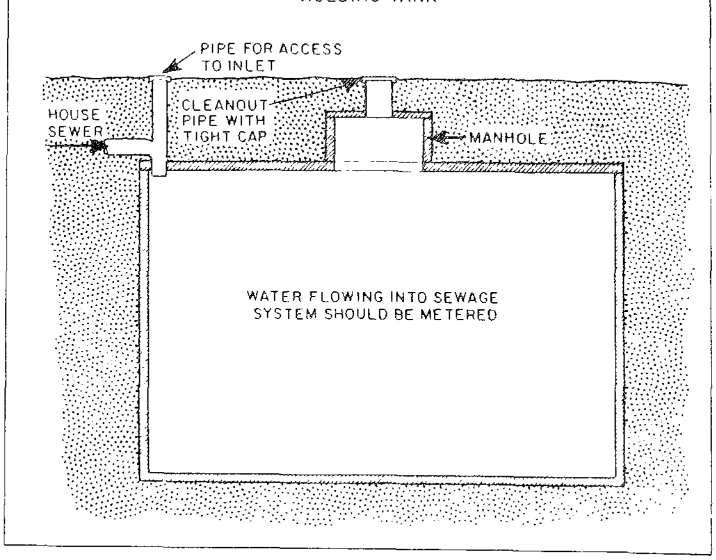
Where housing density is low or failures are infrequent, communities can deal with wastewater problems by offering advice on construction and repair of on-site systems. Naturally, the success of this approach depends greatly on the builders' and homeowners' sense of civic and personal responsibility. Most of all, the homeowner has to be his own expert on the use and care of his system. This form of management was common until the mid-sixties and is still all that is provided in some states and communities.

Regulation of on-site systems by local officials is a further step along the management path. Most local governments now regulate the construction of new on-site systems and enforce the repair of failing systems. But local government rarely takes responsibility for supervising maintenance of on-site systems or monitoring their performance once they are

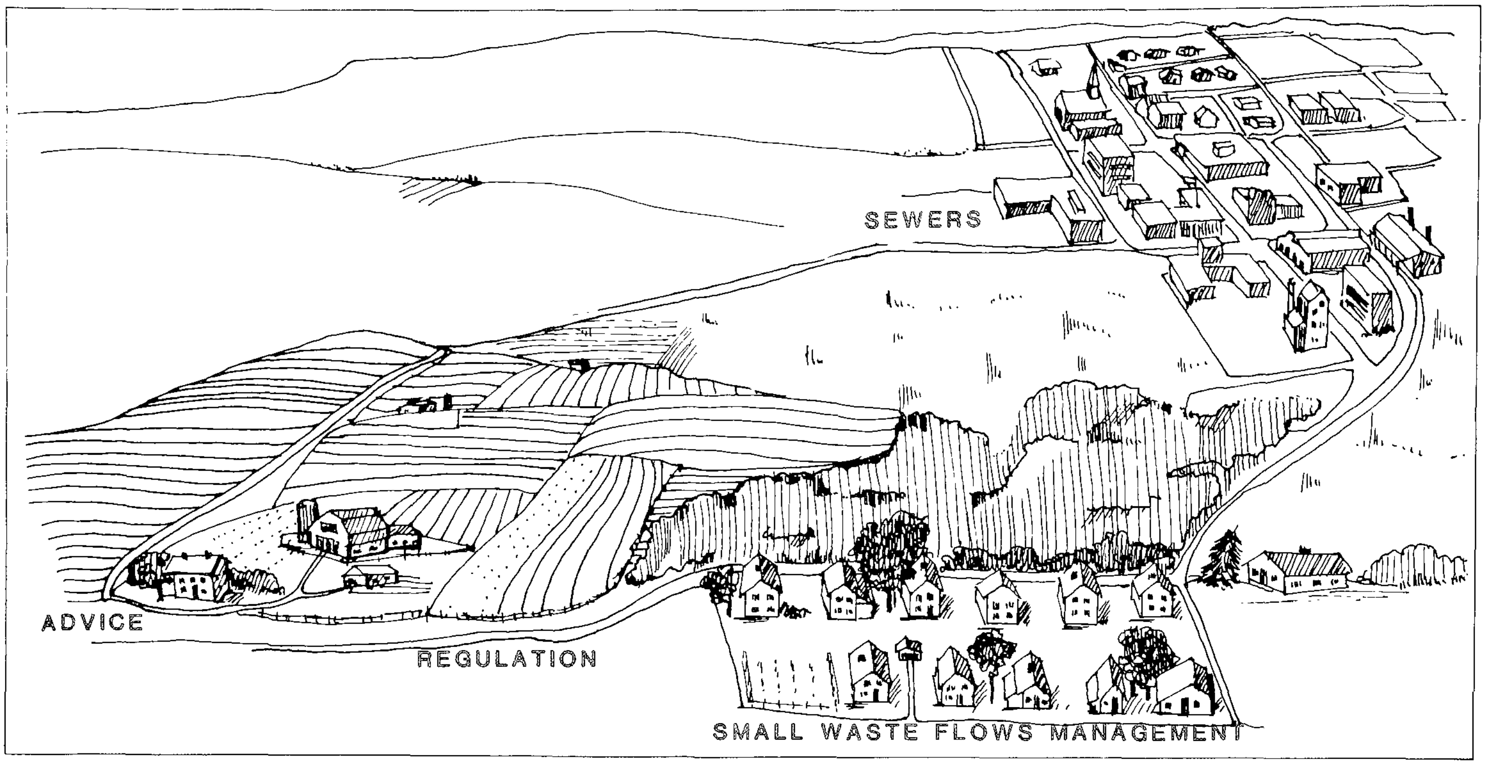




CLUSTER SYSTEM USING SMALL DIAMETER COLLECTION SEWERS AND COMMON SOIL ABSORPTION SYSTEM



HOLDING TANK



installed. Again, the community must rely on homeowners to maintain their systems for the public good. Where failure rates remain low, or where the public health and water quality impacts resulting from system failures are negligible, this regulatory approach is a satisfactory and inexpensive way to deal with wastewater problems.

But as on-site systems age, properties change hands and communities grow, the regulatory approach becomes increasingly unable to make maximum use of on-site systems that do work, to deal effectively with failing systems, and to handle the demand for new housing.

As a result, many communities find themselves standing at the fork in the path and considering two alternatives: the installation of sewers or the adoption of small waste flows management.

For both local officials and homeowners, sewers have often seemed to be the most attractive solution to wastewater problems. Sewers can overcome almost all natural constraints that rule out on-site systems, such as dense clay soils or a high water table. Sewers can easily accommodate growing populations. Where housing densities are high or where failure rates of existing on-site systems are uncontrollable, sewers may be the answer to wastewater problems.

But your community may not easily be able to classify either its housing density or its failure rate for on-site systems as high. And it is an indisputable fact that sewers are costly. The community must weigh this cost against the probable benefits, and, in so doing, it may find itself back at the fork in the path seeking another alternative.

For many communities, small waste flows management can deal effectively with public health and water quality problems at a fraction of the cost of sewering. Small waste flows management is community management of all phases in the life cycle of on-site systems and small-scale off-site systems. These phases include design, construction, use and maintenance, failure, and abandonment or repair. This approach can be used in communities—or even parts of communities—to take advantage of existing systems that are functioning properly, to supervise repair and maintenance of on-site systems, and accommodate new housing up to an environmentally defined limit. Depending on how many existing on-site systems can remain in use, it can be a very cost-effective approach.

It is important to note at this point that neither sewers nor on-site systems alone can solve a community's wastewater problems. These problems generally result from the ways these systems are selected, designed, built, and operated. In short, problems result from poor *management* of either the sewering or the small waste flows approach. Spending a lot of money on sewers will not automatically solve the problems caused by inadequate management of existing on-site systems. Unless an effective management plan is "installed" along with the sewers, there is no guarantee that centralized treatment will solve a community's wastewater problems. This is especially true for on-site and small-scale systems.

What this boils down to is that the most important step your community can take in solving its wastewater problems is to plan for careful management of all aspects of wastewater treatment in the community, from the initial consideration of problems to the final design of the solutions. And the best way to ensure good management is by becoming a part of the management process yourself. If your community is facing up to the off-site impacts of on-site systems, you *will* be involved, possibly as a participant in the planning and decisions, but certainly as a bill payer. Either way, this handbook should help you understand what you are getting into. Or what "they" will get you into if you sit it out.

Chapter 1.
So You Think You Have a Problem

Problems with on-site systems come in various forms and degrees of seriousness. Perhaps, as the title of this chapter indicates, you are reading this because you believe your on-site system is malfunctioning. Or perhaps you don't like the restrictions in water use that an on-site system places on you. But before you bring in the backhoe to dispose of your system, you ought to find out whether it is really failing or just needs some help to work right. If it is failing, why? And what can be done about it?

Some failures result from soil or groundwater conditions that cannot be changed. Replacing the system may result in little or no improvement. Many failures, however, can be prevented or corrected by a variety of measures aimed at controllable factors such as excessive water use, plumbing obstructions, and inadequate maintenance.

You may want to know if a particular type of failure constitutes a health hazard or damages the quality of surface waters or groundwater near your on-site system. Or is it simply a nuisance that can be tolerated?

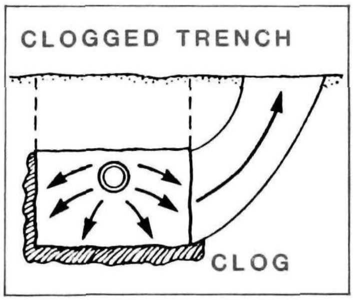
This chapter reviews the most common types of failures and their resulting hazards. It also discusses some of the limitations or constraints that on-site systems impose on property owners.

Failures

Plumbing Backups

Plumbing backups are the most common evidence of on-site system failures. You have this problem when the fixtures at the lowest level of your house will not drain fast enough.

Backups are caused by soil clogging, by *impermeable soil,* by stopped up pipes, or by pipe collapse. Soil clogging occurs where your wastewater flows into the soil around your drainfield, cesspool, dry well or other design of soil absorption system. Organic solids and grease that pass through a septic tank get filtered out in the first few inches of soil. Microscopic organisms that feed on these organic wastes often secrete slime that clogs the soil's pores even more. When the soil is impermeable or becomes clogged, the wastewater from the septic tank cannot pass through the soil, and it either rises to the ground's surface (see surface malfunctions) or backs up into the building's plumbing.



Likewise, if the plumbing becomes obstructed or collapses, wastes cannot flow through the system and consequently back up.

Backups seldom result in water quality problems, but they disrupt the use of essential sanitary fixtures. Recurrent or long-lasting backups can prevent good personal hygiene and, thus, directly harm the health of the residents. The health of persons these residents come into contact with might also be affected.

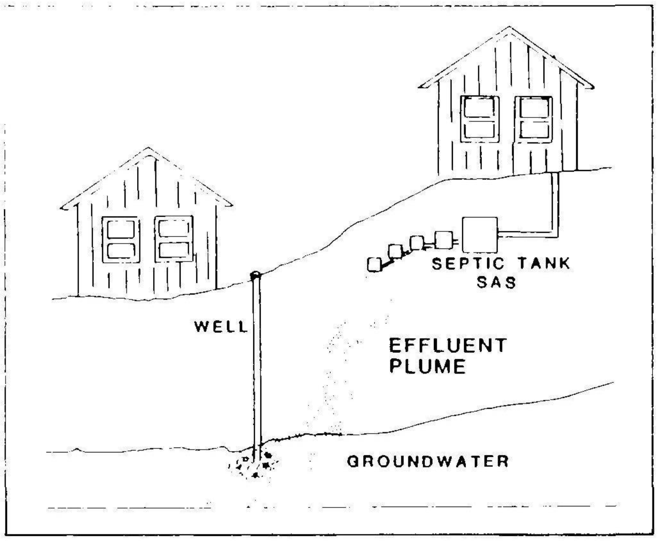
Surface Malfunctions

Your system may have a *surface malfunction* if parts of the ground over your drainage field are regularly damp, or if foul-smelling water pools on top of the ground.

Surface malfunctions are caused by some of the same factors that cause plumbing backups: Clogged or impermeable soils prevent wastewater from percolating downward, so some or all of it is forced to the surface. Stopped up or collapsed pipes outside the house may cause surface malfunctions. A common cause for collapsed pipes is driving cars and heavy equipment over the pipe. They are usually only a few feet underground and are easily crushed. Some soil absorption systems have a "distribution box," a chamber which splits the septic tank effluent into several smaller streams which flow through pipes to individual trenches, beds or pits. If this distribution box settles or is disturbed, all of the effluent may flow to one part of the system, overloading it until it malfunctions. To check out this possibility, you would need to locate and dig down to your distribution box.

Surface malfunctions can vary in degree from occasional damp patches on the surface to constant pooling or runoff of wastewater to a stream, lake or someone else's property. Occasional dampness may result from soil saturation due to recent rains or from temporarily high water use. Dampness might, however, be a forerunner of more serious pooling or runoff due to soil clogging or impermeability. Until it is shown that occasional dampness is not sewage related or that it can be readily prevented, any surface malfunction is considered a failure. Moreover, this failure is the one most likely to annoy not only you but also your neighbors.

Surface malfunctions are potential public health hazards and threats to surface water quality because of the possibility of direct contact by residents with untreated wastes and by the possibility that the wastes will be washed into drinking or recreational water sources. Animals or insects that have had direct contact with the wastes can carry disease organisms to you and your neighbors.



Groundwater Contamination

All septic tank systems contribute water to groundwater. If the soil adequately treats the wastewater, this is beneficial because it replenishes groundwater stores.

However, the problems arise when wastewater discharged by septic tank systems is not sufficiently treated by the soil. This happens when the soil is made up of coarse sand or gravel layers, or when fractured rock beneath shallow soils allows effluents to flow directly to the water table. In some cases, the system may be located too close to the groundwater level, allowing too little soil depth to treat the wastewater adequately.

The significance of groundwater contamination depends on the final use of the groundwater, the types of contaminants discharged to the groundwater, and their concentrations at *points of use*. *Points of use* include any existing water supply well, springs, lake shore, stream bank, potential well sites that comply with required separation distances from on-site systems or any other place where use of the water resource may be impaired.

The contaminants of greatest concern are nitrate and disease-causing microorganisms. Nitrate is a simple chemical compound. Groundwater containing nitrate above a certain level, when used to make baby formula, can cause a condition in infants called *"methemoglobinemia,"* also known as "blue babies."

While septic tank systems can raise nitrate concentrations above the critical level, this requires many systems and somewhat varied groundwater flow conditions. Nevertheless, you and your community may want to evaluate this threat if you keep your on-site systems.

More frequent and potentially more hazardous is contamination of wells by disease organisms. It is too expensive to test for all possible species of disease organisms so we use a group of bacteria, called fecal coliform bacteria, that are abundant in the intestines of warm-blooded animals, especially man. Fecal coliform bacteria found in wells do not necessarily come from septic tank systems. But if they do, you have a real problem. Your water may have to be continuously chlorinated, your well abandoned or your septic tank system moved or abandoned. Experts who know the rock formations and soil types in your community can perform additional tests to see if the source of contamination is sewage.

Nutrients In Lakes

If your septic tank system is near a lake or a stream that flows to a lake, you might be growing plants that you never even knew were yours. Plants growing in water need nutrients just like plants on land. Two important plant nutrients, phosphorus and nitrogen, are abundant in sewage.

As long as wastewater passes through enough soil, nutrient concentrations probably will not be high enough for you to see any plants. However, the algae attached to rock, or the fern-like or grass-like plants growing from the sediments near your shoreline could be using nutrients from your on-site wastewater systems.

If there are many on-site systems near your lake, the nutrients from them may be growing another type of plant, floating, microscopic algae in the open water. If the nutrients, especially phosphorus, accumulate much in the water and sediment of your lake, excessive plant growth will discolor the water, interfere with recreation and use up valuable oxygen in the water. In most lakes, septic tanks systems and other on-site systems contribute a small percentage of phosphorus, the key nutrient in this process, called *eutrophication*. But if your lake is small, does not have a continuous outflow, has sandy or gravelly soils or is highly developed, your community should thoroughly evaluate the nutrient releases from on-site systems.

Direct Discharges

Direct discharges are exactly what they sound like. A pipe carries wastewater from the house plumbing or from a septic tank to a ditch, an unused part of the lot, or a bordering stream or lake where the wastewater is dumped. Pipes or trenches illegally installed over or near soil absorption systems to route surface malfunction overflow away from the system might also be called direct discharges.

Direct discharges are considered failures of the most serious kind, because the wastes are untreated. They are public health hazards and threats to water quality because of the presence of untreated wastes near habitations and in water resources.

Odors

You may believe that odors are a certain sign that your system is failing. But correctly functioning systems occasionally produce odors as a normal part of the waste treatment process. While they may aid in detecting other failures and can be a nuisance, odors are not considered hazardous to either health or water quality.

Constraints

The great majority of people who have on-site systems, especially those designed by current standards, use their sinks, toilets, showers and clothes washers as freely as people who have sewers. But successful performance of on-site systems is highly dependent on the environment. Sometimes that environment, your yard, constrains how much wastewater you can safely generate. Sometimes the environment in your community will limit the number of new people who can safely dispose of their wastewater on-site.

As you will see in Chapter 4, there are methods for maximizing the ability of our soil and water resources to accept and treat wastewater. There are methods for modifying the amount and strength of wastewater that we generate. But there will be some residents and some property owners who will not be able to avoid the constraints presented by their environment, their property.

Water Use Restrictions
Water use restrictions can be just as bothersome to you as some of the failures discussed above even though such restrictions are not considered failures.

Water use restrictions generally come into play when your on-site system is not capable, for a variety of reasons, of handling the quantities of wastewater your household generates. These reasons can include slowly permeable soils, a high water table, or a system that is not large enough.

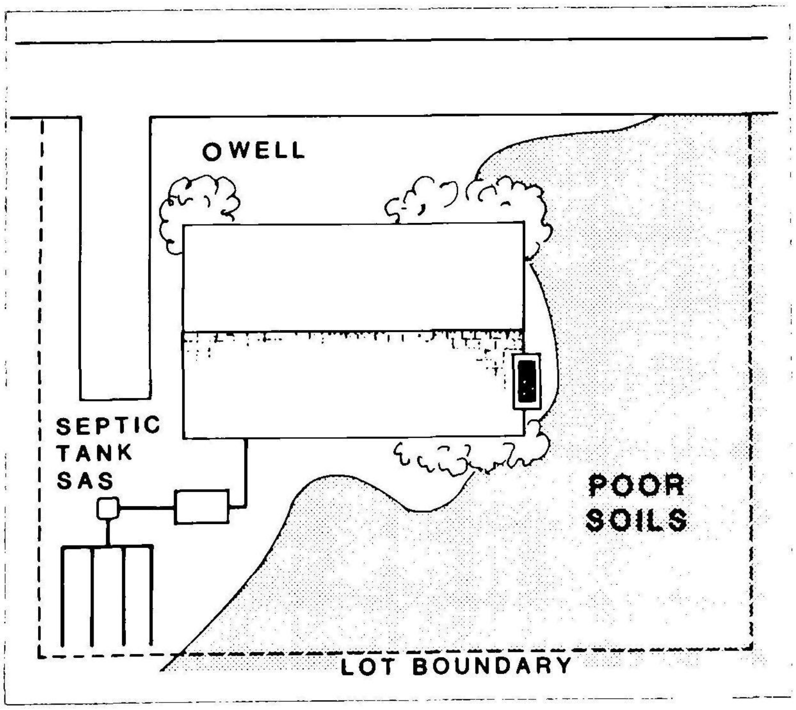
Problems associated with water use restrictions are generally curbs on your lifestyle. You may not be able to install a garbage grinder, a dishwasher, or a water-softening unit in your residence. In most instances, these restrictions are self-imposed. That is, you have to be very careful or you cause a back-up or surface malfunction. Or you may have no problems until the health department rejects your application to add bedrooms onto your house. Either way, this can be an embarrassment and an inconvenience.

