Working for Clean Water
An Information Program for Advisory Groups

Municipal Wastewater Processes: Overview

What pollutants need to be removed from sewage?

How are the pollutants removed?

What is important about the stages of pollutant removal?

How may wastewater treatment techniques be improved?

What factors should be considered in selecting treatment processes?

Citizen Handbook

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Municipal Wastewater Processes: Overview

The Problem Doesn't Disappear

Decisions made by society years ago still haunt us today. How do we get rid of unwanted material? Easy. Dump it in water. Yes, dilution in water allows the waste to be quickly and easily transported away. Dilution also makes the waste less offensive. Out of sight (smell) means out of mind!

Or does it?

Currently we have many waste removal systems designed to operate in this way, and have developed a lot of sophisticated technology to go along with it. Miles of pipe lie under our cities to collect wastewater and carry it somewhere "out of sight". Conventional systems are not all that bad. They can be remarkably dependable. Most can produce environmentally acceptable wastewaters. Some operate for decades beyond their intended life spans.

However, because of high costs and other drawbacks localities are turning to various nonconventional methods of wastewater management. Some communities have inadequate sewage collection, treatment, or disposal. These communities have a choice whether to continue with similar adequate facilities, or to try something different.

Sewage: Pollutant or Resource?

Sewage presents both problems and opportunities.

The construction of wastewater treatment facilities historically began out of concern for waterborne diseases. Most organisms in sewage are harmless to humans, but disease-causing bacteria and viruses are present. Industrialization has created other hazards — toxic substances such as pesticides, heavy metals, and even radioactive materials.

Sewage also contains nutrients such as *organic*, carbon-containing substances that result from living things, and inorganic matter such as nitrogen compounds. Inorganic matter does not come from living things, but from minerals. These materials are not problems at low levels, but at high levels they can degrade water quality. These materials serve as nutrients for bacteria and algae, which can deplete and dissolve oxygen in lakes and streams. As bacteria feed on organic matter, oxygen is consumed in direct proportion to the amount of organic matter present. Such organisms cause a *biochemical oxygen demand* (BOD). The measurement of BOD represents the amount of this kind of organic matter present in water. Excessive growth of aquatic plants may also result from nutrients.

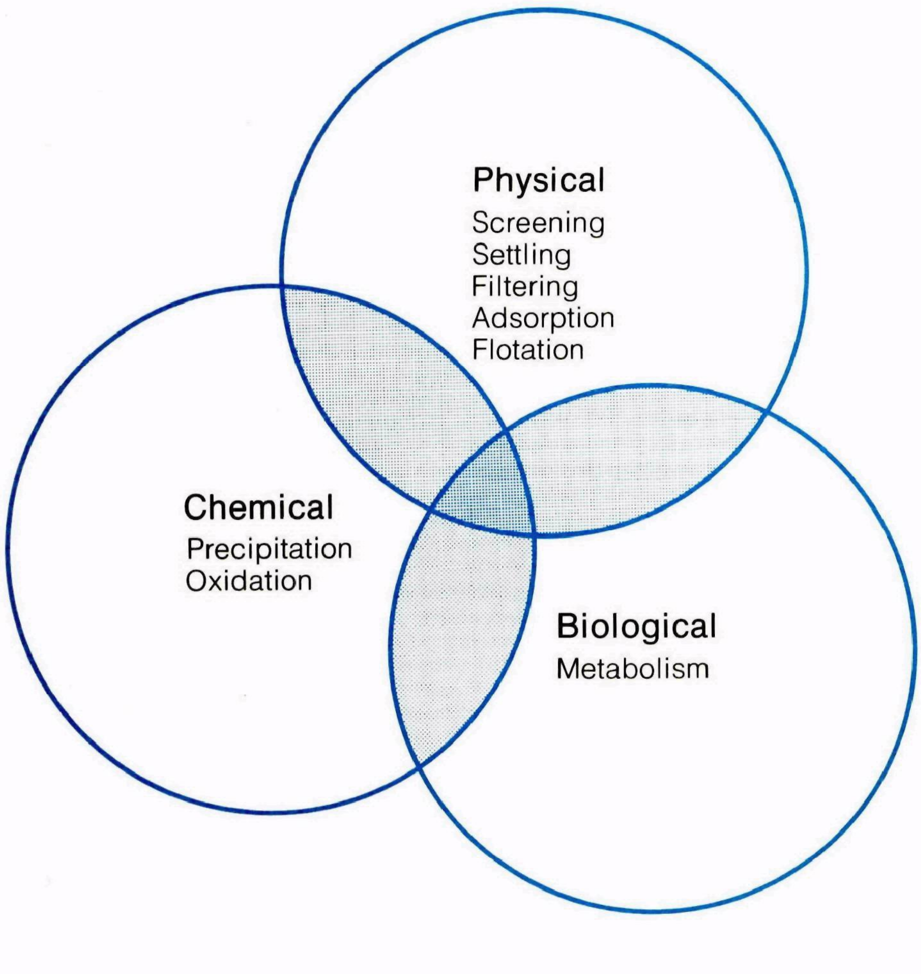
Thus concentration as well as kind determines whether a substance is a pollutant or a resource.

Removal of Pollutants

Sewage is more than 99.9 percent pure water. This amounts to about two drops of waste in a quart of clean water. Because this small amount of pollution can cause a lot of trouble, dirty waters must be cleaned before being discharged into rivers and lakes. This is neither an easy task nor an inexpensive one.

So, what sorts of things are found in this 0.1 percent waste in sewage? How are we going to remove them? The ways of removing pollutants depend upon their biological, chemical, and physical properties.

Wastes in water exist in all three states of matter: gases such as ammonia, liquids such as oils, and solids such as feces or sediment in chunks of various sizes. The physical state of a pollutant has a direct bearing on the selection of wastewater treatment processes.



Methods to remove pollutants combine biological, chemical, and physical approaches.

Large Solids

In wastewater treatment pollutants generally are removed according to size. Large chunks of solids get removed first. Materials such as sticks and rags can be removed by passing the wastewater through a screen. Another approach is to collect the large objects, grind them up, and return them to the wastewater for further processing. A way to deal with floating objects is to skim them off.

Small Solids

Wastewater often contains gravel, grit, and sand in runoff from streets. One removal method is to allow the particles to settle naturally. This can be done by putting the wastewater in a basin where the water current slows slightly, giving the small but heavy solids time to settle with the help of gravity.

Suspended and Dissolved Particles

Other small organic particles are not as heavy as the gravel, grit, and sand. They remain suspended due to the movement of the water. Given more time and less agitation, these particles will settle as well. This process is called *sedimentation* and produces a clearer (clarified) wastewater.