Constraints on Residential, Commercial and Industrial Development
This constraint is most likely to be a problem for your community rather than for you as an individual homeowner.

Even specially designed on-site systems may not handle the volume of wastewater that a proposed commercial or industrial establishment would generate. Consequently, if your community is situated in an area where sewering is impractical for economic or geographic reasons, your community may lose growth opportunities.

Similarly, if your community is situated in an area that will support only a limited number of new residential on-site systems, residential development must be limited to avoid overloading the capacity of the soil to treat wastes. Your community could therefore lose chances to attract new residents.

Constraints on development are not necessarily a drawback in rural areas where communities have stable economies and stable populations, or where the unspoiled beauty of the landscape is worth more than a bigger supermarket. But such constraints may be a serious disadvantage if development pressures cannot be met in nearby areas that already have sewers.



Where to Begin?

Some of the problems discussed above are readily identifiable A pool of sewage standing in your backyard, for example, is a clear indication that some remedial action must be taken But suppose you merely suspect that your system is failing How do you go about gathering information about your system and other systems in your community?

First of all, clarity begins at home Here are some ways you can check your own system:

- If you're not sure whether that puddle or seep in your backyard is sewage, ask your local health department for some dye Flush some down your toilet and watch the wet area for a few days.
- You may be able to distinguish between backups caused by plugged or broken pipes and those caused by your soil absorption system by noting when the backups occur. If they occur after rain or during spring, when many soils are naturally wet, or when you have a lot of company, the soil absorption system may be at fault. If the problem gradually gets worse, starts suddenly, or isn't related to weather, the cause may be your house plumbing or the piping connecting your house, septic tank, and soil absorption system A good way to find out for sure is to have a contractor pump your septic tank and, while it is open, have the pipes entering and leaving it cleaned out If your soil absorption system has a distribution box, have the contractor dig it up to see if it is working properly.

- Determine how much water you're using. Even if you have your own well, a water meter can be installed for about the same cost as a few septic tank pumpings If you use 45 gallons per person per day, you are about average If you use more than 60 gallons per person per day, look for leaks and then consider new low-flow toilets, shower heads, and cleaning appliances.
- Look for sources of excess water. Roof drains, basement sumps, driveway runoff, springs, or even surface runoff from your yard may be filling up your septic tank and soil absorption system faster than you are.

These are things you can check yourself. Other problems may require help from your community's sanitarian, a soil scientist, septic tank installer, water quality scientist, or others with special expertise.

What if you *do* have a problem that requires special expertise? If you do, your neighbors may need the same help. You may find out what the general situation in your community is by discussing it with your local health department officials. Your local health department or public works department may be able to help you by providing information on past well contamination or septic tank repairs in your community. You can also try to find out if any agency has conducted an areawide study of the on-site systems in your community. Use the contacts listed at the end of this handbook as a starting point. If such information is available, it can tell you whether failures in your area are widespread enough for you and your community to consider a full-scale study. If no one else has made a community study and you believe your system is only one of several problem systems, you might consider forming a citizens' committee to conduct a preliminary survey.

These first steps, which require relatively little time and effort on your part, are useful for establishing the outlines of the wastewater treatment problem in your community. If your findings are inconclusive or seem to indicate failure in one or more systems, you will need further information on ways to find and correct them, both of which are covered later in this handbook.

But first . . .

Chapter 2.
Don't Make Things Worse

It Could Happen to You

Your first inclination upon suspecting you have a problem with several on-site systems in your community may be to scrap them entirely and contract for a sewer system. After all, sewers seem so simple: wastewater goes down the drain and you need never give it another thought. Treatment and disposal are someone else's concern, as are routine maintenance and operation. But before you place the call to the design consultant, consider these scenarios*.

Community A
Community A is a midwestern community located on the shores of a large lake. On-site septic systems were replaced by a conventional collection system leading to a treatment plant. The relevant facts and figures are:

- Plant size—3,000,000 gallons per day
- Users served—1,600 dwellings or commercial and industrial users
  Sewered population—4,700 people
- Total cost—$14,500,000 (Local share of this cost was funded by loans, bonds, and assessments)
- Average costs to property owners *after* initial $1,800 assessment:
  - Average hookup—$1,000
  - User charges—$175 to $200 per year
  - Tax levy—$300 per year per property
  - Total—$500 per year per family
- Median income—$9,700 per family
  Annual sewerage costs are thus 5% of median income
- Capital cost per home—$9,100
- Value of average home—$20,000

Community B
Community B is a northeastern community that, like Community A, is adjacent to a large lake. Septic tanks and direct outfalls (that is, direct discharges of untreated wastewater) were replaced by a conventional collection and treatment system. The relevant facts and figures for this new system are:

- Plant size—250,000 gallons per day
- Users served—650 dwellings
  Sewered population—1,350 people
  (The plant was designed to serve a population of 2,500 even though the population has been declining in recent years)
- Total cost of project—$4,200,000
  This cost was paid as follows:
  - Plant—75% EPA funding, 25% state grants
    - Collection system—50% Farmer's Home Administration and Economic Development Administration grants; balance paid by 40-year 5% Farmer's Home Administration loan
- Average costs to property owners
  Connection costs—$500 to $1,200 per connection
  Annual use charge and loan repayment—$220 per family
- Median income—$6,600 per family
  Annual sewerage costs are thus 3.3% of the median income
- Value of average home—under $20,000
- Capital cost per home—$6,500

*These examples are actual case studies reported by Keith H. Dearth, "Current Costs of Conventional Approaches" in *Less Costly Wastewater Treatment Systems for Small Communities*. Proceedings of a national conference given by U.S. EPA, Reston, Virginia, April 12-24, 1977

So What?

Take a minute to consider what these figures mean in human terms.

Many small towns and rural communities have a proportionately large population of older people who my be living alone on small social security payments. Additionally, these communities include farm families whose net wealth is quite often invested in land and equipment.

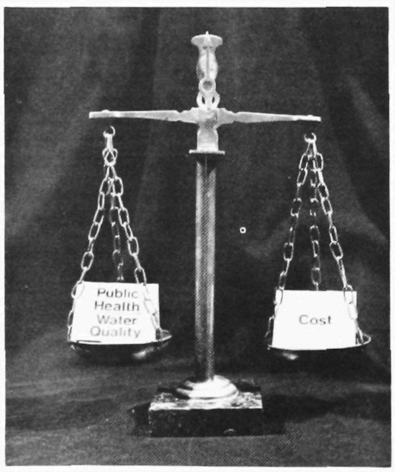
You do not have to be an economist to understand that coming up with an $1,800 chunk of money for connection to a sewer could result in considerable hardship for homeowners living on fixed incomes. Imagine, too, the difficulty a pensioner may have in finding an extra $200 per year for user charges.

How Does This Happen?

It may have been that no effective alternatives to sewer construction were possible in Communities A and B, in which case the high costs were necessary. Government loan and grant programs are justified when they make the right alternative possible, even when it is expensive. But it is a fact that some reasonable alternatives, including the continued use of existing on-site systems, are not always properly considered.

Many factors contribute to the sort of poor judgments made by consultants for Communities A and B. Even if plain incompetence is ruled out, it is still an unfortunate fact that some consultants and local or municipal officials are unfamiliar with the entire range of technologies available. And, while new technologies designed to overcome various siting or soils problems continue to come on the market, contractors are naturally reluctant to accept the risks that accompany installing relatively unproven systems. Thus, a consultant may take the safe way out and recommend sewers, even though they may cost many times the amount of a correctly chosen on-site system.

In the recent past, federal and state governments and other agencies have made the sewering alternative even more attractive by offering substantial subsidies for sewer installations. In the case study of Community B, for example, combined grants paid 100 percent of the costs of the treatment plant and 50 percent of the costs of the collection system. It is another unfortunate fact that the lure of "easy money" attracts consultants and local officials who see that they can get what they believe is the best alternative for a nominal investment by the community.



Another reason why small-scale and on-site alternatives may not be considered seriously is the matter of privacy. Governments generally do not want to send their employees onto private property. Privacy is not a problem with sewers—the resident takes care of the house plumbing and house sewer on his property and the community takes care of the sewer in the street. Privacy can become a concern with community management of on-site systems, however. (See Chapter 5).

Thus, it is easy to see that consultants and local officials have several reasons for overlooking the simple expedient of repairing or replacing failing on-site systems. Even though replacement and upgrading can cost communities far less than expenditures on centralized systems, sewers continue to be recommended as the best—and sometimes as the only—alternative for communities with wastewater treatment problems.

This chapter is not intended to prejudice you against the sewer alternative but to prepare you to deal with the experts who may want to sell you on centralized treatment without fully exploring other options. Even if your expert assures you that the government will pick up the tab, you and your neighbors may still have to pay substantial connection and user charges. The prospect of these charges should certainly provide you with the incentive to explore alternative solutions to your community's waste treatment problems.

Chapter 3. Finding the Smoking Gun

A sound decision to improve wastewater systems cannot be made unless the failures and their causes are known. If your preliminary efforts revealed that on-site systems are failing, its time for the officials who represent your community to take over. They should find out how many failures there are. But just as important, they will need evidence that explains why there are failures—they will need to find the smoking gun. Is it old systems that are under designed? Is it small drainfields in tight soils? Is it septic tanks that are never pumped? Or is it four teenagers who wash their hair twice a day?

The process of finding and explaining the failures is known as *needs documentation*.

Several methods can be used in needs documentation, ranging from simple questionnaires to sophisticated on-site testing. Choosing the right methods is a matter of common sense and knowing what the methods can and cannot do. Its also a matter of costs. The three-phased process that is discussed here begins with the most inexpensive methods and the ones that cover the entire community (Phase 1). Then it continues to more intensive, but limited, investigations on-site (Phase 2). If this needs documentation work shows that the failures can be corrected on-site, it is followed by the last phase, *detailed site analysis*, used to select the right remedy for each system.

The needs documentation (Phases 1 and 2) and detailed site analysis work can get costly. There is no need to go the whole route if there are few failures. If early work shows there are too many uncorrectable failures, then stop and start looking at sewers.

The recommended methods for needs documentation include:

Phase I
- gathering and analysis of available data,
- mailed questionnaires,
- aerial photographic interpretation,
- septic leachate detection (lake communities)
- nearshore plant surveys (lake communities)
- eutrophication modeling (lake communities)

Phase II
- partial sanitary surveys, and
- representative samplings.

Phase I Needs Documentation Methods

Gathering and Analysis of Available Data

Using information that is already available can be a quick and inexpensive way to define the need for improved wastewater management facilities on a community-wide basis. Several sources of information are:

1. Local Well and Septic Tank Permit Records

Some public health agencies keep records on the bacteriologic characteristics of private water supplies; such information may include the locations of wells possibly contaminated by on-site systems. For new wells, many states require logs that will show the geologic setting of your community. Where repair permits for septic tank systems are well maintained, they record the types, frequency, and locations of failures. However, they seldom indicate the course of failures.

2. Sanitarians, Soil Scientists, Septic Tank Installers and Haulers, Well Drillers, and Zoning Officers

Interviews with these people can give you information on the location of on-site problems such as surface malfunctions, plumbing backups, and illicit discharges; as above, this information can pinpoint areas that may need further investigation. These interviews will be particularly useful for gathering information on system problems resulting from poor site conditions or inadequate maintenance practices.

3. Windshield Surveys

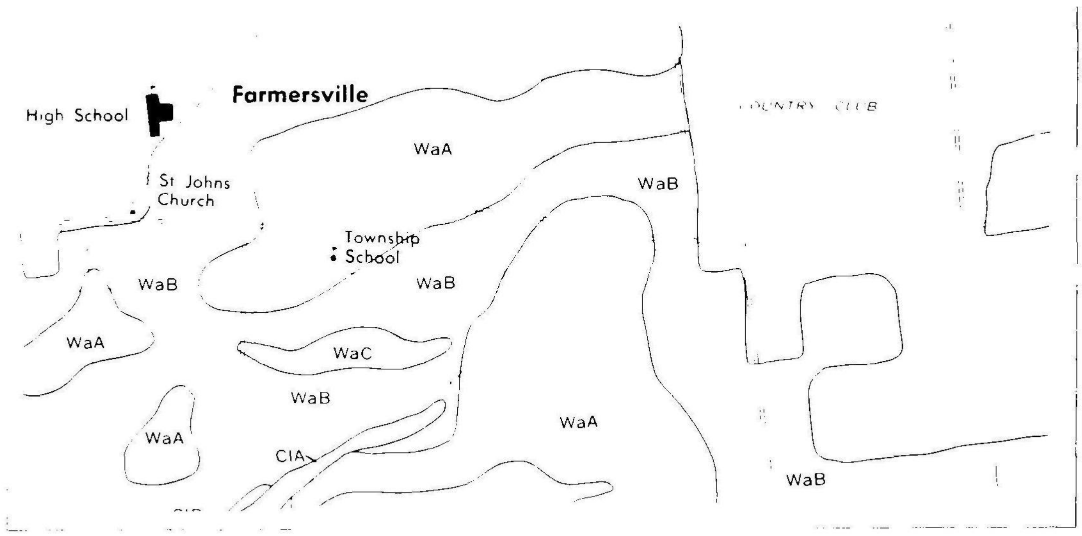
An automobile tour of your community with a local sanitarian, soil scientist, or other knowledgeable person can provide first-hand observation and interpretation of site conditions and on-lot system practices.

4. Soil Maps

Analysis of soil types in your community will not provide direct documentation of need, but it may give evidence useful in guiding your search for problem systems and in analyzing the causes of failures.

Soil maps are published by the U.S. Department of Agriculture Soil Conservation Service in cooperation with state agricultural experiment stations. Soil maps may be general or detailed. Detailed soil maps will describe the types of environmental limitations (like clay layers, high groundwater and flooding) that on-site systems have to operate under. If there is a choice between general and detailed maps, get the detailed ones—they usually have a generalized map included.

Soil maps can be used for preliminary determinations of the suitability of on-site systems on a community-wide basis, as well as to estimate how many lots in a community can be expected to be served satisfactorily by on-site systems. Soil maps can also indicate potential problem areas that may be investigated at a later stage.



5. Available Water Quality Studies and Eutrophication Modeling

Your streams and lakes may have been studied already by universities, state agencies or federal agencies. Such studies may increase your understanding and appreciation of these resources.

Few studies concentrate on the effects of on-site systems on specific bodies of water. An exception is the National Eutrophication Survey, which estimated nutrient inputs to 812 lakes in the United States, 241 of which were in Region V states. These *nutrient budgets* include estimates of phosphorus and nitrogen from on-site systems.

Your state's water resource agency or regional planning organizations are excellent places to look for available water quality studies.

6. Base Map Preparation and Overlays

After exploring these types of available information, your community should consider preparation of a base map. The base map can be inexpensively made by using available maps or aerial photography. Commonly available sources are the U.S. Geological Survey's topograpic maps, the aerial photographs reproduced in U.S. Soil Conservation Service soil maps, and local tax maps. See the end of this handbook for other possibilities. The base map should show, at a minimum, streets, streams, lakes, town and county boundaries, any existing sewer service areas and central treatment plants, and either property boundaries or buildings.

As information is gathered on the natural environment, land use and needs documentation, it can be transferred to clear plastic overlays.

This base map and the overlays will give you preliminary ideas about what sorts of systems your community may need and what areas in your community require additional needs documentation. The base map can later be used to show data collected in the course of new field work.

Mailed Questionnaires
Mailed questionnaires can accomplish a number of objectives. They can be used to inform residents of the objectives of the wastewater management planning effort. They can be used to obtain a variety of information on each homeowner's wastewater system. And they can be used to determine how willing the residents are to allow follow-up surveys and site investigations.

When you consider using mailed questionnaires, you must understand that the responses you get are going to be only as good as 1) residents' knowledge of their property, 2) their understanding of the questions being asked, and 3) their willingness to give you information. You must consider, too, the psychological factors that are involved. Some homeowners may not want to admit their systems are failing because they believe the situation will reflect badly on them. Moreover, if they realize that honest responses to the questionnaire could lead to replacement or renovation of their systems that will cost them a significant sum, they may feel it is in their best interests not to offer information about their sewage disposal systems. A straightforward cover letter explaining what the questionnaire's purpose is and what will be done with the information may encourage full and honest responses.

Aerial Photographic Interpretion
Aerial photographic surveys can provide information on surface malfunctions of on-site systems in an entire community. Such surveys are quick and relatively inexpensive, with the added bonus that no one needs to intrude on private property where there are no surface malfunctions. These surveys are generally timed for late winter or spring when the ground is not snow-covered and tree cover is limited. This does present a minor problem in communities where a large part of the population is seasonal. In this case, photographs may be taken in the summer months when summer people are in residence but the photographs must be analyzed more carefully because visible signs of malfunctions are hidden by trees.

The photographs are analyzed by an experienced photo interpreter who looks for evidence of surface malfunctions, such as:

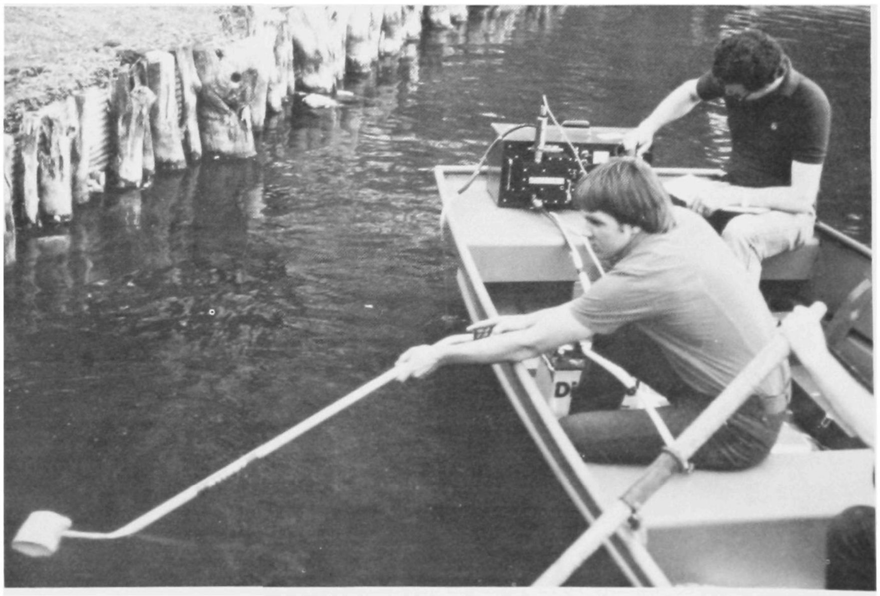
- conspicuously lush vegetation,
- dead vegetation (especially grass),
- standing wastewater or seepage, or
- dark soil indicating excessive accumulation of organic matter.

Suspected malfunctions can then be checked by on-site inspection and reclassified as confirmed malfunctions (standing wastewater from an on-site system is visible on the surface), as marginal malfunctions (accumulations of excess organic matter or the presence of dead vegetation indicates that wastewater has surfaced in the past), or as surface features that mimic malfunctions but are not caused by wastewater.

The color photographs taken to find surface malfunctions can be used in other helpful ways. House counts, land use, and vegetation types (field, wetland, woods, and so on) can be rapidly inventoried and explained to others.

Septic Leachate Detection
Septic leachate detectors are electronic instruments used to locate groundwater discharges or surface runoff carrying domestic wastewater into lakes. These detectors must be used very carefully because they respond to some natural compounds as well as to sewage materials. Also, under some conditions, detectors may miss leachate since it is often recognizable only very close to the place where it enters a lake. Because of the possibilities for error and the many factors influencing the result of septic leachate detection, the validity of the surveys rests heavily on the experience, knowledge, and judgment of the surveyor.

While septic leachate detectors can locate signals resulting from wastewater, they cannot tell whether the leachate was properly treated before it entered the lake. To determine this, samples need to be collected and then analyzed in a laboratory.



Nearshore Plant Surveys
As you learned in Chapter 1, nutrients in septic tank *effluents* that are carried to lakes by groundwater can stimulate the growth of aquatic plants along the lakeshores. Aerial photography taken during the growing season can provide a starting point for surveyors. Close-up inspection of the plants noting their type, density, and nearness to homes will provide more detailed information. Costs for such surveys can be minimized if they are done along with septic leachate detection or partial sanitary surveys.

Nearshore plant surveys can provide evidence that nutrient-rich wastewater from on-site systems may be seeping into the lake. But remember that wastewater from on-site systems is only one, and not always the most important, contributor to excessive shoreline plant growth.

Eutrophication Modeling
If your community includes developed lakeshore areas you may consider modeling to predict the impacts of on-site systems on potential lake eutrophication. Eutrophication modeling can be a useful way of predicting what may happen over time if failing systems are not corrected or if the density of on-site systems located near lakeshore increases.

The model starts with a *nutrient budget*, an estimate of the amount of nitrogen or phosphorus coming from different sources. Commonly, the major sources will include:

- sewage treatment plant discharges
- major tributaries
- storm runoff from land adjacent to the lake
- on-site systems, and
- precipitation

The total nutrient load is then evaluated for its potential to cause too much plant growth in the lake. For freshwater lakes, phosphorus is the nutrient of concern since there is often more nitrogen available than the plants can use.

To predict what happens if the on-site systems are abandoned or if more systems are built, the assumptions for that part of the budget are changed and the plant growth potential is reevaluated.

On studies of 35 lakes in Region V, we found that the fraction of the total phosphorus budget estimated for on-site systems was usually small and that sewering the homes around the lakes would make little difference. There will be exceptions and detailed sampling may be justified to spot them.

Wrapping Up Phase I
Once you have completed the Phase I methods appropriate for your community, stop and take a look at the data. How frequent and how difficult to solve are the problems you have found? Can your local officials and your neighbors solve them without state or federal financial help? Is it obvious that some or all parts of your community cannot get by with on-site systems?

The answers to these questions will guide you in setting up Phase II, or determining whether Phase II is even necessary.

The end of Phase I activities can be a decision point—a time for your neighbors, local officials, consultants, and funding agencies to huddle before the next play. At this time, you should consider the following rules of thumb:

> Whenever it is environmentally sound to do so, the continued use of on-site systems will cost your community less over both the short run and the long run than constructing sewers, with few exceptions. Without sewers, however, industrial, commercial and housing development may be slowed down or stopped because the capacity of the soil and groundwater to accept waste is limited.

Now might be the time to take a hard look at the actual potential your community has for growing, and how much the community is willing to spend to help it happen.

Phase II Needs Documentation Methods

Phase I information should provide a good profile of the types of failures in your community and how frequent they are. If you are lucky, the major causes of failure may also have been revealed. In this case you can make a good guess as to what types of remedies are needed, compare the costs (all the costs! See Chapter 6), and make a decision.

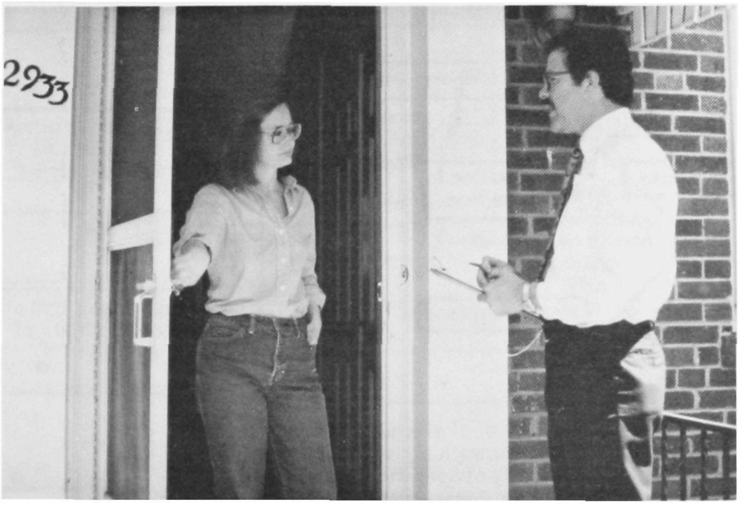
If it is still unclear why failures happen, the next step is to go on-site and find some answers.

Sanitary Surveys

A *sanitary survey,* as the term is used here, is an inventory of the location, age, condition, design, and use of on-site systems based on available data and on-site sanitary inspections. Each sanitary inspection should include an interview with the resident followed by a walk-over inspection of the property to collect and record opinions and data on the on-site wastewater and water supply systems.

If it is decided before the sanitary survey that the community will rely on upgrading on-site systems, the survey may be set up to cover all the residences in the community. However, if there is still a possibility that sewers may be needed, then a complete sanitary survey could be a waste of money. A partial survey that is large enough to estimate the overall percentage of systems needing upgrading and the types of technology required will be sufficient.

Whether complete or partial, sanitary surveys provide an excellent opportunity for the surveyors to explain the initiatives being taken by the community and to find out what the residents want.



Representative Sampling

Representative sampling of soil and groundwater conditions can reveal the causes of failures and can quantify their impacts on water quality. Conditions that could be measured include:

- seasonally or permanently high water table,
- groundwater flow,
- well water contamination,
- shallow groundwater contamination, and
- soil permeability.

Representative sampling can be expensive, but its worth comes from being able to make decisions based on known relationships, not rules of thumb, between failures and their causes. The difference in the quality and ultimate cost of decisions will more than offset the expenses of sampling.

How Much Is Enough?

As a cost-conscious member of your community, you will want to consider carefully how much information you really need in order to make a decision about wastewater treatment in your community. Obviously, the amount of information you need will depend largely upon factors specific to your community. We have presented a fair selection here so that you will have some idea what types of information are required in the needs documentation process, and so that you will understand what information a soils engineer or sanitarian is seeking when he or she suggests them. But your community certainly need not use all these methods. If at the end of Phase I, it is documented that a high percentage of failures exist in your community and that they cannot be fixed, for example, your next step is planning and design of off-site systems, not eutrophication modeling.

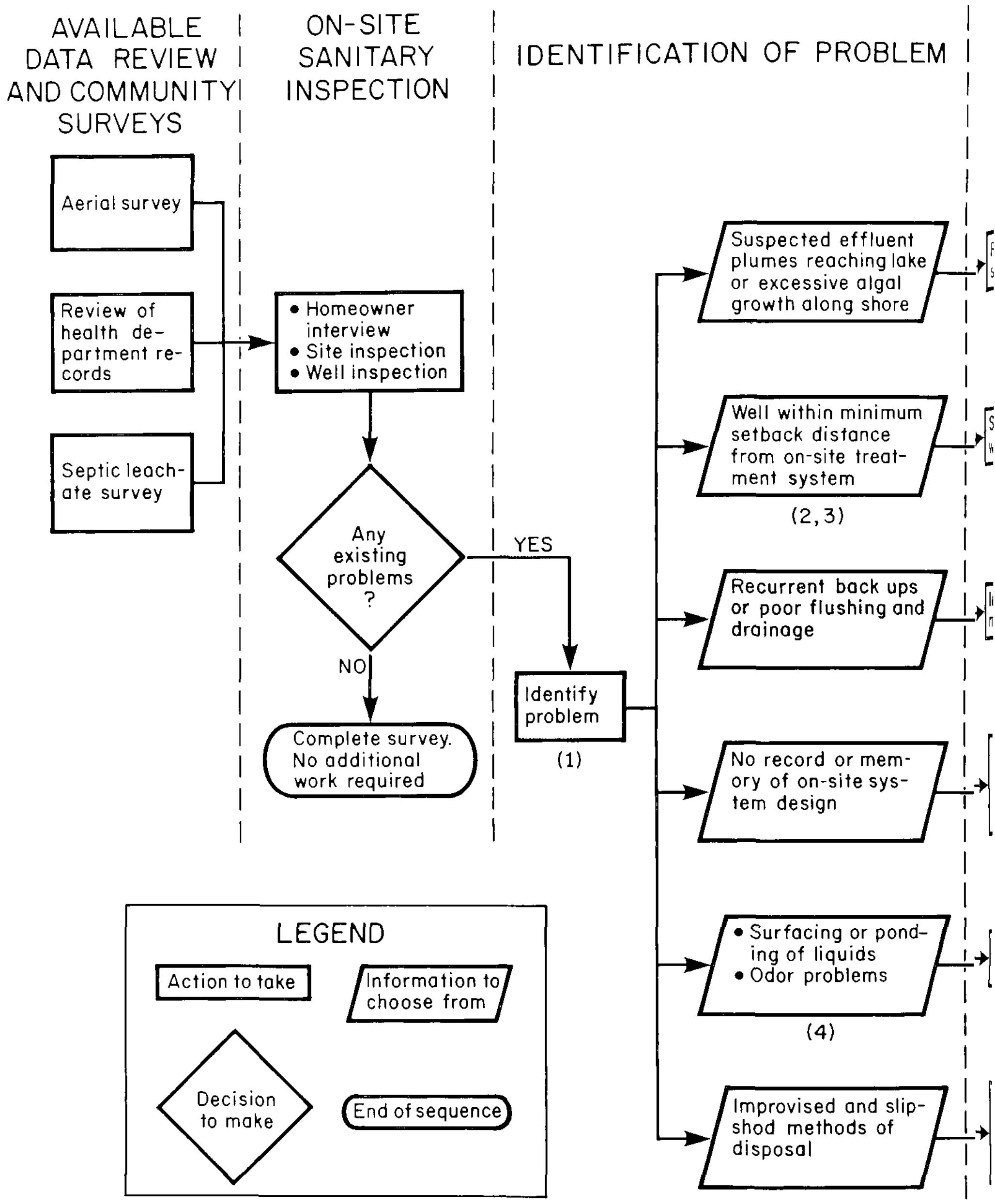
If, however, needs documentation studies show that upgrading and replacement of on-site systems is the way to go, then planning and design work should proceed with detailed site analysis.

Detailed Site Analysis

Whereas needs documentation studies are intended to support community-wide decisions to sewer or not, remaining data collection will support selection of specific on-site technologies for each developed property.

At a minimum, on-site sanitary inspections need to be completed for those buildings not already inspected. The work performed in the remainder of the detailed site analysis depends on the type of problems indicated by these on-site sanitary inspections.

This figure illustrates both the range of analyses that might be needed and the principle that the analyses depend on the type of problem. A possible sequence of analyses and decisions for a common failure, plumbing backups, is highlighted in the figure.



Note: This diagram shows how an individual site with an existing on-site system could be analyzed. Nothing is implied regarding Construction Grants eligibility of specific items or their appropriate timing in the 3-step Construction Grants process.

Notes

1. If, through previous experience, the cause of the problem can be identified at this point, the detailed site analysis can be bypassed.

2. State standards for minimum setback distances should be used unless a hydrogeologic (or other) reason exists to use a larger distance.

3. In using contaminated wells as a criterion for delineating sewer service areas, only data from protected wells should be used.

4. Odors can come from a properly functioning septic tank/soil absorption system. Relocation of vent may solve the problem.

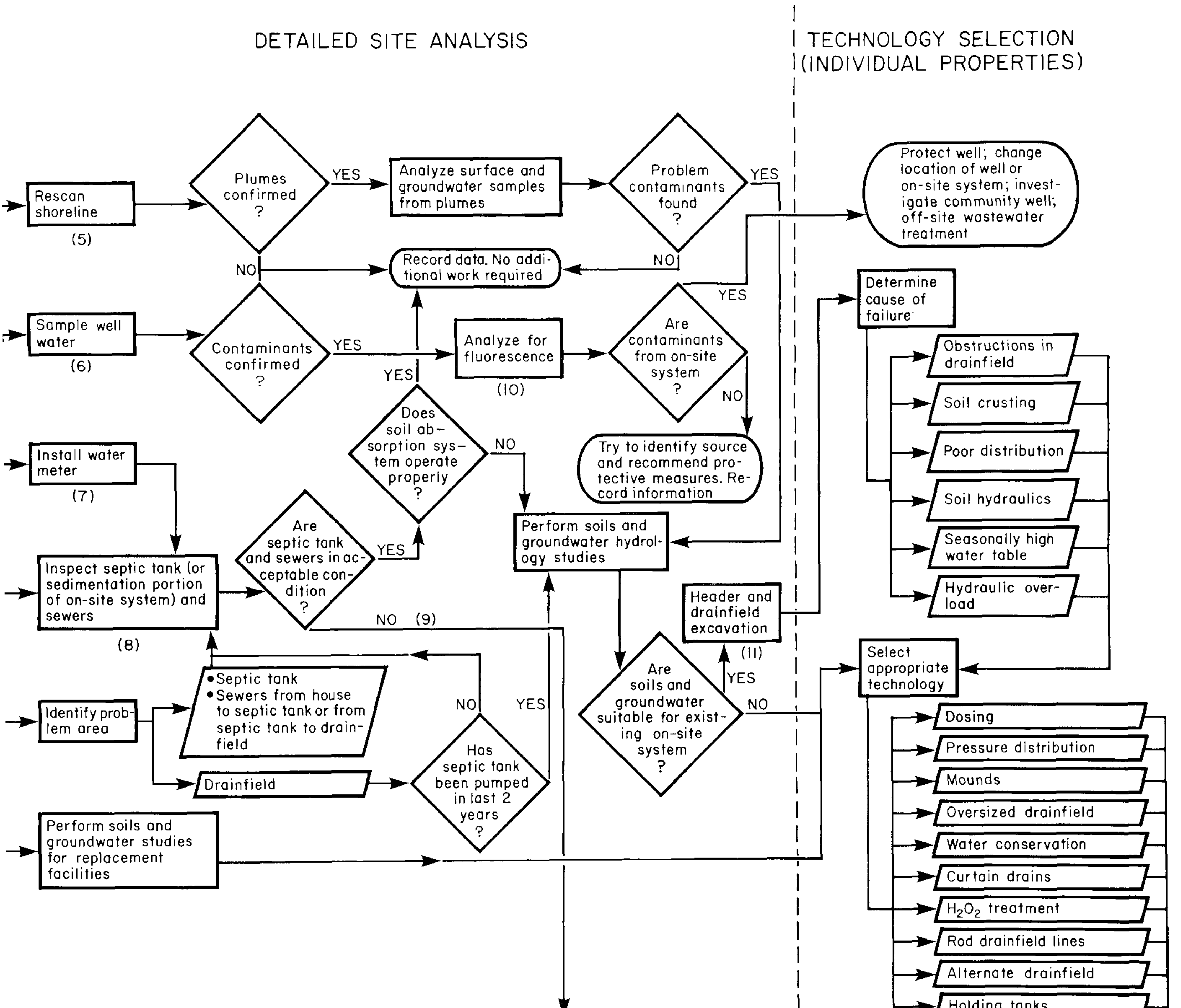
5. Shoreline scan should be repeated to ensure that plumes are located properly.

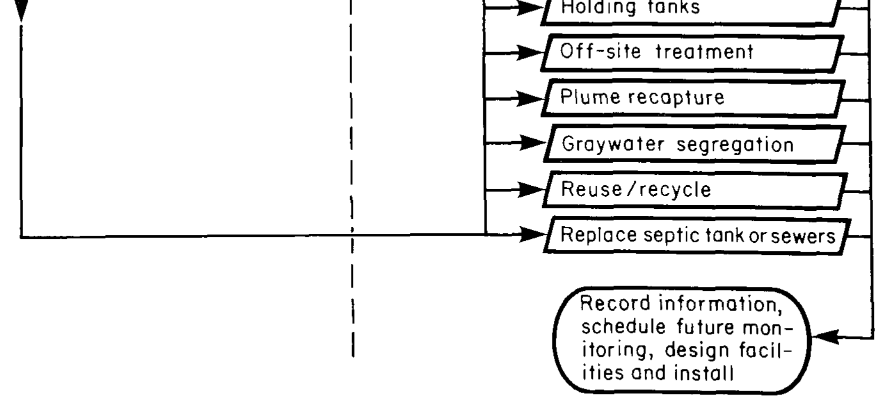
6. Well samples should be taken at least twice to ensure reliability of conclusions.

7. If house drains are likely to be clogged, snaking drains may solve problem. Note: Monitoring of water meter is required after installation.

8. Septic tank and sewer inspection to include: excavation; pumping; inspection for size, structural integrity, outlet and baffle condition; rodding house and effluent sewers; measuring distance and direction to SAS using snake and metal detector.

9. If septic tank and/or sewers (to and from septic tank) need replacement and additional work on drainfield is required, follow "no" route and investigate other factors before replacing septic tank and/or sewers. This process will avoid replacement of septic





tank/sewers when entire system is not functional.

10. Other tests may be substituted if they distinguish between wastewater and non-wastewater sources of well contamination.

11. This procedure is limited to digging and inspecting test pits in the drainfield, excavation and repair of distribution boxes and broken header lines, snaking distribution lines to remove obstructions, and soil borings through drainfield laterals, pits, or trenches.

Chapter 4. Choosing Your Weapons

At this point, your community has a pretty good estimate of how many systems are failing (and why, and how seriously), and how many are functioning satisfactorily. You may have evidence that certain neighborhoods in your community are going to continue experiencing failures because of soil types or groundwater depths.

But what action should you take? Should you replace the failing systems with new ones? Should you replace *all* the on-site systems with a new sewer system?

First, you must understand what the options are.

Conventional On-Site Systems

The predominant type of on-site system is the septic tank/soil absorption system.

The septic tank receives the wastewater first. The septic tank has four functions: it separates solids from liquids, it partially stabilizes organic matter, it stores solids until they can be pumped away, and it allows clarified liquid, the effluent, to discharge to the soil absorption system for further treatment and disposal.

Solid materials in the wastewater settle to the bottom of the tank. As they accumulate, the solids decompose into sludge. A scum of lightweight material such as fats and greases rises to the top. The partially clarified liquid layer between the septage and the scum is allowed to flow through an outlet structure carefully positioned below the scum layer. This liquid is the effluent that flows to the soil absorption system.

One of the major advantages of the septic tank is that is has no moving parts and therefore needs very little routine maintenance. A properly designed and maintained tank made of concrete, fiberglass, or plastic should last for 50 years. Tanks can also be made of steel; because of corrosion problems, steel tanks may last only 10 years.