Organic Pollutants

Removal of the smallest organic suspended solids is often done by biological organisms. Three types of treatment alternatives are often used: The trickling filter, activated sludge, and land treatment. In a trickling filter a film of microorganisms grows on stones or a synthetic medium. The wastewater is allowed to trickle through these materials, and the microorganisms metabolize or digest most of the organic pollutants. In an activated sludge system, the organisms are suspended in wastewater with air blown in to provide oxygen and to enhance mixing. The third alternative is called the "living filter," where wastewater is applied to land, and is purified by the natural biological, chemical, and physical processes of the soil.

After biological treatment, some small suspended organic particles still remain. Most can be removed by *filtration* through a fine screen with small openings, or a deep bed of sand.

Dissolved organic matter can be removed both by biological treatment and by *activated carbon adsorption,* a process in which the pollutants adhere to the carbon particles.

Inorganic Pollutants

Inorganic pollutants such as phosphorus are usually dissolved in water. Dissolved material is generally in the form of tiny charged particles called ions. These ions can be removed by various means, including *precipitation.* Precipitation is really just changing the conditions so as to make the material insoluble in water. Once the solubility is altered, the pollutants can be removed by sedimentation or filtration. Precipitation can be carried out by adding certain chemicals to the wastewater.

Another way is *ion exchange.* In this process a more desirable ion is substituted for the undesirable pollutant. Ammonia nitrogen may be removed from wastewater in this fashion.

Two other approaches, *electrodialysis* and *reverse osmosis,* use membranes. In electrodialysis the ionic compounds, usually salts, are forced out of the water by the action of an electric field. In reverse osmosis, clean water is forced through a membrane, leaving the dissolved solids behind.

Dozens of other treatment processes exist. All are based upon three types of mechanisms: Biological, chemical, and physical actions. These removal approaches can be combined in many different ways to clean up particular kinds of wastewater. Most are patterned after natural methods of water purification. It's just that the methods are accelerated in time, and concentrated in space to keep up with our huge volumes of wastewater.

Wastewater Treatment Mechanisms

Type	*Function*	*Example*
Physical	Screen	Bar rack
	Settle	Sedimentation
	Filter	Sand filter
	Adsorption	Carbon column
	Flotation	Sludge thickening
	Selective transport	Electrodialysis
Chemical	Precipitation	Phosphorus removal
	Oxidation	Odor control
		Disinfection
Biological	Metabolism	Trickling filter
		Activated sludge
		Septic tank
		Land treatment

For additional information see the glossary and the program unit entitled, Municipal Wastewater Processes: Details.

Things to Consider

The advisory group can ask questions that, in effect, direct the scope of water quality planning. A few pertinent questions should be asked early in the planning process:

- What assumptions are the planners using from the outset? Are they appropriate?
- What are the reasons for using a particular removal concept — climate, experience of engineering consulting firm, reliability, nature or amount of wastewater?
- Are the basic design principles well-suited to the particular problem at hand?
- What are the existing facilities? Are these a constraining factor in considering methods?

Before and After Treatment

Any considerations of municipal wastewater process should also include a look at what happens *before,* and what happens *after* the removal of pollutants. Where the wastewater comes from, and how it is collected and transported have a direct bearing on the kinds and concentration of pollutants that must be removed from the wastewater. Also, the disposal of products left after treatment should be considered in the selection of treatment processes.

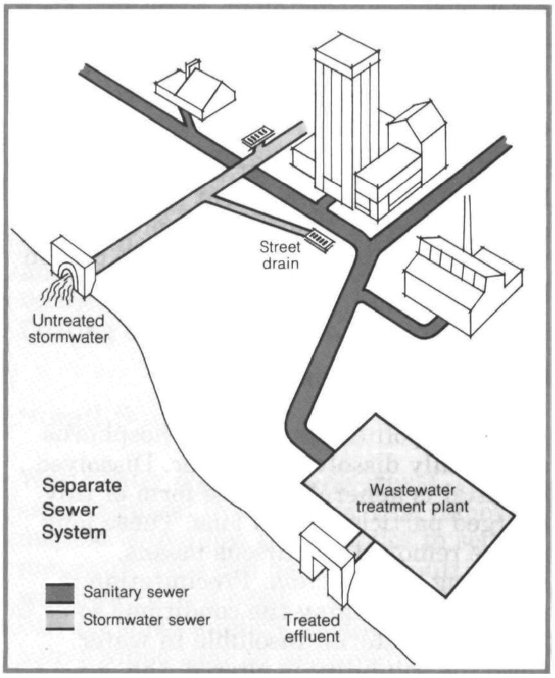
Collection of Wastewater

First of all, how is wastewater collected so that it can be treated? In central treatment systems wastes from homes, businesses, and, sometimes, industry are carried by water through pipes called sewers which lead to the treatment plants. Wastewater is transported by conventional gravity sewers, and other methods such as pressure or vacuum sewers.

Although gravity sewers have a good record for dependability and efficiency, they have drawbacks. In addition to being expensive, they may disrupt the environment. They can require deep excavations that cause extensive dust, erosion, and sedimentation problems. Odors may also be a problem where flat terrain contributes to the slow flow of sewage. Because gravity sewers typically follow natural drainage paths, their construction may disturb nearby watercourses. They also may overflow into adjacent watercourses from time to time.

Other methods of transporting wastes involve the use of small diameter vacuum or pressure sewers. These systems are relatively new and are used only on a small scale. They are likely to have greater operational, maintenance, and energy costs than gravity sewers, but cost much less to install.

Modified onsite disposal systems also may use small diameter sewers. Wastewater from several conventional septic tanks can be transported by sewers to a common disposal area (absorption field).

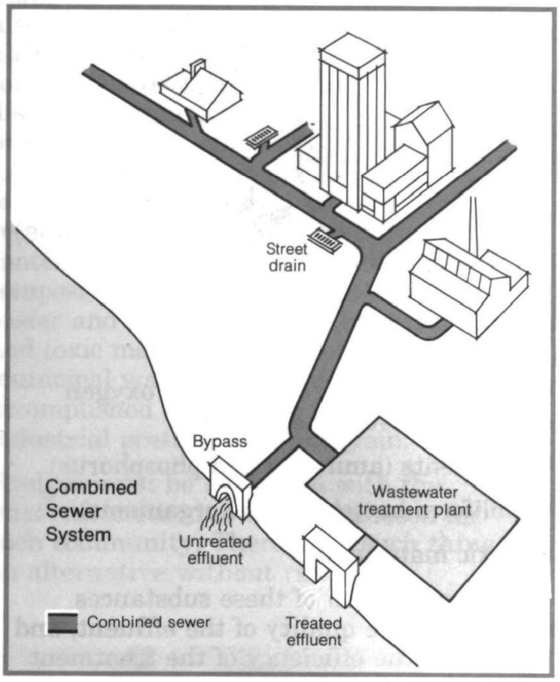


Types of Sewer Systems

There are two basic types of sewer systems — combined and separate. *Combined sewers* carry both water polluted by human use, and water polluted as it runs off rooftops, streets, and land during rainstorms, snow melts, or other forms of precipitation.

Separate sewer systems have two sets of sewer pipes. One system called *sanitary sewers* carries only wastewater from homes, businesses, and industries. A separate system carries rainwater polluted by dirt and other contaminants into pipes that are known as *storm sewers.* These separate storm sewers empty directly into water courses.

Combined sewers are common in the older cities of the eastern United States. About 1,600 communities with a total population of 31 million persons have combined sewers. One problem which plagues these systems is how to accommodate the large quantitites of wastewater during and after rainstorms. When storms occur, the treatment plant often is overloaded. It is then necessary to have some of the wastewater bypass the plant, and flow into the receiving surface waters without treatment. If part of the increased load of water were not diverted, the treatment plant would be hydraulically overloaded, and the purifying processes would not function properly for a long period of time. At times like this some wastewater gets treated and some gets dumped into



waterways as raw sewage. Treatment plants generally are designed to accommodate only dry weather flows, plus a small portion of the stormwater. Special facilities may be constructed to treat excess flows during storms where such flows create pollution problems. Separate holding tanks and equalization basins for storing wastewater are possible remedies. Another approach, but costly, is the separation of sanitary and storm sewers. The cost for this alternative around the country would be millions of dollars. However, this method for stormwater pollution abatement facilities may be eligible for federal funds if they are the most effective means of protecting surface waters.

Sewer Funding

Sewer funding is complex. Eligibility for EPA funds mainly depends upon the type of sewer, installation situation, and state priorities.

Sewer systems are composed of piping, pump stations, manholes, and associated items. The pipes consist of house connections, collectors, interceptors, and force mains. *House connections* carry wastewater from the house into the sewer system. The cost of house connections must be borne completely by the homeowner. The wastewater flows from these pipes into *collector sewers*. New communities, or newly developed areas of existing communities, must bear the entire cost of the collectors. Only communities in existence or wastewater systems two-thirds completed before October 1972 can qualify for collector sewer funding. In many states, however, collector sewers do not receive a sufficiently high priority to receive any funds.

The main conveyance pipe which gathers flows from the collectors and transports the wastewater to the treatment plant is called an *interceptor*. Depending on the terrain, a *force main* may be necessary to carry water, under pressure, from a *pump station* to the treatment plant. Interceptors, force mains, and pump stations are all fundable by the EPA which will pay 75 percent of the cost on all eligible items. However, only 25 percent of state allocations can be spent on pipe-related projects such as interceptors and pump stations.

The community, of course, must pay for all construction costs not covered by federal or state funding. The local users also must pay for operation and management costs from the time the sewers are completed.

In addition to costs, the important considerations in wastewater collection and transport systems include the size of the service area, and service area characteristics such as soils and population projections. This last concern — population — is crucial in determining the sizes of both sewers and treatment facilities. While the sizes must be adequate, they must not exceed reasonable future needs. Otherwise, unwanted costs and undesirable

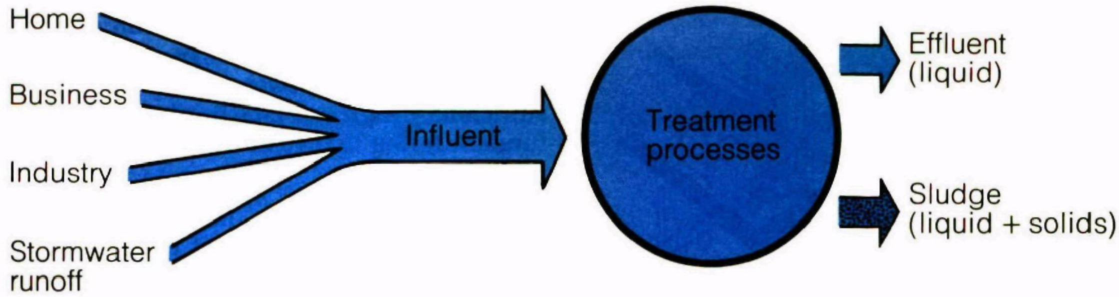
Gravity Sewers

Advantages

- Dependable
- Have low energy and maintenance needs

Disadvantages

- Require deep excavations
- Often built along streams and lakes
- Usually more environmentally disruptive than other sewer alternatives



Disposal of Effluent and Sludge

No matter how good the treatment is, all the pollutants are never taken out of the wastewater. These pollutants leave the treatment facility in two ways. There is the treated liquid called *effluent*. There also is a liquid mixture called *sludge,* which contains solids that have been removed from the wastewater.

Effluent

Before it leaves the treatment plant, the effluent is treated further to kill any disease-causing bacteria. This is usually done by disinfecting the water with chlorine. Then the effluent can be either diluted through discharge into surface waters; applied to land for agricultural production, recreational use, or groundwater recharge; placed in containment ponds to evaporate; or reused as process or cooling water for industry or utilities. The use and the cost of this reclaimed water depend on the degree of waste removal needed, and the availability of alternate water sources.

The quality of the effluent which leaves the plant is of primary importance in the protection of the receiving water. This quality is measured by several factors:

- Organic matter (biochemical oxygen demand and suspended solids)
- Nutrients (ammonia and phosphorus)
- Coliform bacteria (fecal organisms)
- Toxic materials.

The concentration of these substances determines the quality of the effluent, and represents the efficiency of the treatment plants.

Sludge

Sludge is akin to the tail that wags the dog in many municipalities. Proper disposal of sludge is necessary to complete effective waste treatment. It is a mushrooming problem that demands larger portions of wastewater treatment funds every year. Sludge handling may make up half the cost of wastewater treatment.

Sludge is largely water (90-95 percent). The solids are separated by centrifuges, filtration, or drying beds. Final sludge disposal methods include burying, burning, composting, and direct land application. However, these methods are not without their own problems. Incineration can result in air pollution and generates ash that itself must be disposed. Expensive energy supplies also may be consumed in the burning process, although new dewatering methods can minimize this problem. Good engineering design and operation, however, can result in facilities that meet environmental standards.