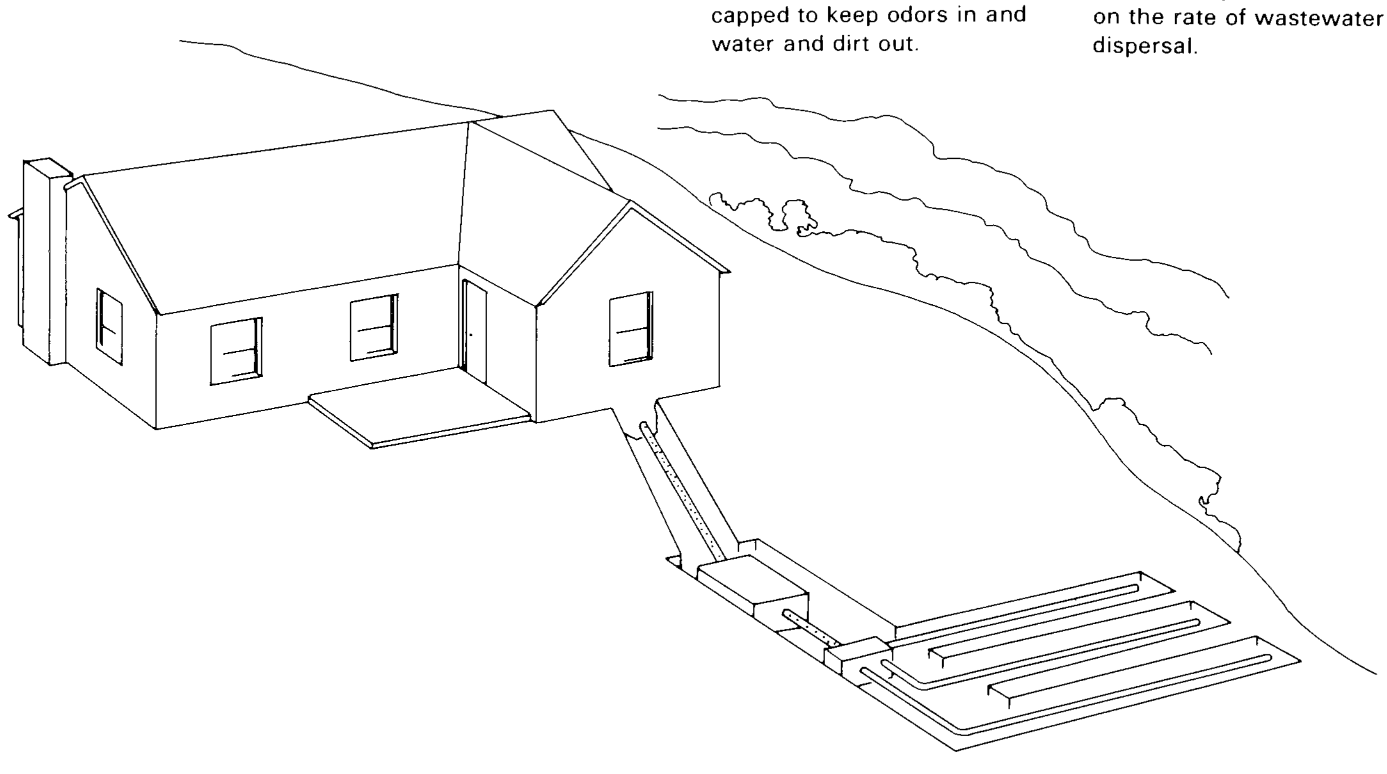
The major cause of septic tank problems is the failure to pump out the sludge solids when necessary. As the sludge layer increases in depth, the liquid volume decreases, which does not allow as much time for settling. Then treatment efficiency falls off, and more solids escape in the effluent. The only way to prevent this problem is to pump the tank regularly. Plan to pump the tank once every 2 to 5 years.

Most septic tanks are buried so that inspecting or pumping them requires some digging. That disruption can be avoided if the manhole covers in the top are fitted with access pipes. These 4- or 6-inch diameter pipes can be cut off just above ground level and capped to keep odors in and water and dirt out.

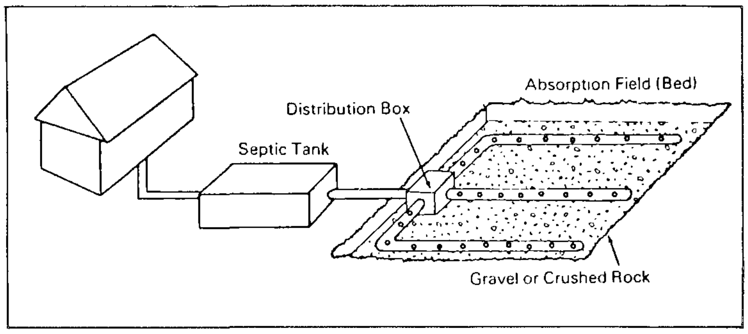
Soil Absorption System

The function of the soil absorption system is to distribute the septic tank effluent to the soil. The effluent then percolates through the soil and is filtered. Many waste materials are removed through reactions with the soil particles.

A *clogging mat* forms at the point where the wastewater meets the soil surface. The formation of this mat depends primarily on how much and what kind of wastes go through the system. This mat slows the seeping of water into the soil, preventing the soil underneath from becoming saturated. This is beneficial because the wastewater has to travel through *un*saturated soil in order to reach the groundwater. This removes disease-causing organisms and other pollutants. Naturally, the clogging mat also slows the rate at which the effluent enters the soil. Well-designed soil absorption systems take into account the formation of the clogging mat and its effect on the rate of wastewater dispersal.



Variations on the Theme



There are several different designs of soil absorption systems, but the most commonly used are trenches, beds, and mounds. All share the following construction similarities: They are covered excavations filled with porous material such as gravel and they include a means for introducing and distributing the wastewater throughout the system. The distribution system discharges the wastewater into the air spaces in the porous material. These spaces provide storage for the wastewater until it can seep away into the surrounding soil.

The type of system selected depends on the site. Of particular importance are the permeability of the soil, the depth of the soil over the water table or bedrock, slope of the site, and the size of the area suitable for system placement.

Where soil conditions are right—that is, the soil is neither too permeable nor impermeable—and the soil is deep enough over the water table, trench and bed systems are most commonly used.

Trenches are shallow, level excavations usually 1 to 5 feet deep and 1 to 3 feet wide. The bottom of the trench is filled with 6 inches or more of crushed rock or gravel over which runs a single line of perforated pipe to distribute the effluent. More rock is placed over the pipe, and then a semi-permeable barrier is placed over the rock to prevent backfilled soil from filtering down into the rock layer.

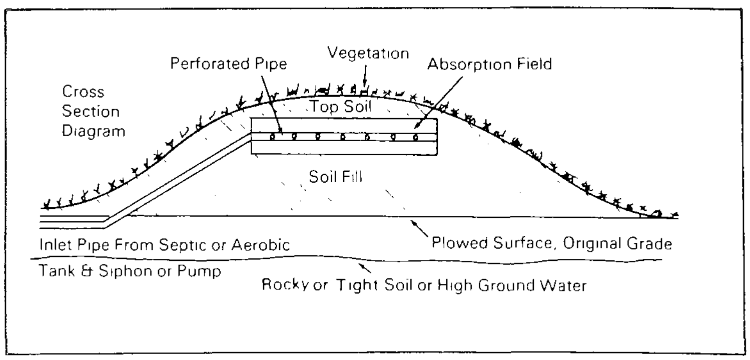
Beds differ from trenches in their width—they are wider than 3 feet. Thus, the bottoms of the beds provide the primary distribution of wastewater to the soil.

If the soil is relatively impermeable or naturally becomes saturated by groundwater within two feet of the ground's surface, or if soil over the bedrock is shallow, a mound system may be used. Mounds are, as you would imagine from their name, raised beds constructed above the natural soil surface. The distribution system discharges into a porous layer just as for trenches and beds, and then percolates down through the soil. This system thus uses the generally more permeable topsoil layer rather than the subsoil, which may be wetter, slowly permeable, or of insufficient depth.

Other design variations are available that are useful for upgrading existing on-site systems or for new systems. A few of these variations and the reasons they would be used are:

- Oversized soil absorption systems can be installed when soils are slowly permeable or when increased wastewater contact with highly permeable soil is needed to get adequate treatment. In either case improved distribution of effluent by intermittent pumping may be necessary to take advantage of the additional trench or bed.
- Another way to improve performance in slowly permeable soils is to split an oversized system in two, provide each half with its own distribution pipes and switch from one half to the other annually.
- Grease traps installed before the septic tank and cleaned routinely can reduce scum formation and the amount of scum that carries over to the soil absorption system.
- Improved baffles in the septic tank, a two-compartment septic tank, or two septic tanks one after the other will reduce the amount of organic solids going to the soil absorption system. If you are going to use a garbage grinder, two tanks or a two-compartment tank is a must.
- Stormwater from roofs, driveways, sump pumps and side slopes can tax the ability of a soil absorption system. Divert this extra water with shallow trenches or pipes.
- Runoff also flows as a temporary water table below the ground surface and over a tight layer in some soils. This extra water can be diverted through *curtain drains,* trenches with perforated pipes at the bottom and partially filled with gravel. Curtain drains should be far enough above the soil absorption system so they do not become direct discharges (See Chapter 1).

These design features can be built into a new or replacement on-site system. Some can be added later if necessary. But what if your existing on-site system is acting up and there is no room left on your property for an oversized soil absorption system? Or a new drainfield that can alternate with your present one?



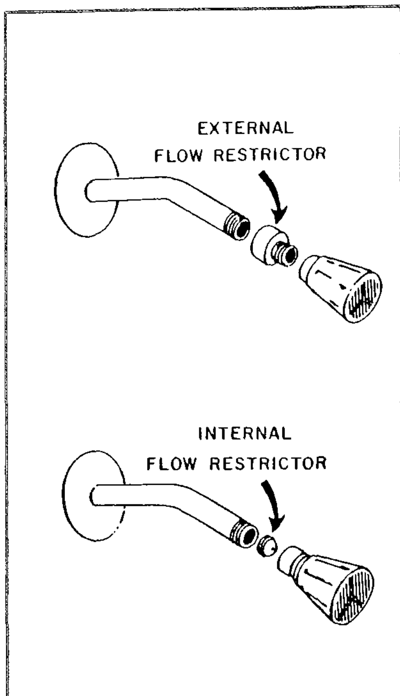
Salvaging A Sinking System

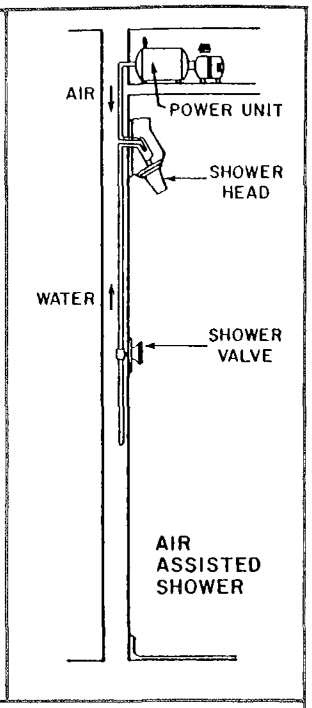
There are still some effective remedies available to you that can control the causes of your system's problems. But first a word of caution. Chemical additives that make claims to clean out your septic tank can make matters worse in the long run. The organic material from your tank just flows to your soil absorption system and can make it fail.

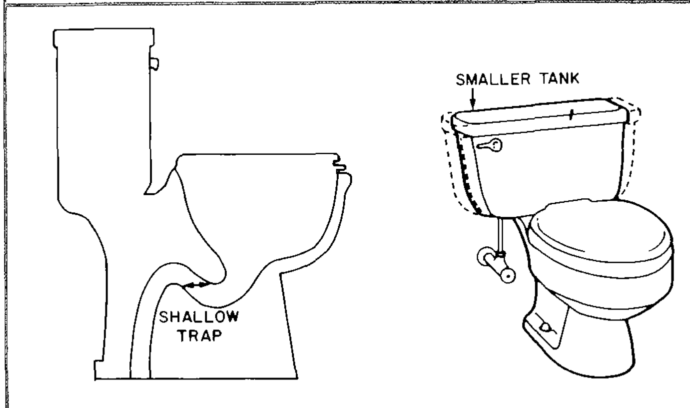
In increasing order of cost and difficulties, the effective remedies are:

- Check the house's plumbing fixtures regularly and repair any leaks.
- If you take baths, switch to showers if you have them. This almost invariably will save water.
- If you use a public water supply, ask the water utility what the water pressure is in your area. If it is above 40 pounds per square inch, install a pressure reducing valve in the water service pipe. This will reduce water consumption and wastewater flows in many such houses. Check the water meter periodically if you have one to see how much you are using.
- Install the inexpensive flow-reduction devices that are available. Most homes that do not already have fixtures designed to save water can get a 10 percent or greater reduction with low-flow shower heads, faucet aerators and toilet tank dams or dual-flush toilet tank adapters. These devices will pay for themselves in a short time by reducing your water supply and water heating bills. You will have to quit taking baths for the low-flow shower head to save water.
- Disconnect your garbage grinder. It contributes about a third of the organic solids going to your septic tank. Unless you have that second tank mentioned above, or are really diligent in pumping your septic tank, this extra solids load can stress your soil absorption system.
- Replace old water-using fixtures and appliances. Many old toilets and faucets were over-designed. Replacing your old 7 gallon-flush toilet with a 3 gallon model is the best switch you can make. Also consider a suds-saving or front-loading washing machine (if your system will handle one at all) and faucets with built-in hot and cold mixing valves.
- Abandon luxury appliances. If your only choices are polluting your neighborhood or washing your clothes at the laundromat, your conscience should take you to the laundromat. But the choice is seldom that harsh.

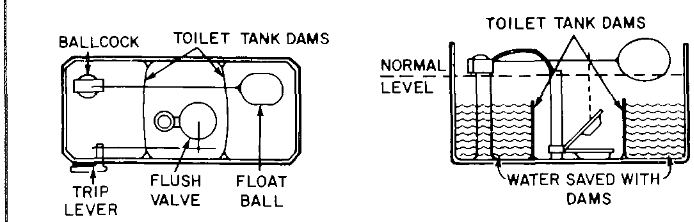
- **Replace your conventional shower with an air-assisted shower. Compressed air is used to spray a reduced flow of water on the bather. To use this, you will have to buy especially designed equipment, replumb your shower, and enclose your tub or shower stall with a sliding door. But it will cut your water use for bathing about 90 percent and will reduce the average household's entire water usage 10 to 25%. This is about the same savings you could get by abandoning your clothes washer.**



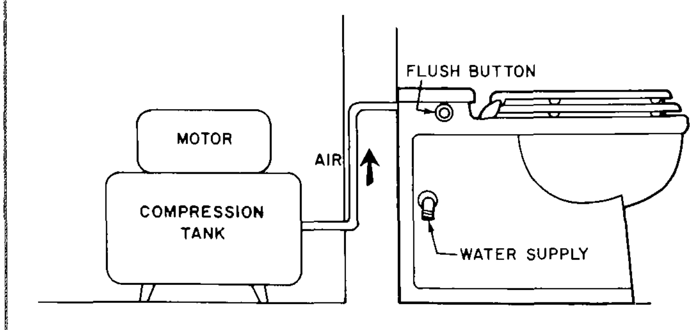




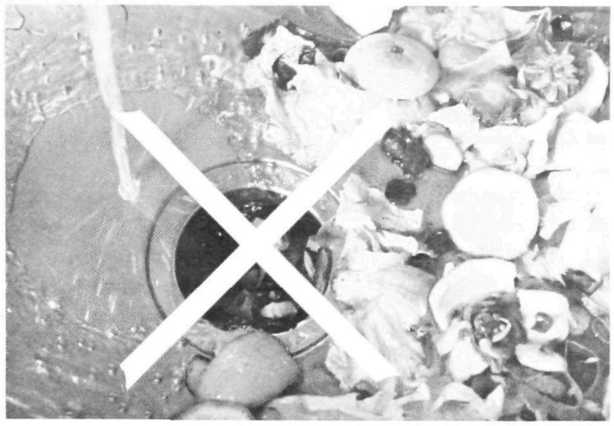
SHALLOW TRAP TOILET

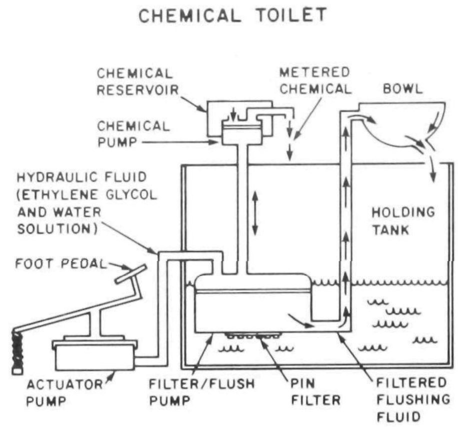


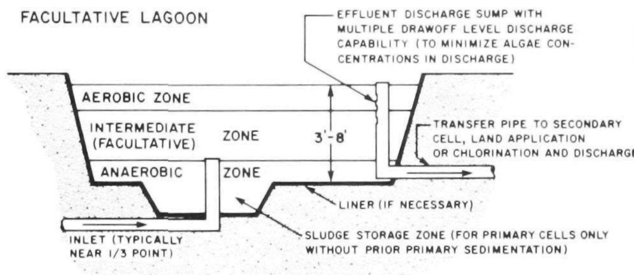
TOILET TANK DAMS



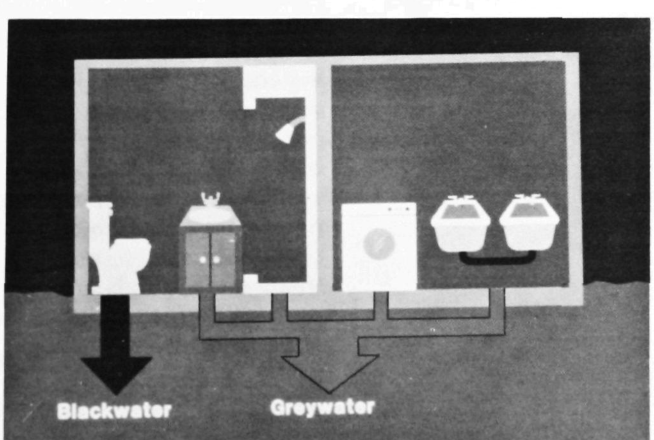
AIR ASSISTED TOILET







- If nitrate or bacteria contamination of groundwater is a potential hazard on your site or additional flow reduction is needed to protect your soil absorption system, handling toilet wastes, or *black water,* separately from other wastewater may solve your problem. There are several ways to do this such as *composting toilets, chemical toilets, incinerating toilets* and *air-assisted toilets.* Separate treatment of black water will reduce flows to your soil absorption system by about a third and nitrogen by a whopping 80 percent. Each method has wastes left over that have to be disposed of separately, but their volumes are comparatively small. You will want advice from an expert to help select the best method for your home. Also check with your health department and public works department to see what is permitted.
- Still not enough? It is possible to reduce the flows by recycling and reusing some of the less contaminated waste streams such as bathing water and laundry water. It will require some replumbing and continued maintenance, but these wastes can be filtered, stored and/or disinfected to be reused for toilet flushing or irrigation of lawn and garden.



- The (almost) last resort is a holding tank and routine pumping and hauling by a tank truck. No one likes them, they are very expensive when all wastewater from a house is collected in them, and the high cost of pumping them encourages illegal emptying into ditches, streams and even lakes. To keep pumping costs to a minimum, any of the methods above will help. But holding tanks will do the job of protecting public health and water quality if you cannot or will not use the next two options.
- If your property is not suitable for soil absorption systems, you may be able to treat your wastewater to a high degree and discharge it to a stream. Septic tanks or home-sized aerobic treatment units or both are used to pretreat the wastewater. A variety of additional treatment units such as various sand filter designs, disinfection devices or small ponds may be needed to provide final treatment. You will have to apply to the agency in your state that issues permits for surface discharges.
- High technology treatment systems have been developed which take all the wastewater from your house and treat it so that it is suitable for all uses, including drinking. These systems include continuous automatic monitoring and mandatory service contracts. They are not universally available because not all states approve them yet and the manufacturers require a minimum number of sales before delivering new units. But these systems show what can be done when it has to be done.

If you are the only homeowner within a quarter of a mile or so that has to go to this much trouble for adequate wastewater disposal, then you may have to go it alone.

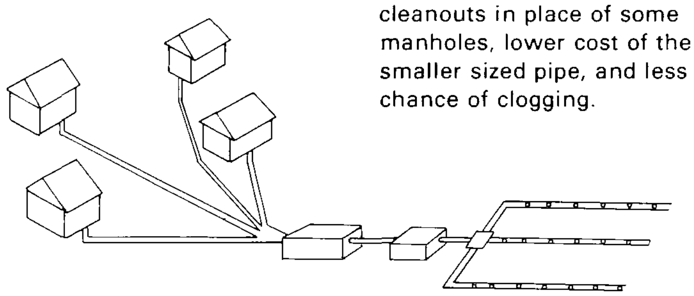
But what if your neighbors are having similar problems? As the number of problems and the density of development increase, the economic and public health justifications for off-site systems increase.

Off-Site Systems

Off-site systems collect wastes from individual dwellings for processing at a centralized location. Off-site systems might be limited in extent to serve just those groups of buildings with severe problems or they may extend throughout a community. Each type is discussed in the following sections.

Cluster Systems
Cluster systems are so called because they provide treatment services for a small number of dwellings. Wastewater is collected in sewers and carried to a nearby site for treatment and disposal. Low-maintenance technologies are used for treatment and disposal, including large soil absorption systems or lagoons. In either case, existing septic tanks can be left in place to pretreat the wastewater. Large soil absorption systems are often divided up into two or three drainfields to allow periodic resting of each and to provide emergency backup.