Composting and direct land application also have mixed benefits. Energy and nutrients may be obtained from sludge, but toxic agents such as heavy metals and disease-causing organisms also may be present. Indeed, since sludge contains *concentrated* pollutants, it must be disposed of with care. Whether or not sludge is a resource or a problem depends upon its contents, processing, and the market for compost. Sludge disposal becomes much easier and less expensive if heavy metals and toxic materials are kept out of municipal wastewater. This can be accomplished through an effective industrial pretreatment program.

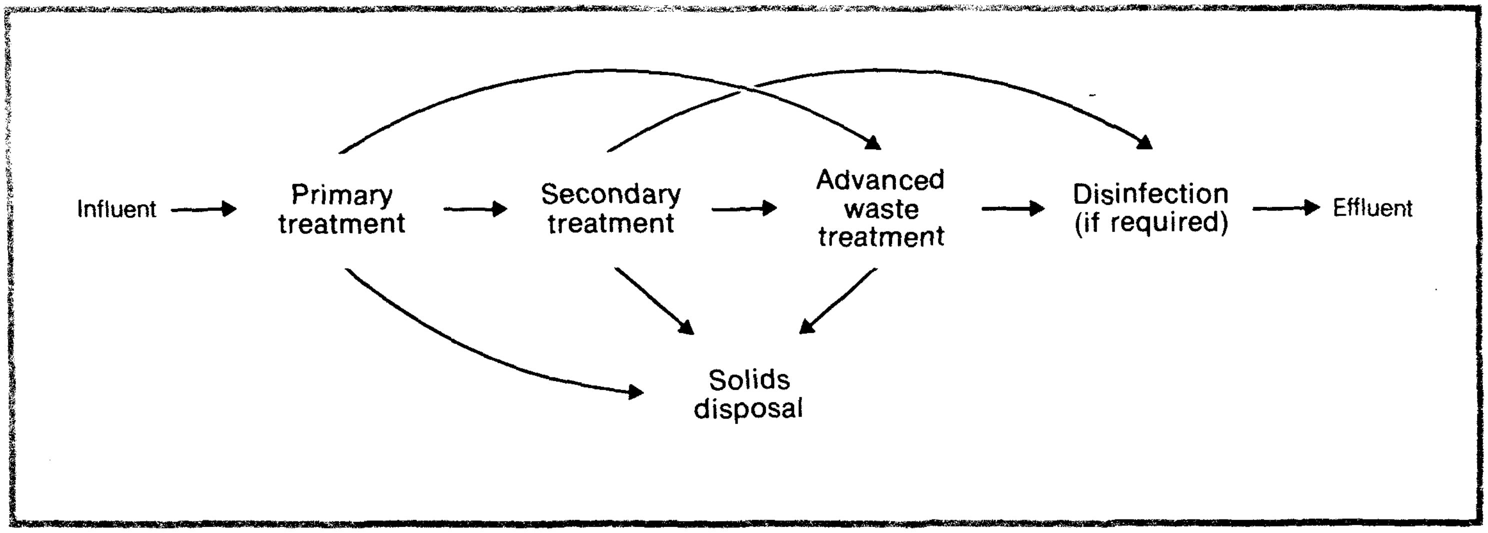
Sludges must be evaluated with the *least-risk* method of disposal chosen for each community. There is no such thing as an alternative without risk.

Construction of a sewer system.

Questions about Sewers and Sludges

Questions to ask about "before and after treatment" include:

- **Where does the wastewater come from, and has thought been given to reducing this quantity of water?**
- **How is the stormwater runoff controlled, collected, and treated?**
- **How is sewage collected and transported?**
- **If new sewers are necessary, where are they to be built?**
- **What are the effluent/sludge disposal options and their related costs?**
- **How will the disposal techniques affect the environment?**
- **Do the choices fit in with the values of the community?**
- **What environmental standards must be met for the effluent and sludge?**



What Happens at the Treatment Plant?

Traditionally, the stages of wastewater treatment were designated as *primary, secondary,* and *tertiary,* but the definition of tertiary was unclear. Therefore, tertiary is now referred to as *advanced waste treatment* since there is a lot of overlap in what certain processes can accomplish.

Primary Stage

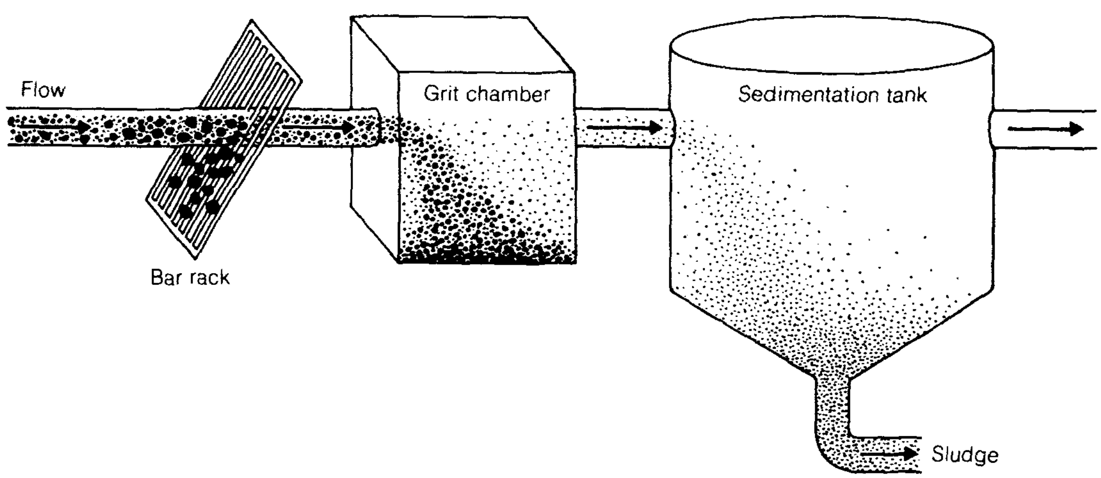
This process, mainly mechanical, removes solids which either settle or float. At best, suspended solids can be reduced by 60 percent and the BOD by 35 percent at the primary stage.

Basically this process involves passing the wastewater through a screen or bar rack to remove large floating solids. Instead of a screen, some treatment plants use a grinder to shred large pieces of solid materials. Next, the wastewater flows into a *grit chamber* where sand, cinders, and small stones settle out. Suspended solids are then removed in a *sedimentation tank,* collecting on the bottom as raw sludge.