Use of cluster systems depends on sites suitable for subsurface discharge or nearby streams that can accept lagoon effluents.



The best system for your area need not consist entirely of one kind of treatment. A scattering of clusters or mounds for the worst problem areas may accompany simple upgrades or even no action. This house-by-house mixing and matching can drastically cut costs.

Centralized Collection and Treatment
The most common methods of wastewater collection are conventional gravity, small-diameter gravity, pressure, and vacuum sewers. Topography, depth to bedrock, depth to groundwater, and housing density are the major factors that determine relative costs of these types of sewers in a particular community.

Conventional gravity sewers are usually made of clay but can also be made of plastic, cast iron, concrete, or asbestos cement. They are designed to carry raw wastewater and, therefore, are normally 8 inches in diameter or more to avoid solids buildup and clogging. A variation of conventional gravity sewers is small-diameter sewers. These 4- or 6-inch diameter sewers can be made of the same materials as conventional sewers. Used with septic tanks at each house to remove coarse solids, small-diameter sewers can be laid at slighter grade and require fewer lift stations than larger sewers carrying raw sewage. Other advantages of small-diameter sewers include fewer manholes, use of lower-cost cleanouts in place of some manholes, lower cost of the smaller sized pipe, and less chance of clogging.

Two types of pressure sewers are available: grinder pump pressure sewers and septic tank effluent pump (STEP) sewers. The grinder pump does not use a septic tank at each house as does the STEP system. Both systems transport wastewater under pressure from small pumping stations serving one or two houses each to a treatment facility or to an area where gravity sewers are used. Infiltration of groundwater through cracks into conventional sewers is not a problem with these 1- to 4-inch diameter pressure sewers. Other advantages of pressurized sewer systems include easier installation (a downhill grade is not necessary), and lower costs than conventional sewers, especially in areas of steep slopes or shallow bedrock. However, the lower cost of the sewers is partially offset by pumping units and electricity costs. Density of development, therefore, is a factor in economic comparisons between gravity and pressure sewers.

Vacuum sewers have the same advantages over conventional sewers that pressure sewers have. The main difference between vacuum sewers and pressure sewers is that wastewater is transported by a central vacuum pump instead of many pumps located at individual residences. Neither pressure sewers nor vacuum sewers depend on gravity, so the excavations to install them do not have to be as deep and wide as excavations for gravity sewers. Therefore, detrimental impacts of disturbing streambeds and low-lying wetlands during construction can be more readily avoided.

Once the wastewater has been collected, it can be treated and discharged in three ways: by land application, by wetland discharge, and by surface water discharge.

Land application of large flows consists of some form of pretreatment followed by discharge of the wastewater to the surface of the soil. Rates of application and whether the treated effluent is recovered vary depending on site conditions.

If suitable wetlands—marshes, peatlands, or swamplands—exist near the community, treated wastes may be discharged into these areas for more complete treatment and natural recycling of nutrients. Sometimes artificial wetlands are constructed for this purpose.

Although wastewater may be discharged to surface waters, this option is often not considered for lake areas when such discharges are likely to add to the nutrient level of the lake. In some instances, however, surface water discharges are necessary, such as when continued use of on-site systems and land application have been shown to be unfeasible. A wide range of treatment methods are possible before discharge to streams or rivers.

Chapter 5.
The Road Not Taken— An Introduction to Community Wastewater Management

Why Do Anything?

This is really the $64,000 question. Why should your community become involved in wastewater management? You can probably think of plenty of good reasons to let sleeping dogs lie: What does community management involve? I don't know anything about wastewater management, and neither do my neighbors, so who's going to do the managing? Why should my neighbors follow the advice of a community agency? And why bother with management anyway? Why don't we just let the current situation go on? After all, it isn't so bad, is it?

You will find the answers to some of these questions in this chapter. You'll learn what a management agency does and who actually serves in the agency. But we should answer the essential question of *why* before you get into the details.

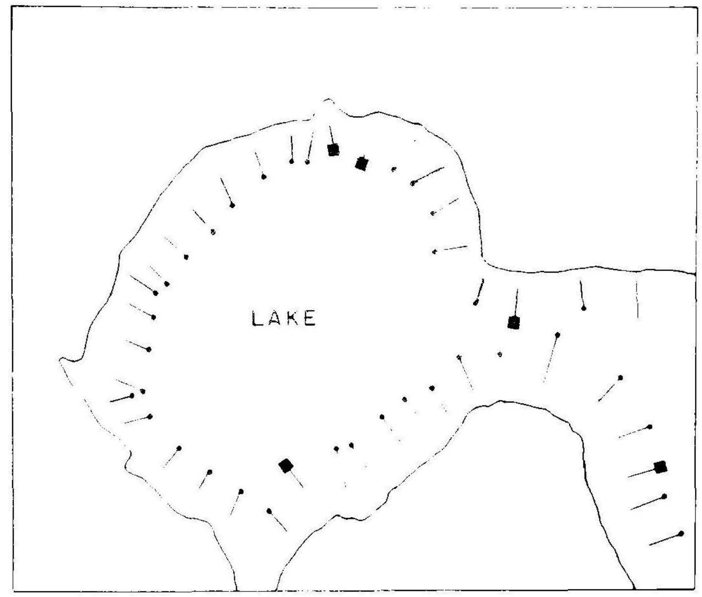
If your on-site system affected water quality only on your property and the health of your family alone, the community would not need to become involved. The problem of correcting these impacts would be your problem, and no one else in the community would need to be concerned in the repair or replacement process. If you wanted to reduce the health risks to your family or threats to your water quality, you would simply fix your system.

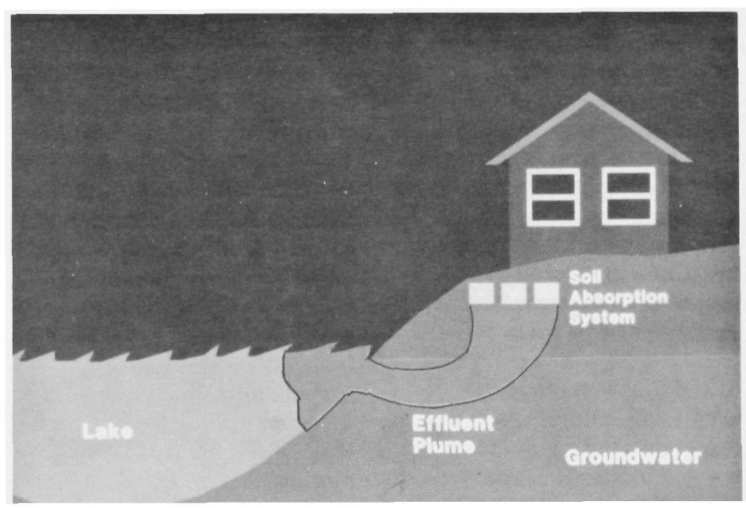
However, on-site systems can have off-site impacts. Your failing system could be affecting the water quality of the lake used by the entire community. Your neighbor's system could be contaminating the groundwater from which you draw your drinking water.

As housing densities and failure rates increase and when sensitive water resources become involved, the problem of off-site impacts becomes too serious to be solved by individuals alone. Some sort of supervisory agency is needed to ensure that the solutions to the problems are carried out.

But community management is not just a convenience. Local governments are obligated to protect the health and welfare of its citizens and the quality of their water resources. Where on-site systems are creating off-site problems, the community is obligated to solve these problems.

There are several other reasons why your community should undertake the management of its own wastewater facilities. Consider the fact that no one from outside your community is as familiar with local problems and interests as you and your neighbors are. Community management is thus more likely to be responsive to the specific concerns of the neighborhood. Additionally, community management can avoid enforcement actions by higher levels of government.





What Does a Community Management Agency Do?

As your community considers the management of its wastewater treatment systems, at some point you and your neighbors will ask, "How much management is enough?" Generally, management responsibilities should increase in direct relation to the density and the number of problems encountered with the wastewater systems in the community. Also, sensitive water resources such as lakes and groundwaters that are the only source of drinking water must be considered in the planning of wastewater treatment. The costs of managing and the authority given to the management agency are flexible, and can be matched to the severity of what happens if management is not sufficient.

Several management models are discussed below to give you an idea how community management can work and how responsibilities for maintenance and repair are handled in increasingly problematic situations. Keep in mind that your management program need not adhere to any one model. It should be designed to meet your community's unique requirements and be revised as necessary based on periodic performance reviews.

Regulatory Model
This is the management approach presently in use in most states and small communities. It is suitable for areas where community obligation for the regulation of private systems is low because of low density of systems, few problems with existing systems, and/or lack of sensitive water resources. Such areas include rural land areas where scattered development, farms, and large tract sudivisions predominate. This type of program is usually limited to management agency approval of permits for septic tank system construction, inspection of system installations, and investigations of complaints concerning failures of on-site systems. It is distinguished from the following model by its lack of any routine inspections of the system or monitoring of their impacts on water quality.

Under this approach, the homeowner is completely liable for system operation and maintenance, including necessary system repairs. The management agency does not conduct routine inspections or monitor system performance, does not finance repairs, does not consider the use of off-site treatment, and does not permit the use of experimental on-site designs.

Voluntary Participation Model
Some communities may have limited areas of high density, high failure rates, or sensitive resources, any of which may increase community obligations for private systems. Increased services are made available to residents in these problem areas who elect to pay user fees for services provided. In addition to the management program outlined under the Regulatory model, the management agency provides the services of routine inspection and water quality monitoring. Homeowners are notified of necessary repairs for their systems, and the community management agency offers technical and possibly financial assistance to make the repairs. If a significant enough problem area is identified, homeowners could receive state or federal funding for repair of their systems. The community management agency could apply for and distribute the funds to those homeowners whose systems qualify for assistance.

Under this model, the homeowner retains both responsibility for system operation and maintenance and liability for system repair. The management agency's role is to educate, provide technical assistance and advise or remind residents to maintain their systems.

Universal Community Management Model
As system density, failure rate, and sensitivity of water resources increase, community obligations for managing private systems increase so that all on-site systems within prescribed areas would be included in a management program. Depending on the risk and consequences of failures, the management agency could assume responsibility for system operation and maintenance and liability for system repairs. This would insure swift correction of serious problems and, at the same time, minimize the consequences of homeowner negligence.

This level of management may be seen as an insurance policy. You would not buy it if you do not need it. But if you do, everyone covered would have to pay their share. This means that a fair and efficient user charge system will be needed (See Chapter 6).

Multizone Management Model

This approach is useful when sections of a given community have different wastewater and management needs. For example, sewers may serve one area and on-site systems serve other areas. Owing to varying risks of failures, both voluntary and universal management zones may also be present.

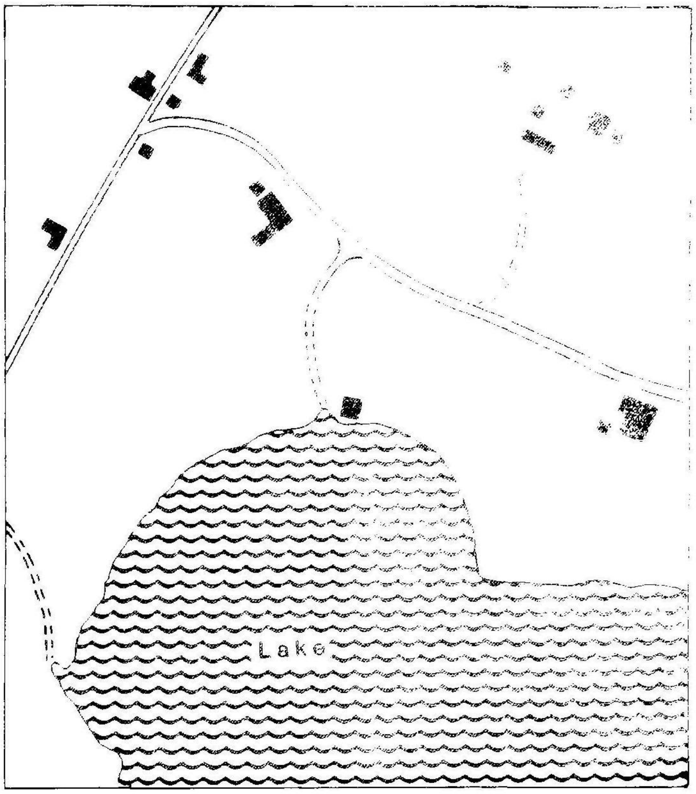
Under this approach, the management agency must develop specific programs for each section of the community. By so doing, the agency can ensure that the program meets each given area's needs.

A possible objection to this approach is the diversity of skills that management agency personnel may need. However, there may be enough overlap in skills so the agency staff can be kept to a reasonable number.

Under a multizone management approach, homeowners would be responsible for paying annual fees to support the management services they receive. Responsibility for operation and maintenance and liability for system failure may vary within each zone.

Comprehensive Water Quality Management Model

Where the sensitivity of water resources is of the greatest concern, prevention and control of water pollution need not be limited to monitoring of wastewater facilities. The management program in communities with these concerns may be based on universal management of the wastewater facilities and expanded to include identification and control of other sources of water pollution. Responsibilities under this expanded approach could include:



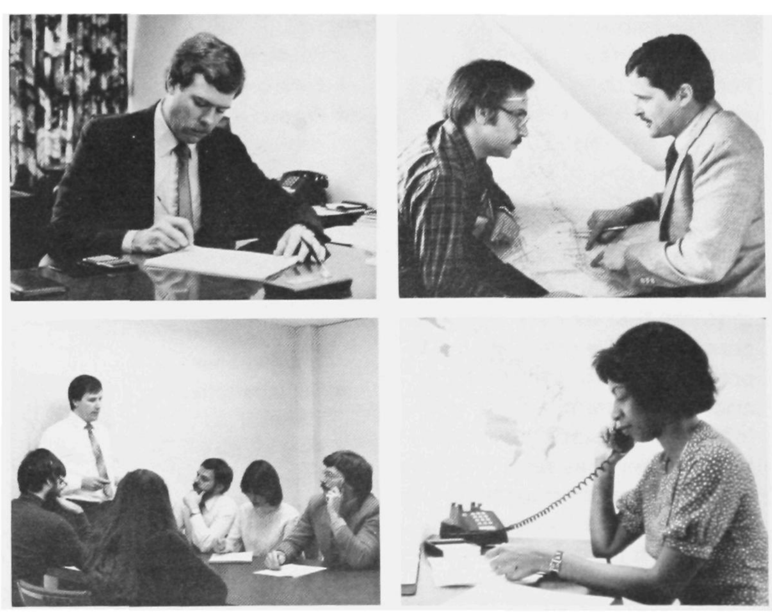
- *non-point source* monitoring and control,
- education of residents and visitors about individual pollution control policies, costs, and benefits,
- inventory of the biological resources of the lake and its tributaries,
- research into the chemical, physical, and biological characteristics of the lake, and
- coordination with other local, state, and federal agencies on pollution control activities and funding.

Communities with such a high interest in the control of water pollution are also likely to assume direct responsibility for system operation and maintenance and liability for correcting system failures.

Who Is the Management Agency?

The management agency can be made up of members from a wide variety of public and private sources. Public sources of management agency personnel may include state, regional, or local agencies and nonprofit organizations; private sources may include homeowner associations and private contractors.

The community management agency need not be a new organization, nor need it be solely devoted to the purpose of wastewater management. People with the appropriate skills and experience may already be available in agencies that have the necessary authority to provide public management services. A combination of agreements among agencies, additional training of existing personnel, and hiring new people will provide the basis of management agencies in many communities.



Services Provided

The range of services that a management agency can perform varies greatly. Common sense dictates that the services chosen be only those needed to fulfill community obligations without unnecessary regulation, authorities, labor, or investments. Although a few services are essential to all management programs, many are optional, and it is left to the community to decide which to include in the management program. Table 1 lists administrative, technical, and planning services that a community might select.

The services that the management agency will provide are determined to a degree by the factors of risk and liability. *Risk* refers to the likelihood of system failure. *Liability* involves acceptance of responsibility for remedying failure. These factors ultimately affect who will pay for system repairs. When the management agency is set up, an assessment of the risk of future system failure should be made, and assignment of liability for repairs should be agreed upon by the agency and the community.

Where risks of failure are high, the management agency may assume full liability for repair or replacement. In this case, the agency often requires that owners contribute to a reserve fund to provide financing for repairs and replacement.

Where risks are low, each homeowner may retain liability for his or her own system, making repairs as necessary.

Part and parcel of selecting services is deciding *how* the services should be performed and *who* should perform them.

Risk And Liability

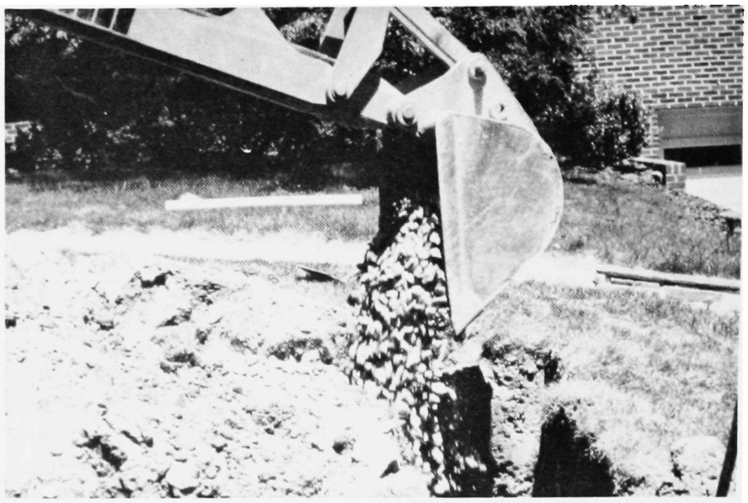
Answering the *how* question defines specific methods that will be used to provide services. Consider the service of water quality monitoring, for example. *How is water quality monitoring to be performed?* Answering this question involves decisions on whether to include nonpoint source and surface water monitoring, the design of the groundwater and other monitoring plans, the development of the user charge system that will pay for the monitoring, and decisions on financing the local share of costs for this service.

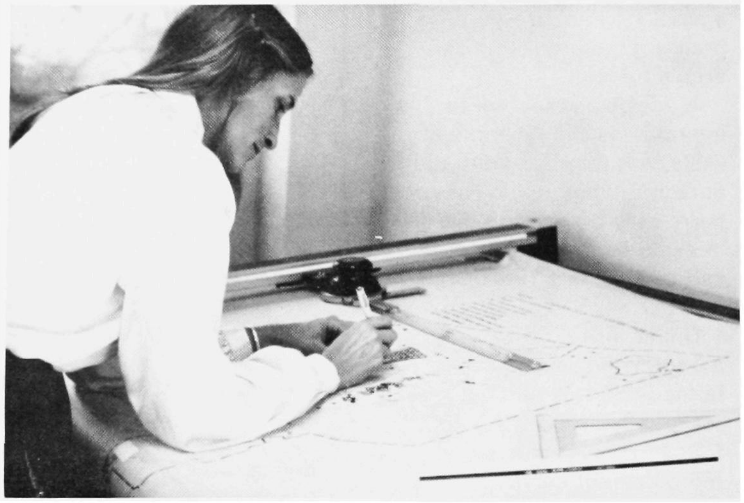
TABLE 1.

Administrative
- Staffing
- Financial
- Permits
- Bonding
- Certification programs
- Service contract supervision
- Accept for public management privately installed facilities
- Interagency coordination
- Training programs
- Public education
- Enforcement
- Property/access acquisition

Technical
- System design
- Plan review
- Soils investigations
- System installation
- Routine inspection and maintenance
- Septage collection and disposal
- Pilot studies
- Flow reduction program
- Water quality monitoring

Planning
- Land use planning
- Sewer and water planning





Who performs these services? Generally, three groups of people can provide the services that are selected:

- the public management agency, which may get assistance from regional and state organizations,
- property owners or occupants, and
- private organizations such as contractors, consultants, development companies, private utilities, and private community associations.

Some communities may control services by providing them directly, but others may provide only those services that the designated regulatory body can provide (such as issuing permits and enforcement), and supervising the services assigned to owners or private organizations. When the community assigns service responsibilities, it should make sure that the designated person or persons have the necessary skills, financial capabilities, and regulatory authority to provide the service. The community should also consider the costs required for different groups to supply these services, as well as the risks associated with poor performance.

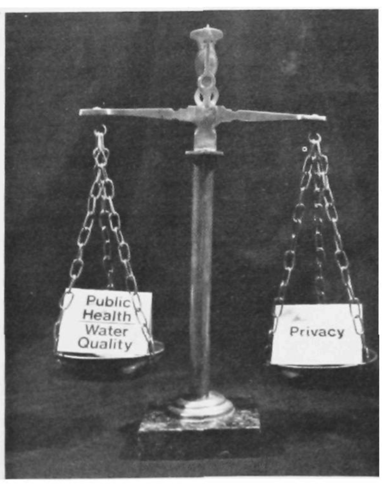
The Problem of Privacy

Although required by both federal legislation and common sense, local management of on-site systems raises concerns about individual privacy and the sanctity of private property. When you relinquish authority over your system to a governing body, even if it is composed of your neighbors, you may feel that you have lost control over part of your property and that you will be subjected to intrusions at the whim of the management agency. For this reason, members of community management agencies are urged to exert their authority tactfully and sparingly, with the goal of balancing public health and water quality needs against any infringement on privacy.

Possible violations of your privacy from community management of on-site systems depends, as one would expect, on the performance of your on-site system. If your system is causing no problems and meets current design standards, short-term intrusion would include a 1- or 2-hour interview and site inspection during a sanitary survey and possibly a return visit for well water sampling. Continuing intrusions would include periodic (every 1 to 3 years) site inspections by a surveyor, routine septic tank pumping every 2 to 5 years, and, for lakeshore dwellings, possible groundwater and surface water monitoring along their beaches. All these intrusions can be minimized by careful advanced notice and mutual agreement on public entry.

If your on-site system requires repair, replacement, or upgrading, intrusions caused by detailed site analysis and construction will be roughly comparable to laying out and installing house sewers. Either could require modification of interior plumbing that may be disruptive as well as annoying.

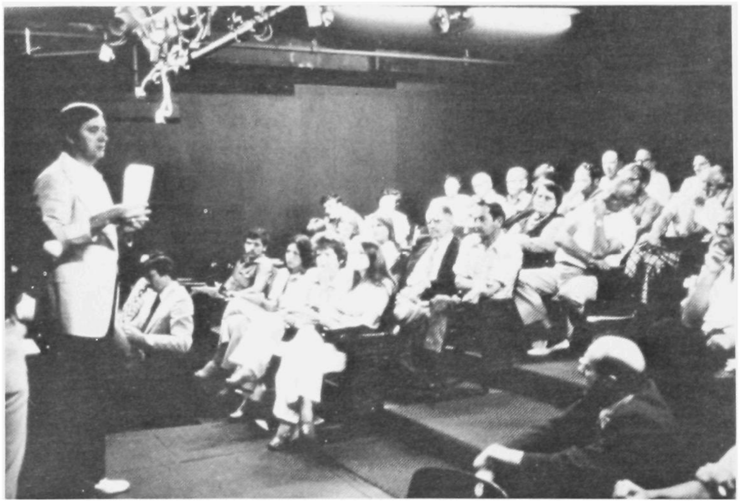
For some on-site systems needing repair, replacement, or upgrading, continuing intrusions will also be greater than for properly designed and operating systems or with gravity sewers. Continuing intrusions will be related to the complexity of the facilities necessary to deal with site limitations; the more complex the facilities, the more maintenance will be required.



The Community Management Agency Wants You

One of our goals in preparing this handbook is to get more homeowners involved in the wastewater management process in their own communities. It makes sense that you will weigh costs and other decisions that affect your family more carefully than might a state or federal official. Besides, you will be involved in the process whether you want to be or not if your management agency requires you to replace, repair, or upgrade your system. Why not have a hand in determining whether such expenditures are necessary or not?

You can contribute to the process by joining your neighbors in setting up a homeowners' advisory committee that can keep the management agency aware of your concerns and your opinions on the program of wastewater management in your community. You might even convince the people setting up the management agency to formalize the role of your homeowners' advisory committee. The committee could act as an arbiter between the agency staff and homeowners. It could also work like a zoning appeals board to ensure that rules and regulations don't impede acceptable solutions.



Chapter 6. Is It Worth It?

By this time, you are ready to consider the thorny issue of costs.

When you think about the costs of wastewater treatment alternatives, your immediate question will likely be, How much am I going to have to pay for decent wastewater management in my community? But we want to encourage you to consider the costs of wastewater treatment in broader terms. It is certainly important to understand the concept of *cost-effectiveness* and important to know who might pay for the systems and how the money can be raised. But it is equally important for you to understand the *other* costs related to wastewater treatment: the costs to the environment if you choose some alternatives and the costs to your community in development potential if you choose other alternatives. You may not be able to measure these costs in a tangible way, as you can measure the dollars-and-cents costs of paying for a new septic tank. But as an informed and interested resident of the community, you need to look at *all* the costs of the systems you are considering.

Cost-Effectiveness of Alternatives

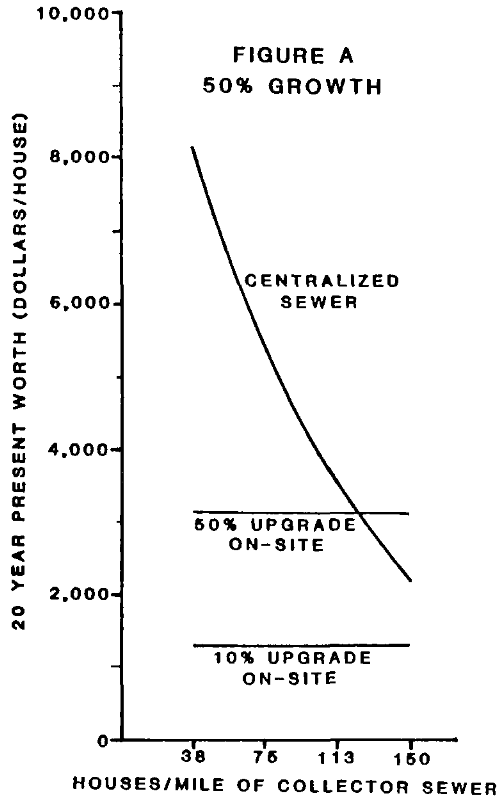
What *is* cost-effectiveness? The term implies making the most effective use of your money.

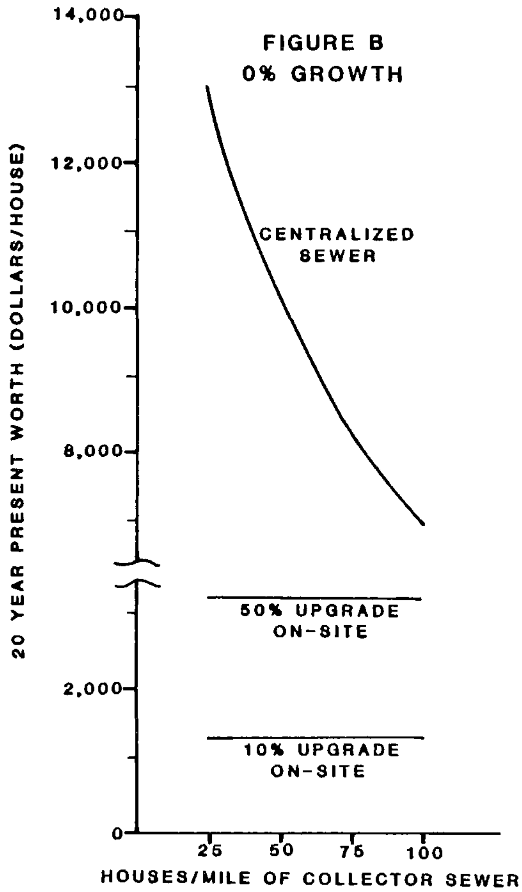
In theory, cost-effectiveness is a measure of all monetary, environmental and social costs of achieving a specified goal. In practice, many environmental and social costs cannot be reduced to dollars and cents, so calculations of cost-effectiveness depend heavily on estimating monetary costs. Then environmental and social impacts are considered in selecting among the least costly alternatives that meet specified goals.

All of the alternatives that have been discussed in this handbook have monetary costs that fall into one of three main categories: present capital, future capital, and annual. In addition, at the end of the period over which costs are compared, the facilities will have some worth for their continued use—this is called salvage value. *Present capital* includes expenses required to get the project built in the first place and may include, besides construction, engineering and legal fees, interest on a construction loan and costs of establishing a management agency, among others. *Future capital* includes construction and related costs of new facilities needed to upgrade existing facilities or to provide capacity for more users. Both present and future capital costs will go for facilities that may have some *salvage value* at the end of the planning period. *Annual costs* include labor, energy, transportation, replacement parts, chemicals, supplies and other goods and services necessary to make a wastewater management alternative work the way it is intended.

Because money has time value (put it in a bank at 6 percent and after a period of time, you have more money), we cannot just add up all of the dollars expended over the planning period. So let's see how the present capital, future capital and annual costs of on-site and centralized alternatives differ, then look at some overall comparisons.

- **Present capital**
  a. Centralized facilities require a large capital outlay at the beginning of a wastewater facilities project. Typically, a large portion of all the money spent over a 20-year period for new centralized systems will be for the initial design and construction.
  b. Upgrading and repairing on-site systems will involve a much smaller part of the long-term costs. Since not all on-site systems will require funds for construction, the average capital cost will usually be a fraction of the cost of centralized facilities per house.
- **Future capital costs**
  a. The major capital investments for centralized facilities are made at the beginning of the project. After start-up, capital improvements will usually consist of extending sewer lines. Reserve capacity for increases in flow are built into the pipes and tanks. The expense for population growth are already committed whether growth occurs or not.
  b. Future capital expenses for on-site systems will be for replacing systems that fail and for building systems to serve new homes and businesses. Reserve capacity for development is not built into the system, so increases in future capital expenses will be directly related to growth.
- **Annual costs**
  a. After the centralized system begins operation, costs for operation and maintenance of sewers, pumping stations and treatment facilities rise slightly as flows increase and the facilities become older.
  b. Maintenance and management costs can vary widely from one on-site system to another. The amount of electrical or mechanical components required will partly determine operation and maintenance costs. Also, the effort required for monitoring, inspection, and administration will cost money. Cost analyses for several rural lake communities indicate that community-wide operation and maintenance costs will be comparable with or less than centralized facilities. Costs for individual houses, such as those on holding tanks, could be substantially higher than the average.





Present Worth Comparisons

The way that these varying costs are converted to some comparable values is by calculating *present worth*. This is the amount of money that, if available at the beginning of a project, could be spent or invested at an assumed interest rate so that it would pay all costs over a specified period of time. Twenty years is the planning period for federally-funded projects.

Now let's look at some present worth comparisons between on-site system upgrading and centralized collection and treatment alternatives. Figure A reflects a situation where conditions are favorable for installing a new centralized system: the growth rate is 50 percent over the 20-year planning period and the soils and topography are just right, so no pumping stations are needed and excavation costs for sewer construction are as low as possible. The curves reflect present worth per house at a range of housing densities that might be found in small communities. Housing density is expressed as houses per mile of sewer that would be needed.

Note that costs for the centralized system decrease as housing density increases. This is called an *economy of scale*.

The costs for on-site system upgrading benefit from a different type of economy. Since there is not a good technical term for this, we will call it *if-it-ain't-broke-don't fix-it economy.* The two lines in the graph represent costs for upgrading 50 percent and 10 percent of existing on-site systems. At 50 percent the types of upgrades are assumed to be more expensive than at 10 percent because conditions must be worse to cause the higher failure rate. Therefore, while the average cost of sewers heavily depends on housing density, the average cost of on-site upgrading depends most heavily on failure rate.

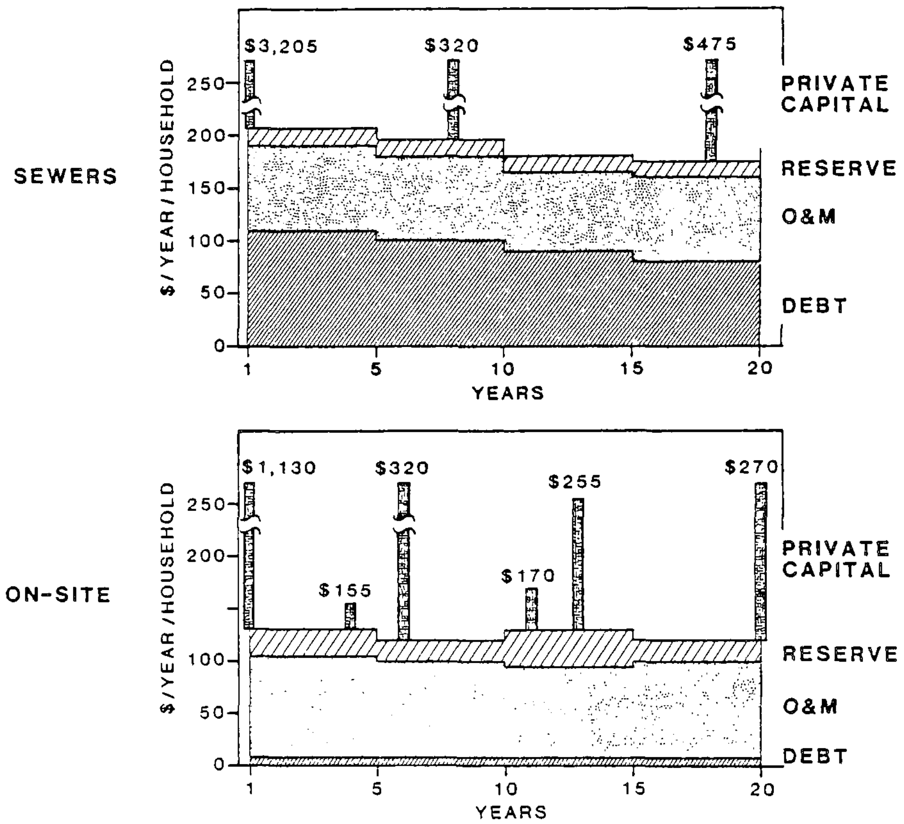
Note that the costs of the centralized alternative never competes with the 10 percent upgrade alternative. At 50 percent the trade-off point occurs at 60 houses per mile (92 houses per mile after 20 years). The average lot sizes would have to be below three-quarters of an acre to allow this density.

If we change the assumptions to favor on-site upgrading instead of the centralized alternative, as in Figure B, there is just no comparison between them. In this figure, the on-site alternative costs go down because no future growth is assumed. The per house costs for the centralized alternative go up because there are fewer homeowners to share the cost (no growth also) and sewer construction costs are much higher because steep topography and shallow depth to bedrock are assumed.

One of the major conclusions coming from these and similar cost comparisons is that information on the performance of existing on-site systems (See Chapter 3) is critical to comparing on-site upgrading with new centralized alternatives.

Local Economics

HYPOTHETICAL CASH FLOW COMPARISON BETWEEN USE OF ON-SITE SYSTEMS VS. CONSTRUCTION OF NEW SEWERS



Once you accept the fact that no wastewater treatment is free, despite various federal and state subsidies, you need to know what costs you may have to pay and how they might be charged. You also need to know what costs your community may be liable for and how it can finance its share of total costs. These aspects of the costs of wastewater systems to you and your community are detailed in the following sections.

Homeowners' Costs
You are likely to encounter some or all of these costs:

- **Private capital costs.** These are the costs that you, the user, will have to pay for items related to a wastewater treatment project, such as house sewers, necessary plumbing modifications, on-site systems for new housing, and flow-reduction devices. Your community is not involved in the payment of these costs.
- **Public capital costs.** These costs include interest on debt incurred during the project, local share of initial capital costs, and reserve fund (see below) costs. Your community generally pays these costs by charging users of the systems for service. (User charge systems are discussed later in this section.) These costs may also be charged at the beginning of the project in the form of hookup fees or frontage fees. For centralized facilities and cluster systems, the community can recover capital costs by charging both present and future users for services, but public capital costs for on-site systems are recovered from present users only. People moving into a community and building new on-site systems will have to pay the full cost themselves.
- **Operation and maintenance costs.** These costs are determined by several factors. If your community has received federal grant money to construct new systems, operation and maintenance costs must be allocated on the basis of each user's proportionate use of the system. For centralized systems, proportionate use can be measured by wastewater strength or flow since operation and maintenance costs are closely related to these wastewater characteristics. However, proportionate use for on-site and small-scale systems is more closely tied to services provided by a management agency.
- **Reserve fund.** The reserve fund is a kind of insurance policy to cover future costs of major equipment replacement, sewer extensions or repair of failed on-site systems. For communities leaning heavily to on-site systems, the reserve fund can be used to replace systems that may fail in the future. This fund reflects the liability a community is willing to assume for each type of system used. If, for example, your community wants to assume no liability for future failures of wastewater systems, a reserve fund is not necessary. Payments into the reserve fund will generally be low when the failure rate for systems is low; conversely, higher payments are required for communities with relatively high failure rates. Homeowners with high-risk systems might be charged higher reserve fund assessments that those with low-risk systems.

How many of these costs and how much you will have to pay depend on your community's specific situation and the status of wastewater treatment systems in your area. When you do pay them, all but the private capital costs may be levied in the form of *user charges,*.

User Charges

We have talked about user charges without really explaining what they are and how they're set up. This is the point to go into some detail about them.

Simply put, user charges are fees that you pay to a wastewater management agency for services provided. These charges can include your share of the costs for administration, operation and maintenance, monitoring by management agency experts, and the recovery of local public costs, mentioned in the previous section.

Setting up a user charge system requires careful planning to make sure that the charge system is both fair and efficient. Obviously, the fairest way to charge users would be on an individual basis—you pay for precisely the amount of service you receive. But keeping track of each person's charges would create bookkeeping chores that small communities may not be equipped to handle.

If most users receive roughly the same benefits from the wastewater management program, then an average charge may be the fairest and most efficient way to allocate costs. Average costs are also the easiest to calculate.

A third alternative is to establish specific groups or classes of users on the basis of factors such as flow, type of technology, or location. These groups can then be charged amounts proportionate to the equipment and services they need. This alternative works well when a community has a mix of wastewater systems, because costs for equipment and services can vary significantly according to the type of system. Charging according to what type of system you have can prevent the bad feelings that may arise when users with low-cost systems have to subsidize users with high-cost systems. Charging by user class does, however, require the community to spend more time and effort on bookkeeping than it would to average costs among all users.

Your Community's Role in Financing

Part of the local economic situation is your community's fiscal capability to undertake a wastewater treatment program. Even if the community is counting on receiving federal funds to help finance the program, it still must demonstrate that it has the necessary financial resources to ensure adequate construction, operation, and maintenance of the proposed facilities.

The fiscal capability of a community is determined by its ability to pay for and maintain wastewater facilities. First, the community must acquire funds to meet the local share of the capital costs of the wastewater facilities. This is generally accomplished through the use of either *general obligation* or *revenue bonds*. Second, the community must be able to bear the total annual debt service costs (principal and interest payments on the bonds) and operation and maintenance costs. Finance officers who judge a community's fiscal capability usually look at factors such as property values, median family income, community growth characteristics, and the revenues, expenditures, assets, and total outstanding indebtedness of the local government.

To some extent, your community's role in financing wastewater facilities depends on what type of community it is and how long it has been in existence. Newly established special purpose districts that do not have property taxing authority will have difficulty raising funds to meet costs. Such districts also will not be able to issue general obligation bonds and will have to pay a higher rate of interest on debt. And new districts, whether or not they have taxing authority, will have no record to prove how reliably they discharge their debts. They are therefore likely to face higher interest rates.