Primary treatment is a rather coarse procedure. Only the large chunks of wastes and solids that either float or settle are removed. The process has little effect upon finely suspended and soluble pollutants. They must be removed at other levels of treatment.

Secondary Stage

By adding secondary treatment to the primary processes, more than 85 percent of the BOD and suspended solids are removed. Under controlled conditions, biodegradable organic wastes are converted



into carbon dioxide and water by microorganisms in an accelerated process similar to that which occurs in a natural stream.

Two common types of secondary treatment are the *trickling filter* and the *activated sludge* processes. A trickling filter is a bed of stones or synthetic material through which the wastewater passes after primary treatment. Bacteria and other organisms on the stones consume most of the organic matter in the wastewater as it trickles through the bed. In the activated sludge process, aerated wastewater and microorganisms are held together for several hours in a basin.

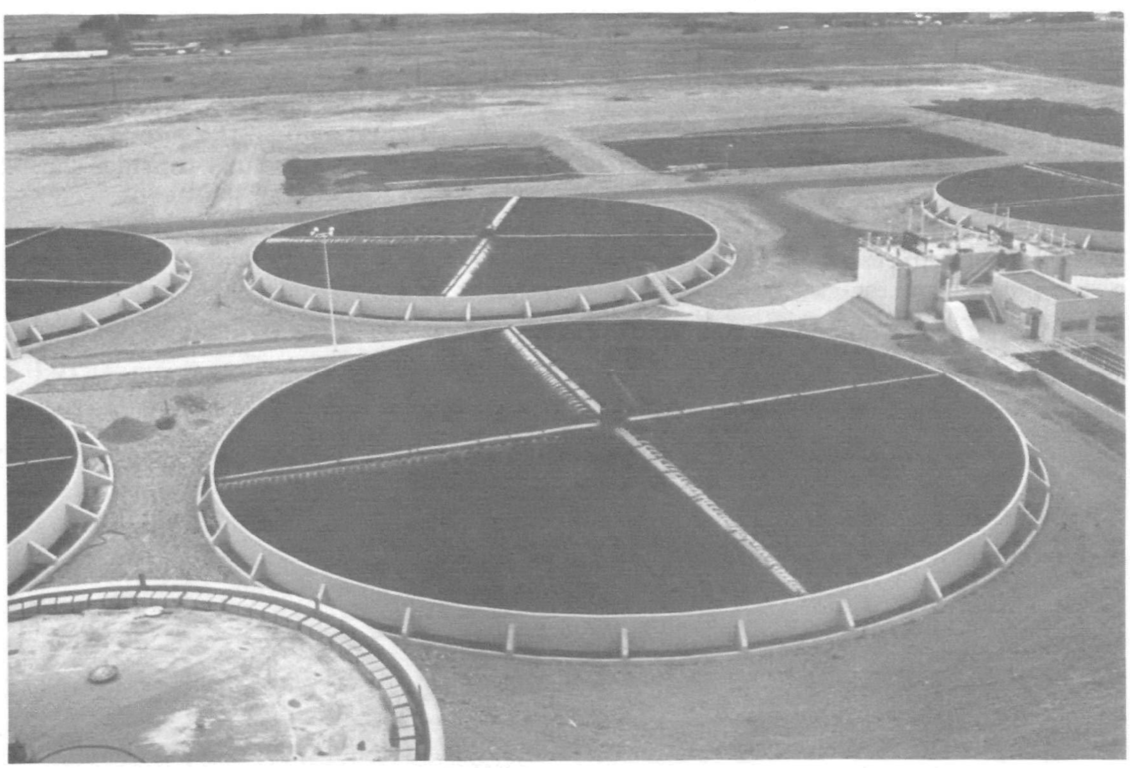
Other approaches to secondary treatment are the *oxidation pond or lagoon, carrousel aeration, rotating biological contactor, activated biofilter,* and *land treatment.* Oxidation ponds or lagoons that are not artificially aerated offer a low energy and operational cost alternative where land space is available. Complexity of operation is low for ponds as it is for land treatment. These approaches are also biological in nature, and provide an adequate environment for the breakdown of soluble organic materials. Many of these processes with unusual names simply provide surface areas onto which the microorganisms attach, or create suitable conditions for growth.

Since secondary treatment is a biological process it is effective mainly for removing biodegradable wastes. Care must be taken not to introduce substances that are toxic or damaging to the microorganisms.

Most regulatory agencies require that the final step in secondary treatment be disinfection to kill any pathogenic bacteria and viruses. Disinfection is usually accomplished by adding chlorine to accomplish the required kill.

Secondary Treatment Processes
(BOD and Suspended Solids Removal)

Trickling Filter
Activated Sludge
Oxidation Ponds or Lagoon
Carrousel Aeration
Rotating Biological Contactor
Activated Biofilter
Land Treatment



Trickling filter for breakdown of organic wastes.

Advanced Waste Treatment

The pressures are mounting on our waste treatment systems. As we become more urbanized, wastes concentrate faster than the local environment can assimilate them. Every year industry creates new products which also become pollutants. Our demands for larger quantities of water further aggravate the problem. Today water must be used over and over in a variety of ways. This increasing need to reuse water calls for better waste treatment. Advanced methods of treating wastes satisfy some of these needs.

When secondary levels of treatment are not adequate to protect the quality of sensitive water bodies, more advanced processes must be used. Treatment beyond the conventional primary and secondary stages can remove most of the pollutants: nitrogen, phosphorus, non-biodegradable organic matter, and heavy metals as well as BOD and suspended solids. However, the costs often are very high.

Combinations of chemical, physical, and a few biological techniques accomplish this additional removal of pollutants. Examples of conventional advanced treatment processes are chemical precipitation to remove phosphorus, chemical reactions to remove nitrogen, coagulation and filtration to extract additional amounts of suspended solids, and activated carbon to adsorb organic compounds that cause unpleasant tastes or odors or are not biodegradable. However, the increasing appearance of hazardous substances such as polychlorinated biphenyls (PCBs) and synthetic chemicals is challenging even these advanced processes. New approaches to wastewater flow reduction and treatment are needed. A relatively old process, land treatment, is becoming more and more viable as an alternative to conventional advanced waste treatment processes.

Advanced Waste Treatment Processes

Phosphorus Removal

Coagulation-sedimentation
Land treatment

Nitrogen Removal

Biological nitrification-denitrification
Ammonia stripping
Ion exchange
Breakpoint chlorination
Land treatment

BOD and Suspended Solids Removal

Coagulation-sedimentation
Filtration
Microscreening
Land treatment

Non-biodegradable Organic Materials Removal

Activated carbon
Land treatment

Advanced techniques are not a cure-all for our wastewater problems. Many require chemicals that are expensive to purchase or create residues that are difficult to dispose. Some approaches are very energy intensive. Many advanced techniques are relatively new, and may not be time-tested. The benefits of advanced waste treatment must be weighed against the costs. Communities must carefully consider the need for advanced waste treatment.

Concerns about Advanced Waste Treatment

Much thought needs to be done before planning advanced wastewater treatment (AWT) systems. The advisory groups can contribute by keeping the following questions at the forefront of the discussion:

- **Have community options such as wastewater flow reduction and changed water uses that will diminish the need for AWT been explored?**
- **Is AWT really needed to meet surface water quality standards?**
- **Has land treatment been considered as an alternative to conventional AWT?**
- **Can the community afford the on-going chemical and energy expense of AWT?**
- **Are there sufficient disposal sites in the area for increased sludge due to AWT?**
- **Will the treatment facilities have competent personnel for dealing with the complex AWT processes?**

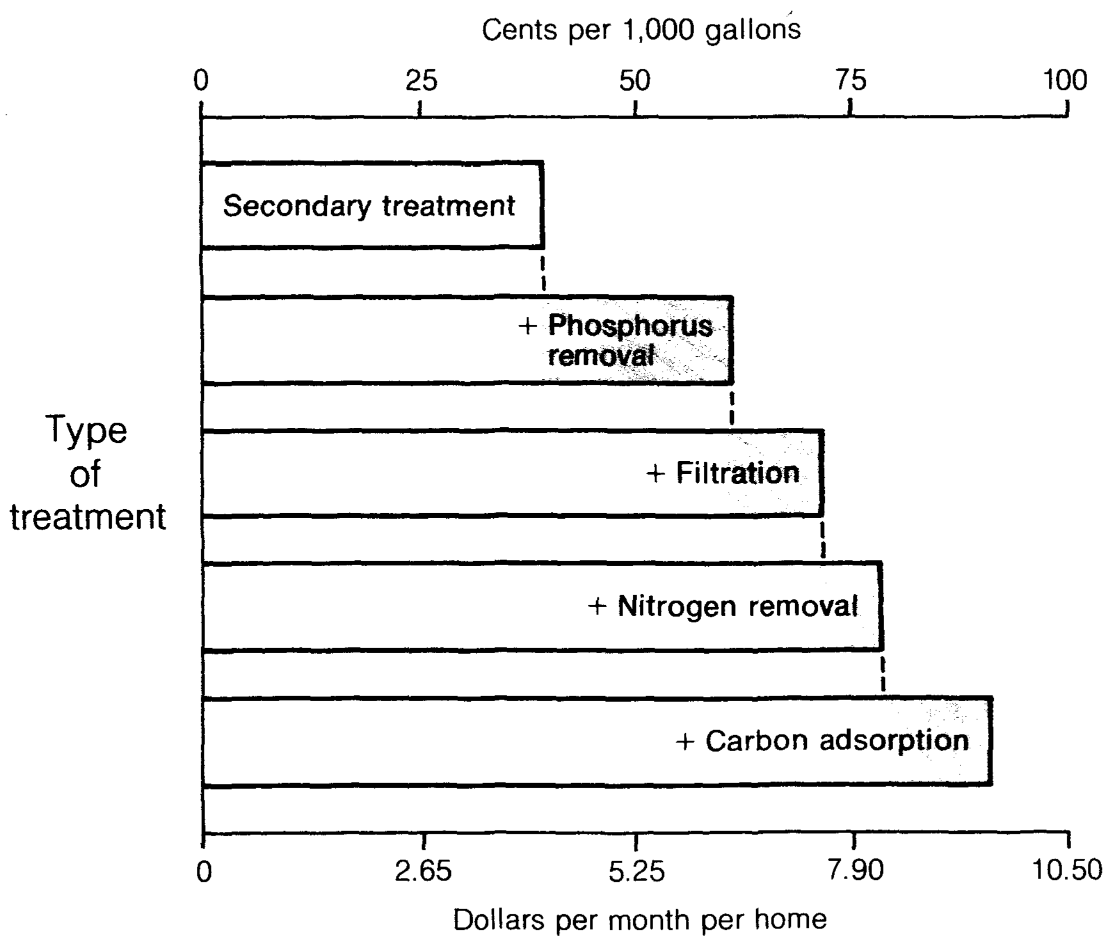
Efficiency of Treatment Processes

(Percent of Pollutant Removed from Domestic Wastewater)

Pollutant	*Primary Treatment*	*Secondary Treatment*	*Advanced Treatment*
BOD	25-30	85-95	90-99
Suspended Solids	60-65	85-95	90-99
Nutrients (Nitrogen, phosphorus)	Minimal	Minimal	90-95

Increased removal efficiencies are achieved at increasing costs. The elimination of the last 15 percent of major pollutants from wastewater is several times more costly than the removal of the initial 85 percent. Indeed, wastewater clean-up does not come cheap.

An advisory group can play a key role in identifying tradeoffs between the degree of pollutant removal and the monetary and environmental costs.