Your community can get help in planning its financial role by retaining the services of a bond attorney. A bond attorney can assist your community in assessing its financial resources and can recommend the types of financing available to the community.

Environmental Impacts

If you and your neighbors value the natural beauty of your community, the high productivity of your farmlands, or the diversity of wildlife in your forests and streams, the costs to the environment of both on-site and centralized systems will be a major concern for your community. Understanding how wastewater treatment systems affect the environment can guide you in your choice of the least costly facility.

Water Quality Impacts

As you read earlier, soil absorption systems discharge to the groundwater. This will cause no problems as long as the systems are working properly to prevent contaminants from reaching water supplies. If the soil underlying soil absorption systems doesn't provide thorough filtration, then contamination of groundwater by bacteria may result. Even if the systems *are* in good repair, nitrate buildup in the groundwater can occur, resulting in a possible health hazard to pregnant women and infants.

Moreover, groundwater may be contaminated by viruses and toxic substances, but more information is needed on this possible health and water quality impact because the extent and effect of such contamination are at present not defined.

Surface Water Impacts

Lakes and rivers may be affected by effluents from both on-site and centralized treatment systems.

On-site systems can contribute both bacterial and nutrient loads to surface waters. Bacterial contamination is most likely to result from direct discharges and runoff from surface malfunctions, both of which problems can be resolved by careful management programs. Bacterial contamination may also occur if on-site systems are situated in sandy or gravelly soils very near lakeshores or streams. Excess nutrients can stimulate local plant growth and increase the overall potential for excessive plant growth in surface waters. But nutrient loads from on-site systems are generally small compared with total nutrient loads. Small waste flows management can often reduce nutrient loadings from on-site systems.

If wastes from centralized treatment plants are discharged to surface waters, they can also boost nutrient levels, with the same impacts as described above. Because centralized discharges are much larger and not necessarily better treated, their impacts on aquatic plant growth and on bacterial quality can be signigicantly greater than dispersed individual systems.

Environmentally Sensitive Areas

Environmentally sensitive areas are cultural or natural resources that are particularly sensitive to damage caused by wastewater facility construction or development. Examples are floodplains, wetlands, prime agricultural lands, aquifer recharge areas, steep slopes, habitat for rare and endangered species, and historical and archaeological sites. Damage to them may consist of the disruption of delicate ecological balances, the loss of valuable farmland, or disturbance of significant historical areas.

Floodplains, wetlands, and steep slopes are generally protected by on-site sanitary code prohibitions. However, cluster systems and sewers can overcome natural constraints to development in such areas, opening a way for permanent environmental damage. Innovative on-site systems can also overcome site limitations and may permit development in sensitive areas, although the degree of impact would probably be less than for centralized systems.

Unless protective legislation is enacted, many irreplaceable cultural resources and natural areas can be damaged or destroyed because of development made possible by centralized wastewater treatment and some of the innovative on-site and small-scale systems. The loss of natural resources, farmlands, wildlife refuges, and other sensitive areas can be a stiff price to pay in return for wastewater treatment.

Development

What are the costs of development?

You can really rephrase this question in two ways, in terms of wastewater treatment facilities: How much will we have to pay for the kind of systems that will enable our community to develop as we want? What will development cost us in social and environmental impacts? And to these questions we can add another: Is development worth the combined costs of systems and impacts?

To answer the questions requires you and your community to agree on development objectives. Only if you know what your development goals are can you decide the relative costs of systems.

Community managed on-site system plans may affect the amount, rate, and density of development in communities within a reasonable commuting distance of employment centers. Building sites suitable for on-site systems may be getting scarce in and near your community. If so, committing to continued use of on-site systems may place serious constraints on new development, preventing your community from taking advantage of its proximity to the employment center.

Cluster systems that discharge off-site provide one means of creating more building sites. Cluster systems may therefore permit higher density residential development. These systems may also permit infilling within existing development areas, resulting in loss of open space buffers between existing development. Growth may extend into areas having natural features unsuitable for residential development.

The argument about the costs of development is obviously double-edged. If you want development in your community, then you may believe that more costly centralized systems are worth every penny. If development in your community is not an important issue or if you see that the additional revenues from development are substantially offset by the additional demands, then you may decide that these expensive systems are not worthwhile. Ultimately, the question of whether the costs associated with development are worth paying must be answered by each community.

What's It Worth to Whom?

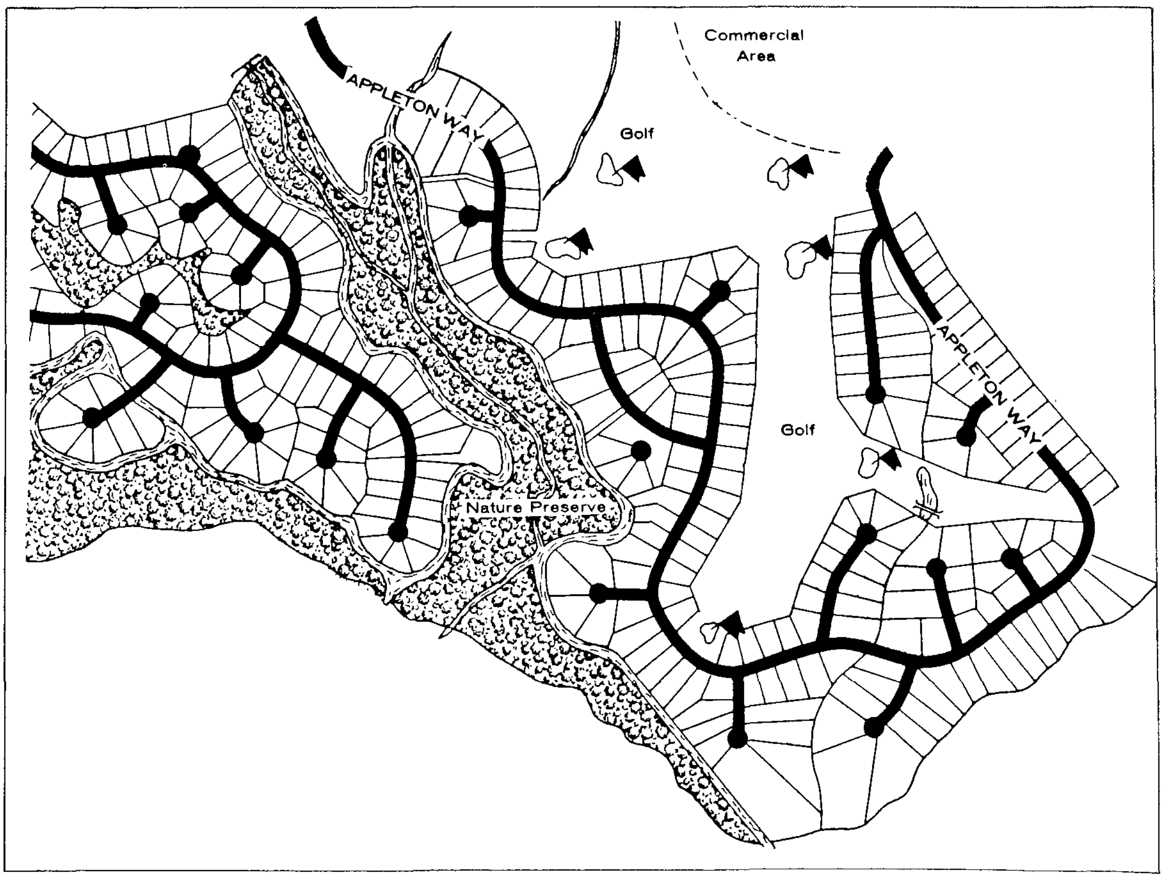
We have been skirting this issue throughout this chapter, but the time has come to consider that one person's meat is another's poison. While you are milling over the relative costs of systems and of financial, environmental, and developmental impacts, you must remember that other members of your community may have very different opinions about what is best for the community. Suppose you are all for replacement of poorly performing systems. Do you think the necessary investment will seem worthwhile to the summer people down the road who have always managed perfectly well with a holding tank?

Let's turn that example around and look at it a different way. Perhaps you are worried that their holding tank is polluting your drinking water. In that case, do you think it's worth it to you to see that the system is managed properly?

What is effective wastewater management worth to you? And how can you be certain that the best interests of all the community's residents are being met?

If your answer to the first question is that properly functioning wastewater systems are worth quite a lot to you and others in your community, then you are ready for the last step of facilities planning, laying out the actual plans for new systems. And in the course of this planning, you can answer the second question by accepting or rejecting alternatives that serve only certain members of the community at the expense of other members.

To find out how facilities planning works, read on.



Chapter 7. Facilities Planning

We have been talking about many of the steps involved in facilities planning in Chapters 3 through 6. Needs documentation, systems selection, management agency development, environmental impact assessment and cost analyses are all part of the facilities planning process. In this chapter, we will put them together in sequence along with other aspects of facilities planning so that you will have an idea how the process works. When your community undertakes the facilities planning process, you will understand what the planners are doing.

Defining The Planning Area

The first step in facilities planning is to consider what areas will be included in the plan. It is often better to work with a larger area than a smaller one, because information on a county, for example, may be more readily available than information on half a township. Also, if facilities must be purchased, it is more economical to buy a large number than a few.

When deciding on planning area boundaries, these factors are also considered:

- local growth and development objectives,
- wastewater treatment needs,
- housing density and known public health problems,
- sensitivity of local water resources to on-site system failure,
- availability of data (both socioeconomic and environmental), and
- cooperation of local municipalities.

For some communities it will already be clear that an improved management program for private systems is needed. The area presently covered by the likely management agency might be an additional criteria for planning area boundaries.

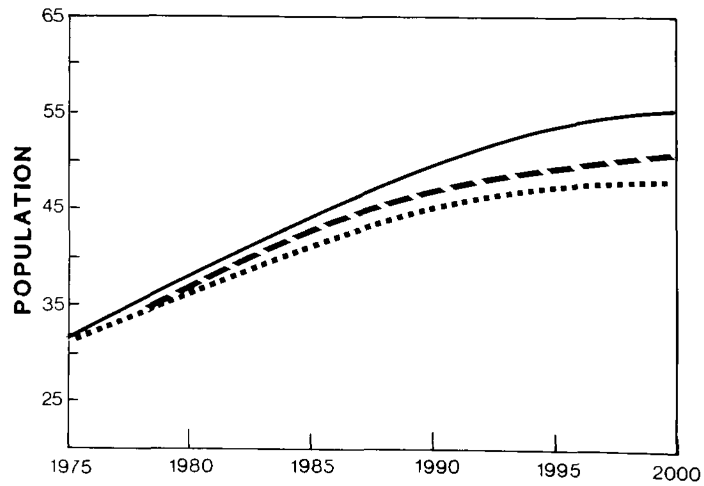
Demography

An important part of facilities planning is considering the *demography* of your community, that is, the characteristics of the people who are going to be served now and in the future. Demographic studies determine these characteristics. Once the planners have a statistical profile of a specific population, they can make assumptions about future growth of that population.

Demographic studies undertaken for facilities planning in rural lake communities will concentrate on gathering information on seasonal versus permanent populations, population projections, and economic characteristics of residents. But it should be noted at the outset that published information may be limited for rural areas, so demographic studies may require surveys and interviews that would not be necessary in urban communities.

Population Projections

Population projections are essential to planning wastewater facilities expected to accommodate possible growth in a community. Where the information base is strong, demographic studies can rely on projection models based on various factors associated with population growth. However, as mentioned earlier, population information in rural areas is not as accurate as in urban areas. Thus, projections of growth for small populations in rural areas are determined as much by educated guesses as by projection models. The community should be concerned about the *reasonableness* of the projection rather than striving for absolute accuracy. A reasonable projection of growth is important because the projection will influence cost-effectiveness comparisons between sewering and nonsewering options. For example, if a reasonable projection estimates that the population of your community will skyrocket over the next few years, sewering will be relatively more cost-effective compared to on-site upgrading than if the population is projected to be stable. But if you build the expensive system and no one shows up to help pay for it, you may be stuck with high costs and agitated neighbors.



Seasonal Versus Permanent Population

Obtaining correct figures for seasonal and permanent population is a recurring problem in rural areas surrounding natural receational resources, such as a lake, mountains, or a river. You can understand that an accurate estimation of population levels within a proposed wastewater management service area is important in choosing the design of the systems and evaluating possible impacts. Most published population information, however, does not include data on seasonal residents.

There is no straightforward or easy method of determining the percentage of the population that is seasonal. House-to-house surveys provide the most reliable figures, but are also expensive and time-consuming. However, if house-to-house surveys are needed for other purposes anyway (such as sanitary surveys), then the additional cost of obtaining population and occupancy information would be negligible.

Local utilities may be willing to indicate which dwelling units are receiving various utility services on a year-round basis. The use of this information eliminates the need for house-to-house surveys except for some possible follow-up or cross-checking surveys.

If there are resorts or tourist facilities in the community, these should be contacted for occupancy rates.

Another useful method is to use property tax rolls, which indicate the home address of the owner of each residence. This then tells you how many homes are occupied by their owners. Dwellings that are not owner occupied may be presumed to be rented to seasonal or permanent residents or occupied seasonally by the owner. In combination with other methods, this can provide a fairly accurate figure on the seasonal and permanent population of a given community.

Economic Characteristics of Residents

Economic information about residents is needed to help facilities planners set expenditure limits for proposed systems. Economic information is available from several sources, including economic censuses, state government agencies, regional planning agencies, and municipal and county planning departments. Other sources of information are property tax rolls, local real estate agents, homeowner associations, chambers of commerce, utilities, and other community groups.

The types of information that will be valuable for facilities planning are per capita income, employment levels, commercial and industrial statistics, and property values.

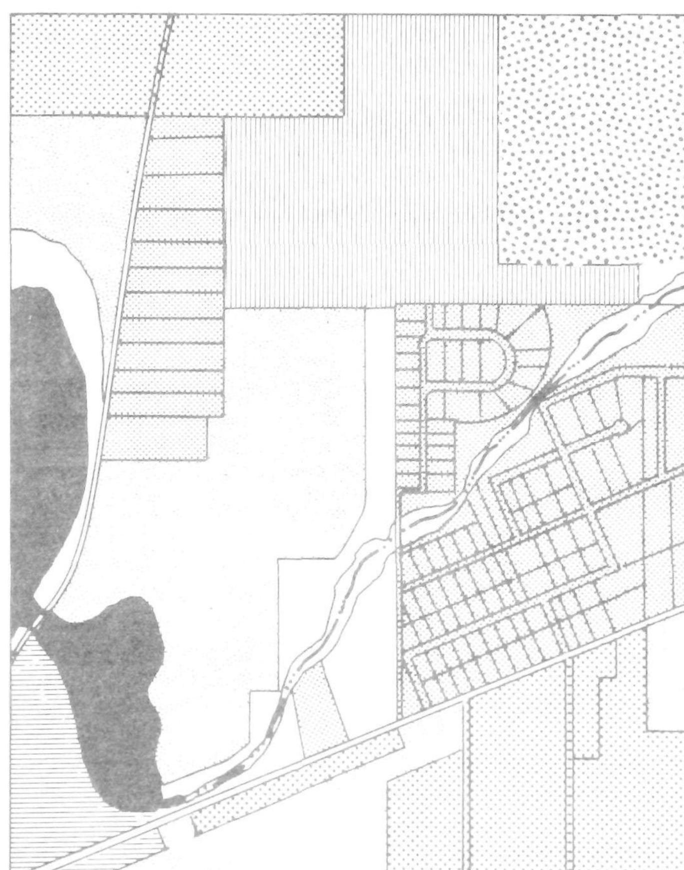
Joint Land Use and Wastewater Planning

You have read about some aspects of land use in previous chapters that discussed development problems. To anticipate and possibly minimize the impacts that might result from development in unsuitable or environmentally sensitive areas, your community should consider *land use planning* before or at the same time as wastewater facilities planning. Land use planning at this stage should consider the suitability of the area for development, define community development goals, and specify standards that wastewater systems must meet to reduce possible impacts of both wastewater facilities construction and associated residential development.

Needs Documentation and Alternatives Development

Chapters 3 and 4 of this handbook have already covered both of these steps in some detail. The key points to review are these:

- Establish, with proof, that your community does indeed have a need for some form of action, whether that means replacement or upgrading of existing on-site systems or construction of new centralized systems. The methodology of documenting need is summarized in Chapter 3.
- Consider the alternatives. Available technologies are summarized in Chapter 4. Alternatives development includes analysis of the cost-effectiveness of each alternative. The several types of costs that are considered in this analysis are discussed in Chapter 6.



Environmental Impact Analysis

Needs documentation studies will reveal valuable information on your local environment and how it responds to the stresses of on-site wastewater disposal. The understanding that comes with those studies will also improve the facilities planner's judgement in developing and comparing small-scale and centralized alternatives.

Before the environmental impact analysis is complete, the planner needs to know what other cultural and environmental resources are present. Often, the citizens in a community will have information on these resources, information that does not appear in the published references the planner uses. Help yourself by pointing out the wildlife areas, historic sites, Indian sites, scenic areas, fishing grounds, farmlands and recreational areas that are important to you. Try to do this before the alternatives are developed and the reports are presented to the public.

Read the assessment of environmental impacts included in the facilities plan. If cultural or environmental features important to you are not considered to your satisfaction, discuss your concern with your local officials in charge of the planning. You may find that there is no threat to the things you hold dear or you may find that there is a threat that was not realized but that there are ways to minimize possible damage. But do not just sit it out expecting someone else to save the things you want saved.

Financial Analysis

The accuracy of cost estimates made during planning is subject to many changing factors such as interest rates, price competition between construction contractors, final design specifications and, if not yet completed, detailed site analysis for on-site upgrading alternatives.

Nevertheless, the ultimate success of any alternative relies on your community's ability to continue paying the necessary costs of making it work as planned. So the financial analyses discussed in Chapter 6, homeowners cost estimates, initial user charge system development, and community fiscal capabilities, should be completed before final decisions are made on which alternative is best.

Public Participation

You may count yourself fortunate, in a way, because you have the opportunity to make your voice heard in the plans for the future of your community. In order to be sure that your concerns, and those of your neighbors, are understood and considered by local officials and decision makers, you and your neighbors might want to form a citizens' advisory committee when your community first begins to deal with its wastewater management problems. Such a committee can represent homeowners' opinions and concerns, providing valuable information and guidance during the preliminary problem-solving stages.

Later in the actual facilities planning process, you will have further opportunities to contribute your ideas. You can participate at the following points in the process:

- During sanitary surveys. Each on-site sanitary inspection includes an interview. At this point you can learn about the project and discuss your concerns about it with knowledgeable project personnel.
- During alternatives selection. Your major opportunity to share your opinions on facilities will likely be at public hearings conducted to review facilities plans. This is the point to ask pertinent questions about costs and impacts, and to reassure yourself that the planners are proposing the least expensive facilities that will provide adequate treatment.
- After the planning is over, if you want to be involved more directly in the design and work of the community management agency, you and your community members could set up a sanitary review board. This board can ensure that the agency's technical and economic decisions meet with the approval of other citizens. The sanitary review board can reflect citizens' interests, even to the point of arbitrating between citizens and the management agency over disputed decisions.
- Finally, if you are very committed to the goal of sensible wastewater management in your community, you may want to become a member of the community management agency.

Alternative Selection

This is what the entire planning process is about, selecting the best overall means of wastewater management. If the planning was thorough and objective, this final step can be conclusive and widely supported by the people it affects.

Chapter 8. Help—Extending Your Resources

As a concerned citizen, you have read through this handbook picking up ideas that, we hope, will help you to realize your personal interests and your community's interests in good wastewater management. If you feel better equipped to get involved, we have done our job.

Additional resources that you can use to achieve good wastewater management are discussed in this last chapter. They include funding from state and federal resources and information from professionals in your state and from the literature.

Federal Funding

The Construction Grants Program
The Construction Grants Program of the U.S. Environmental Protection Agency provides funds to pay a portion of the capital costs of eligible municipal wastewater treatment systems. At present, the Construction Grants Program will provide 75 or 85 percent funding toward construction of wastewater treatment facilities that comply with the Environmental Protection Agency's rules and regulations.