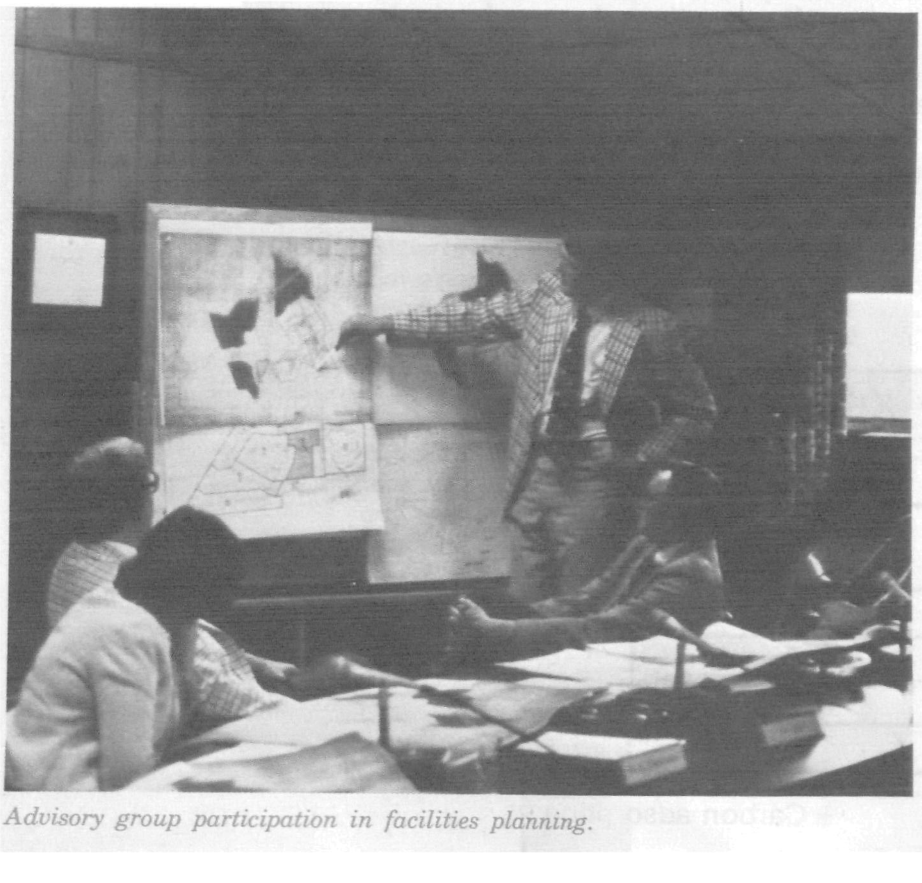


Treatment beyond the secondary level nearly doubled the cost in 1978.

Planning Questions

Additional questions for advisory groups include:

- **Are local environmental values reflected in the final choice?**
- **Are alternative and innovative technologies as well as multiple uses of treatment facilities considered?**
- **Will the level of sophistication of the treatment processes create problems in finding qualified people to operate and maintain the plant?**
- **If the wastewater treatment facility has other uses such as recreation, will funding still be obtainable?**
- **Will the removed pollutants create future environmental problems at another place or time?**
- **Does the plan permit revisions for increased flows, wastewater reclamation, or water reuse in the future?**



Advisory group participation in facilities planning.

Room for Improvement

Alternative or innovative wastewater treatment technologies may possibly be substituted for conventional treatment processes. These may save energy, operating or construction costs, or offer some other advantages. Another cost-saving approach is to improve the efficiency of conventional facilities through design changes or improved operations and management. Such measures may avoid the need for expensive new facilities.

Another approach involves the equalization of sewage flows. The flow of wastewater corresponds to our daily activities. This routine sets a pattern of peaks and valleys of sewage flow and strength. The purpose of flow equalization is to dampen these variations, and to permit the treatment facilities to operate at greater efficiencies, rather than constantly trying to adjust to changing flows. Large basins for collecting and storing wastewater are used to achieve flow equalization.

Treatment facilities may be used effectively for multiple uses such as environmental education. Experience has shown that both the facility operations and educational experiences are improved by this use.

It may be surprising to learn that treatment plants do not always achieve the results they are supposed to. Studies show that these can be deficiencies in design or equipment, but inadequate operations and management (O&M) can also be at fault. The principles of wastewater treatment processes are few and simple, but the technologies that use these principles are complicated. Many processes, especially those of advanced waste treatment, require considerable operator training. Since communities pay the entire cost of O&M, some localities take funding short cuts in maintenance and operator training. Plant operations suffer as a result. Well-trained and paid operators are essential to facility operations and management.

Wastewater treatment facilities are community resources that must be planned in coordination with development of the rest of the community. Plants that become prematurely overloaded are victims of poor planning. Similarly, plants that are too large for a community do not operate efficiently, and the costs of operation fall on the few users.

Selection of Processes

The array of treatment processes is extensive. A major portion of facility planning involves choosing one of them.

Over a hundred different techniques, options, and processes exist for wastewater treatment. In determining the best solution to a wastewater problem, these alternatives should be evaluated carefully in light of specific local conditions. Among the factors that should be considered are:

- Wastewater amount and characteristics (domestic, commercial, industrial uses)
- Effluent requirements
- Environmental effects
- Public acceptance
- Resource consumption
- Sludge handling
- Process complexity, reliability, and flexibility
- Implementation capability
- Monetary costs

The bottom line for most people is how much a system costs. Both nonmonetary and monetary costs are involved. Environmental, social, and indirect effects such as land development are the principal nonmonetary considerations. Monetary costs consist mainly of capital, operations, replacement, and management expenditures. The costs should be presented in a form that has meaning for the taxpayer, such as dollars per household per year. These costs, especially for operations, are increasing rapidly due to escalating energy costs.

Total Energy Consumption In Wastewater Treatment Systems

Treatment Level	*Electricity (Thousand Kwh/yr)*	*Fuel (Million Btu/yr)*
Treatment Higher than Secondary		
BOD, 10-20 mg/L; SS, 5 mg/L; Total Phosphorus, 1 mg/L		
• Independent physical-chemical	1,781	72,747
• Activated sludge plus chemical clarification and filtration	2,301	26,278
Advanced Treatment		
BOD, 1 mg/L; SS, 1 mg/L Total Phosphorus, 0.1 mg/L Total Nitrogen, 3.0 mg/L		
• Land treatment	2,701	0
• Activated sludge plus nitrification, denitrification, chemical clarification, and filtration	3,477	48,430

Total requirements for a 5 million gallon per day plant including indirect requirements for chemicals, 1978.

Main Points

Whether or not a substance is a pollutant or a resource depends upon its nature, concentration, and location.

Basic biological, chemical, and physical mechanisms are involved in removing pollutants from wastewater. Usually the larger floating and suspended particles are removed first. The remaining suspended materials come second. The dissolved substances, where necessary, are extracted last.

Pollutants generally are separated by processes that operate in three stages: primary, secondary, and advanced. The total cumulative removal of pollutants increases through this series of stages. However, costs also increase markedly, especially from the secondary through the advanced waste treatment stage.

Current treatment practices are being improved through approaches such as flow equalization, comprehensive planning, and efficient operations and maintenance.

Considerations other than treatment — the collection of wastewater, and the disposal of wastes, effluent, and sludge — affect the choice of wastewater treatment methods. The disposal of sludge can be especially troublesome.

The selection of treatment processes is based upon many of the same factors that are used elsewhere in facilities planning: wastewater characteristics, effluent requirements, monetary costs, sludge handling, process reliability and flexibility, implementation capability, and public acceptance.

Costs are the main concern for most people in selecting treatment processes.

This handbook provides background information. Another unit entitled, *Municipal Wastewater Processes: Details,* gives specific information on comparing and evaluating various wastewater treatment alternatives.

Wastewater treatment facility under construction.

Need More Information?