These regulations reflect the concern of many federal and state regulatory people that small communities were being made to pay high costs for systems they did not really need. Thus, the Construction Grants Program stresses cost-effective choices and urges the consideration of alternative systems in the facilities planning process by funding 85 percent of their construction.

The special problems of small communities were considered in the design of the Construction Grants Program, resulting in guidelines intended to respond to their needs. Some of these guidelines are:

- set-aside funds for small communities,
- increased funding for innovative and alternative technologies,
- increased funding for individual systems,
- loans for Step 1 and Step 2,
- state management assistance, and
- public participation.

Because these policies may affect your community's ability to qualify for funds, each is briefly discussed below.

Set-Aside of Funds for Small Communities
Each state is given a specific sum of money for funding the federal share of wastewater facilities. Under the Construction Grants Program, 4 percent of the total funds given to rural states must be set aside to fund alternative technologies. *Alternative technologies* are defined in this case as systems designed to conserve, reclaim or reuse water, recover energy, recycle resources, or reduce costs. On-site systems and small-scale off-site systems are alternative technologies. Since these funds will be given to other states if they are not spent, rural states have an incentive to fund such projects and to encourage planning that could result in such projects.

Funding for Innovative and Alternative Technologies
Innovative technologies are defined the same way as alternative technologies, with the exception that alternative technologies are proven and innovative technologies are not fully proven. The U.S. Congress is interested in promoting use of these systems. To do this, the Construction Grants Program provides up to 85 percent of the capital costs of alternative or innovative systems, rather than the standard 75 percent for conventional sewers and treatment plants.

Funding for Individual Systems
The Program will provide funds for upgrading or replacing privately-owned treatment systems that serve one or more existing households, where new systems will correct existing water pollution or public health problems.

Some strings are attached to these funds: Groundwater monitoring is required; a management agency must ensure that the systems are properly operated and maintained; the system must be cost-effective; and the funds can be used *only* for households or commercial establishments that were in existence on December 31, 1977.

Loans for Step 1 and Step 2
The 1981 Amendments to the Clean Water Act delay Program funding of Step 1 planning and Step 2 design work until the construction grant is made at the beginning of Step 3. An exception is made for small communities that need financial assistance in order to prepare Steps 1 and 2. The states can loan such communities program funds for this purpose.

State Management Assistance
Under the Program, states are allowed to spend 4 percent or $400,000, whichever is greater, of their allotment on state management assistance to help administer the Program. This amount may be increased to account for state management of Construction Grants for small communities.

Public Participation
The Construction Grants Program specifically requires public participation in the planning of wastewater facilities that it funds: A public hearing must be held on all projects before an alternative is selected, and the planning board must provide free access to all important documents associated with the plan. These requirements will ensure that no significant decisions are made without the knowledge of the interested public and that the public will understand official programs and the proposed actions.

Other Sources of Federal Funding
Besides the Construction Grants Program, other sources of federal funding may provide help for your community. You can investigate funding from:

- the Farmer's Home Administration (FmHA) of the Department of Agriculture, and
- the Community Block Grants Program of the Department of Housing and Urban Development.

Some of these funds can be used for the local share of projects eligible for Environmental Protection Agency funding. Others, such as funds from the FmHA Housing Progam, may help make the local costs more affordable for low-income residents in the community.

State Funding

Most states have grant programs for wastewater facilities that supplement federal programs. These programs can be used to fund worthwhile projects that may not for some reason qualify for Construction Grants funds.

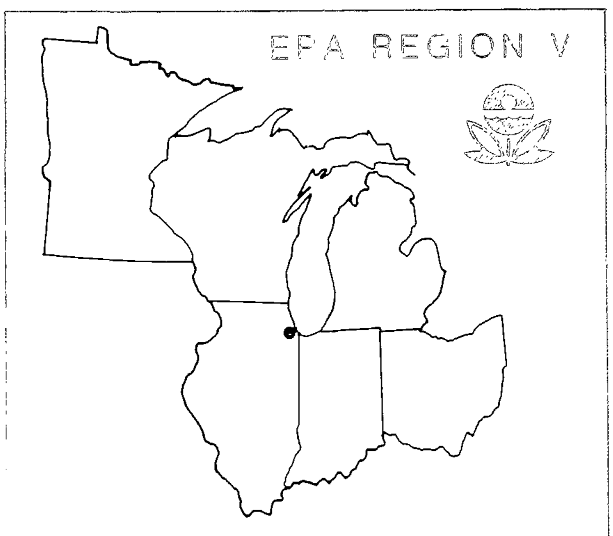
In addition to providing funds, state and regional agencies can provide management assistance to communities that may encounter problems in dealing with the Construction Grants Program. Such management assistance may range from providing technical assistance to assuming full management responsibility for a community's Construction Grant.

State agencies responsible for administering the Construction Grants program should be contacted for information on current funding and management assistance policies.

Assistance—Who to Contact

If you are interested in your own on-site system or one on a property you're thinking of buying, and you want to know more about the soils, the design of the system or past problems, contact the local or district health department. Look in your telephone book under county or state listings. The sanitarian who best knows the area may be able to find old permits or repair records; he'll know about the local soils; and he may even have worked with that system. Calling the local contractors who install on-site systems or who pump septic tanks may also turn up some specific information about the system you're concerned with. Look in your local Yellow Pages under "Septic Tanks."

If you are thinking of buying a lot and building a new house and on-site system, by all means contact the health department and apply for a permit before you buy. If a standard septic tank-soil absorption system won't work, ask whether water conserva-tion or alternative system designs might overcome site limitations and how to get approval for them.



Local officials may be more interested in community management, funds for facilities construction, and their obligation to protect the public health and water quality. In coordination with your health department and public works directors, your state health department and water pollution control agencies should be contacted for information. Do keep in mind that many of the technologies and wastewater management methods summarized in this Handbook are new—your state personnel may not have all the answers for you. But then your community might be just the place where they want to start trying the new solutions.

Whatever your individual or local concerns, you may wish to learn about the research and training programs that are sponsored by organizations such as the U.S. Environmental Protection Agency, the National Sanitation Foundation, the National Environmental Health Association and the American Society of Agricultural Engineers. The Alternative and Innovative Technology coordinators in each U.S. EPA Region can tell you what is going on. In U.S. EPA, Region V, contact:

Mr. Al Krause
U.S. EPA, Region V
230 South Dearborn Street
Chicago, IL 60604
312/353-2126

Glossary

Air-Assisted Toilets—A low-flow, water flushed toilet which discharges to a small chamber. The wastes are then evacuated from the chamber to a house sewer, holding tank or septic tank by a surge of compressed air.

Alternative technologies—Types of wastewater facilities that are fully proven and that reclaim and reuse water, productively recycle waste-water constituents, eliminate the discharge of pollutants, or recover energy.

Annual costs—Continuous or recurring expenses needed to make wastewater facilities work as intended. These are included in economic analyses as annual costs.

Black water—Wastewater from water-flushed toilets.

Cesspools—Leaching pits dug in the soil, usually lined with stone, blocks or wood, into which raw sewage discharges.

Chemical toilets—Toilets which use chemicals to trans-port, store, deodorize or treat human wastes. They are usually provided with a storage tank or chamber which requires periodic emptying.

Clogging mat—The biological growth on and in the soil that limits the flow of water from a soil absorption system.

Cluster systems—Wastewater facilities serving two or more buildings using small-scale collection, treatment and disposal technologies.

Composting toilets—Toilets that do not use water but that rely on aerobic biological activity and the heat from that activity to stabilize and dehydrate human waste and sometimes kitchen refuse. The humus generated in a well-operated composting toilet may be recycled on soil.

Cost-effectiveness—A measure of the economic, environmental, social and institutional costs of an alternative. The alternative is most cost-effective that meets water quality objectives at the lowest present-worth cost without overriding adverse impacts.

Curtain drains—A trench with drain tile at the bottom and partially or wholly filled with gravel, designed to intercept groundwater and to transport it away from some structure or facility such as a soil absorption system.
Demography—The statistical study of human populations.
Detailed site analysis—The sequence of investigations and decisions made to determine the causes of problems with existing on-site systems and to develop information for selecting appropriate repairs, replacements or upgrading.
Economy of scale—The economic phenomena that the unit costs of goods and services often decrease as their production or delivery increase.
Effluent—Wastewater flowing out of a collection, treatment or disposal facility.
Environmentally sensitive areas—Biological, agricultural, geological or cultural resources that are subject to degradation or destruction by man's activities.
Eutrophication—The enrichment of bodies of water by dissolved nutrients, resulting in over-production of plant life, seasonal stress from lowered oxygen concentrations and, ultimately, the filling in of the water body by sediments and organic material.
Future capital—Significant construction expenses expected after the initial year of operation.
General obligation bonds—Municipal bonds backed by the property tax base of a community.
Holding tank—A large concrete, metal, fiberglass or plastic tank used to store wastewater until it can be hauled away.
Impermeable soil—Horizons or layers of soil through which water flows away slowly or not at all.
Incinerating toilets—Toilets that do not use water but that convert human wastes to ash and vapor using heat from a gas flame or high temperature eletric heater.
Innovative technologies—Types of wastewater facilities that have been tested on a small scale but are not fully proven. They offer potential to reclaim and reuse water, productively recycle wastewater constituents, eliminate the discharge of pollutants, or recover energy.
Land use planning—The establishment of goals, policies and procedures for the accommodation of increased urban use of land.
Liability—As used here, the obligation to pay for and implement remedies for the failure of wastewater facilities.
Methemoglobinemia—Nitrate poisoning of infants caused by excessive nitrate concentrations in formula or water.
Needs documentation—The collection and analysis of on-site system performance information in sufficient detail to decide whether sewering is necessary or not.
Non-point sources—Dispersed sources of pollutants that are not controllable by collection and treatment.
Nutrient budget—An accounting of the annual load of nitrogen or phosphorus to a lake as generated by major point and non-point sources.
Nutrient load—The mass of phosphorus or nitrogen discharged from a source or the total mass discharged to a lake or stream within a specified time period, usually a year. Usually expressed as pounds per year (lb/yr) or kilograms per year (kg/yr).
Operation and maintenance—Activities required to make wastewater facilities function as intended.
Plumbing backups—Inadequate drainage of wastewater from a building's plumbing due to clogging within the plumbing, clogging or collapse of house sewer or effluent sewer, or failure of the soil absorption system.
Points of use—In reference to groundwater resources, places where groundwater has existing or potential use as drinking water or where groundwater flowing into a spring stream or lake could affect those resources.
Present capital—Expenses for designing and building wastewater facilities at the beginning of a planning period.
Present worth—An estimate of the funds that could be invested at the beginning of a project to pay all costs, including construction and operation and maintenance, for a specified number of years. Future costs and the salvage value of the facilities at the end of the period are discounted to the present with a specified discount rate.
Private capital costs—Expenses for construction or purchase of wastewater facilities that are paid directly by users and not funded by federal, state or local agencies. Examples are house sewers on private property, plumbing, and water conservation devices.
Public capital costs—Expenses for construction of wastewater facilities that are funded by federal, state or local agencies. Public capital costs funded by local agencies are usually recovered from users through hook-up charges, front-foot charges, increases in property taxes or amortized debt repayment as part of user charges.
Reserve fund—An account established by a wastewater management agency to pay for replacement, repair, expansion or major modifications of wastewater facilities in the future. Contributions to the account usually are collected as part of user charges.
Revenue bond—Municipal bonds backed by the authority of the management agency to collect user charges.
Risk—As used here, the statistical probability that an on-site system or a type of wastewater technology will fail.
Salvage value—The estimated worth of wastewater facilities at the end of a specified planning period. For example, a facility that costs $10,000 to construct and is expected to last 50 years would have a salvage value of $6,000 after 20 years.
Sanitary survey—An inventory of the location, age, condition, design and use of on-site systems in all or parts of a community based on available data and on-site inspections.
Septic leachate detectors—Instruments designed to detect traces of wastewater in lakes and streams.
Septic tank/soil absorption system—This is the most common and generally the least expensive on-site wastewater system in the United States. The septic tank is large enough to hold several days' wastewater flow and is internally baffled to retain sludge and scum. It discharges to a soil absorption system of various designs which distributes the wastewater to the soil beneath the ground surface.
Small Waste Flows Management—Supervision of all phases in the lite cycle of on-site and small-scale wastewater systems. Includes provision of specified services by a management agency, delegation and oversight of services provided by other organizations and by homeowners, and services necessary to maintain the management agency itself.
Surface malfunction—A seep or flow of wastewater to the ground's surface from an on-site system.
User charges—Periodic fees paid by users of a wastewater system to the management agency. Parts of the user charges may pay for debt retirement, payments to a reserve fund, operation and maintenance of facilities, and other services provided by the management agency.
User charge system—A schedule of payment and the means for collecting user charges.

Information— What to Read

In the last decade research, policy development, and public awareness in the field of rural wastewater management have increased significantly. Over a thousand books, research reports, seminar proceedings, and journal articles have been published, reflecting this increase.

Listed below are 17 recent publications that together define the current state of the art in rural wastewater management.

Title, Author and Date	Ordering Information	Comments
Final Generic Environmental Impact Statement for Wastewater Management in Rural Lake Areas. (U.S EPA, Region V and WAPORA, Inc., 1982)	No charge while supply lasts Available from. Mr Jack Kratzmeyer U.S EPA, Region V 230 South Dearborn Street Chicago, IL 60604 312/353-2157	A companion document to this Handbook, the Final EIS is based on case studies of 7 rural lake communities within Region V and on 69 detailed research reports supporting the EIS Topics include documentation of need, on-site and small scale technologies, community management, facilities planning, policy analysis, and environmental impacts 150 pages plus appendixes.
Introduction to Wastewater Management in Unsewered Communities; Small Waste Flows Technologies; Small Waste Flows Management; Needs Documentation in Unsewered Communities, Land Use Planning and Small Waste Flows (filmstrips; Gerald Peters and Melissa Wieland, 1982)	No charge for two-week loan Available from Mr Jack Kratzmeyer U S EPA, Region V 230 South Dearborn Street Chicago, IL 60604 312/353-2157	These 5 slide shows highlight topics in rural wastewater management of possible interest to the lay public A written script for narrating each show is included. One 80-slide tray for each slide show
Management of Small Waste Flows (Small-Scale Waste Management Project, University of Wisconsin-Madison, 1978)	Price. $49 50 Available from National Technical Information Service 5285 Port Royal Road Springfield, VA 22161 Order No EPA-600/2-78-173	This report is a compilation of laboratory and field investigations conducted at the University of Wisconsin between 1971 and 1978 Topics include characteristics of household wastewater, flow reduction and waste segregation treatment processes, on-site systems, soils, community management, and alternative selection Useful to scientists, engineers, and sanitarians. 86-page summary plus 664 pages of references and appendixes
Individual On-Site Wastewater System (8 vols) (Nina I McClelland, ed., 1972-1981)	Price per volume $30 Available from Ann Arbor Science Publishers, Inc The Butterworth Group 10 Tower Office Park Woburn, MA 01801	Proceedings of the annual National Sanitation Foundation conferences. Individual papers cover 9 wide variety of topics
Proceedings, National Symposium on Individual and Small Community Sewage Treatment Vol 1· *Home Sewage Disposal* (1974) Vol 2 *Home Sewage Treatment* (1977) Vol 3 *On-Site Sewage Treatment* (1981)	Prices Vol 1, $15, Vol. 2, $15, Vol 3, $19 50 Available from. American Society of Agricultural Engineers P O Box 410 St Joseph, MI 64502	Proceedings of the 1974, 1977, and 1981 Symposia on Individual and Small Community Sewage Treatment sponsored by the American Society of Agricultural Engineers. Individual papers cover a wide variety of topics.
Planning Wastewater Management Facilities for Small Communities (P L Deese and J F Hudson, 1980)	Price $15 Available from National Technical Information Service 5285 Port Royal Road Springfield, VA 22161 Order No EPA-600/8-80-030	Procedures for planning wastewater facilities for small communities of 1,000 or less Applicable for planning conventional sewer systems as well as small-scale and on-site systems. 147 pages
Management of On-Site and Small Community Wastewater Systems (Roy F. Weston, Inc , 1981)	Price Free Available from. ORD Publications U S EPA/CERL Cincinnati, OH 45268	A guide for developing institutional arrangements for the management of small wastewater systems.

Title, Author, and Date	Ordering Information	Comments
Home Sewage Treatment Workshop Workbook (R. E. Machmeier and M. J. Hansel, 1980)	Price: $15 Available from University of Minnesota Bulletin Room 3 Coffey Hall 1420 Eckles Ave. St. Paul, MN 55108	This workbook can't give you the experience that your sanitarian has. But it will tell you most of what he knows about on-site systems. Even though it is specific to Minnesota, this workbook illustrating and explaining commercially design guidance, and personnel training efforts that states can and do provide for localities. Three ring binder.
Septic Tank Practices (Peter Warshall, 1979)	Price: $3.95 Available from Doubleday & Co. (Anchor Books) Garden City, NY 11530	"A guide to the conservation and re-use of household wastewater." Entertaining and informative with some philosophical musing on human relationships with wastes. For the resident. 117 pages
Residential Waste Conservation (Murray Milne, 1976)	Price: $7.50 Available from: California Water Resources Center University of California Davis, CA 95616	Everything you would want to know about controlling your flow. Especially good for illustrations and explaining commercially available water conservation equipment.
Flow Reduction: Methods, Analyses, Procedures, Examples [FRD-15] (U.S. EPA Office of Water Program Operations, 1981)	Available from: Mrs. Bernita Starks (WH-547) U.S. EPA Office of Water Program Operations 401 M St., SW Washington, DC 20460	While this report is intended for people planning centralized treatment plants, the information on flow reduction techniques, public education, and cost analysis will also be of interest if you are making your on-site systems work better while working less. 92 pages.
Small Wastewater Systems: Alternative Systems for Small Communities and Rural Areas (U.S. EPA Office of Water Program Operations, 1980)	Available from: Mrs. Bernita Starks (WH-547) U.S. EPA Office of Water Program Operations 401 M St., SW Washington, DC 20460	Illustrations and brief descriptions of 21 alternative technologies for the collection, treatment, and disposal of small wastewater flows. One-sheet foldout.
1979 Bibliography of Small Wastewater Flows (EPA Small Wastewater Flows Clearinghouse, 1979)	Price: $7 Available from Bookstore West Virginia University Morgantown, WV 26506	Abstracts on 531 publications concerning on-site and small scale wastewater. Also title, author, state, and subject indexes. Update planned for late 1982
Community-Managed Septic Systems—a Viable Alternative to Sewage Treatment Plants (Comptroller General of the United States, 1978)	Price: Free (1 copy) U.S. General Accounting Office Publications Department Washington DC 20548 Order No.: CED-78-168	The General Accounting Office's stamp of approval on the concept of community management
Innovative and Alternative Technology Assessment Manual (U.S. EPA, Municipal Environmental Research Laboratory, 1980)	Price: $30 Available from: National Technical Information Service 5285 Port Royal Road Springfield, VA 22161 Order No.: EPA-430/9-78-009	Fact sheets on unit processes for collection, treatment, and disposal of wastewater, including some on-site and small-scale processes. Also, criteria for increased Construction Grants funding of innovative and alternative technologies
Design Manual: On-Site Wastewater Treatment and Disposal Systems (U.S. EPA, Office of Water Program Operations and Municipal Environmental Research Laboratory, 1980)	Price: $30 Available from National Technical Information Service 5285 Port Royal Road Springfield, VA 22161 Order No.: EPA-625/1-80-012	Technical information for scientists, engineers, and sanitarians. Also a few pages on management. 391 pages.
1979 State of the Art Manual of On-Site Wastewater Management (National Environmental Health Association, 1979)	Price: $5 Available from: National Environmental Health Association 1200 Lincoln St., Suite 704 Denver, CO 80203	A good overview of technologies and management considerations for community management of on-site systems. 108 pages.

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