Construction Costs for Wastewater Treatment Plants. Publication Number EPA-430/9-77-013. Washington, DC: U.S. Environmental Protection Agency, January 1978. 125 pp.

This document presents information which can be used to determine the alternate municipal wastewater treatment process schemes that will meet specific effluent guidelines. Procedures and information which can be used in determining the cost of each alternative are also given. This publication is available as MCD-37 from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225.

Environmental Pollution Control Alternatives: Municipal Wastewater. Publication Number EPA-625/5-76-012. Washington, DC: U.S. Environmental Protection Agency, May 1976. 79 pp. Order #5012. (Note: An updated edition is in press at the time of this writing.)

This document is an excellent non-technical discussion of available municipal wastewater treatment processes. It describes the processes, gives costs and energy requirements, and discusses their efficiency, advantages, and disadvantages. The discussion in this handbook is based upon this document. It is available from Technology Transfer, U.S. Environmental Protection Agency, Cincinnati, OH 45268.

Innovative and Alternative Technology Assessment Manual. MCD-53. Washington, DC: U.S. Environmental Protection Agency, September 1978. 388 pp.

This document contains fact sheets for 117 different wastewater treatment process variations. Each fact sheet describes the process and its modifications and discusses technology status, applications, limitations, equipment manufacturers (list only), environmental impact, and references. Flow diagrams, capital costs, and operating costs are also given. It is available from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225.

Primer on Wastewater Treatment. MCD-65. Washington, DC: U.S. Environmental Protection Agency, Fall 1980. 26 pp.

This booklet is a vastly reduced version of the above publication. Although it does not give details such as the advantages of specific treatment process, it is valuable as a brief overview of major water quality concerns and treatment options. It is available from General Services Administration, Centralized Mailing List Services, Building 41, Denver Federal Center, Denver, CO 80225.

Activated Sludge — waste solids that have been aerated and subjected to bacterial action; process for removing organic matter in raw sewage during secondary waste treatment.

Adsorption — attraction and accumulation of one substance on the surface of another.

Advanced Waste Treatment — treatment beyond secondary or biological stage; removal of nutrients such as phosphorus and nitrogen and most suspended solids.

Biochemical Oxygen Demand (BOD) — amount of dissolved oxygen required in the biological breakdown of organic matter in water.

Biodegradable — capable of being decomposed through the action of microorganisms.

Coagulant — chemical such as lime or alum which causes a clumping together of particles in wastewater to settle out impurities.

Coliform Bacteria — organisms found in the intestinal tracts of humans and animals, whose presence in water indicates pollution.

Collector — sewer including laterals, submains and mains.

Combined Sewer — system that carries both sewage and stormwater runoff.

Composting — a method of organic breakdown of matter using natural processes.

Cost-Effectiveness Analysis — determination of whether a project or technique is worth funding; both monetary and nonmonetary factors are involved.

Effluent — treated or untreated waste material discharged into the environment.

Electrodialysis — process by which electricity and a membrane separate mineral salts from sewage.

Gravity Sewer — collection system which relies on gravity to transport wastewater from homes to a central treatment or disposal facility.

House Connection — sewer that carries wastewater from the house to a collection system.

Insoluble — material that cannot be dissolved in a liquid.

Interceptor — exceptionally large gravity sewer collecting waste from several communities.

Ion Exchange — exchange of one ion in water for another; specifically, exchanging ammonium nitrogen for sodium or calcium.

Lateral — the small sewer serving individual streets.

Main — the intermediate-sized sewers connecting submains to plants or interceptor.

Metabolism — process by which food is built up into living protoplasm, and protoplasm in broken down into simpler compounds with the exchange of energy.

Nitrification — biological conversion of nitrogenous matter into nitrates.

Oxidation — combining of oxygen with other chemical elements.

Oxidation Pond — holding area where organic wastes are broken down by bacteria in the presence of oxygen.

Pathogenic — disease-causing.

Polychlorinated Biphenyls (PCBs) — a group of toxic, persistent chemicals used in making transformers and capacitors.

Precipitation — process where chemicals combine to produce a compound that can be easily removed from a solution.

Pressure Sewer — collection system in which wastewater is pumped under pressure from homes into a central treatment or disposal facility.

Primary Waste Treatment — first stage of wastewater treatment; removal of floating debris and solids by screening and sedimentation.

Pump Station — facility used to pressurize or raise sewage to a higher elevation.

Secondary Waste Treatment — bacterial treatment of wastewater to consume organic wastes in the presence of oxygen; pollutant removal resulting in effluent of 30 mg/L or less of BOD and SS.

Sedimentation — letting solids settle out of wastewater by gravity during treatment.

Separate Sewer — collection system which uses a sanitary sewer to carry only wastewater, and a storm sewer to carry runoff from rainwater.

Sludge — concentrated solids removed from sewage during wastewater treatment.

Soluble — material that can be dissolved in a liquid to form a homogeneous material.

Submain — sewer connecting laterals to mains.

Suspended Solids (SS) — small particles of solid pollutants in sewage that cause cloudiness and require special treatment to remove.

Vacuum Sewer — collection system in which a central vacuum source maintains a vacuum or small-diameter pressure mains.

Watershed — the land area that drains into a stream or river.

Working for Clean Water is a program designed to help advisory groups improve decision making in water quality planning. It aims at helping people focus on essential issues and questions by providing trained instructors and materials suitable for persons with non-technical backgrounds. These materials include a *citizen handbook* on important principles and considerations about topics in water quality planning, an *audiovisual presentation*, and an *instructor guide* for elaborating points, providing additional information, and engaging in problem-solving exercises.

This program consists of 18 informational units on various aspects of water quality planning:

- Role of Advisory Groups
- Public Participation
- Nonpoint Source Pollution: Agriculture, Forestry, and Mining
- Urban Stormwater Runoff
- Groundwater Contamination
- Facility Planning in the Construction Grants Program
- Municipal Wastewater Processes: Overview
- Municipal Wastewater Processes: Details
- Small Systems
- Innovative and Alternative Technologies
- Industrial Pretreatment
- Land Treatment
- Water Conservation and Reuse
- Multiple Use
- Environmental Assessment
- Cost-Effectiveness Analysis
- Wastewater Facilities Operation and Management
- Financial Management

The units are not designed to make technical experts out of citizens and local officials. Each unit contains essential facts, key questions, advice on how to deal with the issues, and clearly-written technical backgrounds. In short, each unit provides the information that citizen advisors need to better fulfill their role.□

This program is available through public participation coordinators at the regional offices of the United States Environmental Protection Agency.

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This project is dedicated to the memory of Susan A. Cole.