United States
Environmental Protection
Agency

EPA 440/6-90-004
April 1990

Office Of Water
(4602)

Citizen's Guide To Ground-Water Protection

ACKNOWLEDMENTS

This document was prepared under the direction of Marian Mlay, Director of the Office of Ground-Water Protection (OGWP) and written by OGWP Project Manager Jan Gallagher.

Citizen's Guide To Ground-Water Protection

Office of Ground-Water Protection
Office of Water
U.S. Environmental Protection Agency
April 1990

CONTENTS

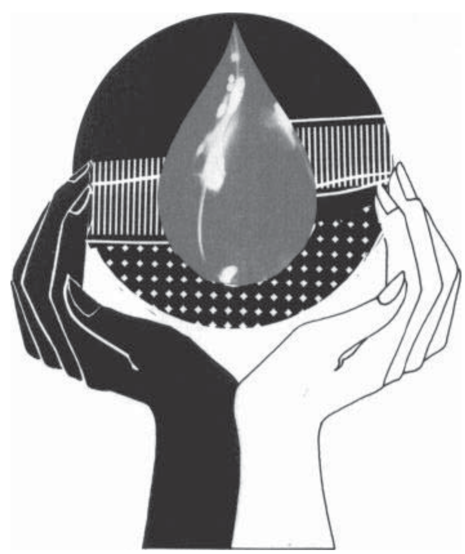
PREFACE

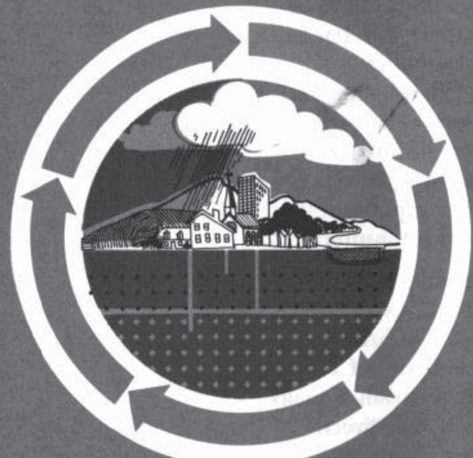
Half of all Americans and more than 95 percent of rural Americans get their household water supplies from underground sources of water, or ground water. Ground water also is used for about half of the nation's agricultural irrigation and nearly one-third of the industrial water needs. This makes ground water a vitally important national resource.

Over the last 10 years, however, public attention has been drawn to incidents of ground-water contamination. This has led to the development of ground-water protection programs at federal, state, and local levels. Because ground-water supplies and conditions vary from one area to another, the responsibility for protecting a community's ground-water supplies rests substantially with the local community.

If your community relies on ground water to supply any portion of its fresh water needs, you, the citizen, will be directly affected by the success or failure of a ground-water protection program. Equally important, you, the citizen, can directly affect the success or failure of your community's ground-water protection efforts.

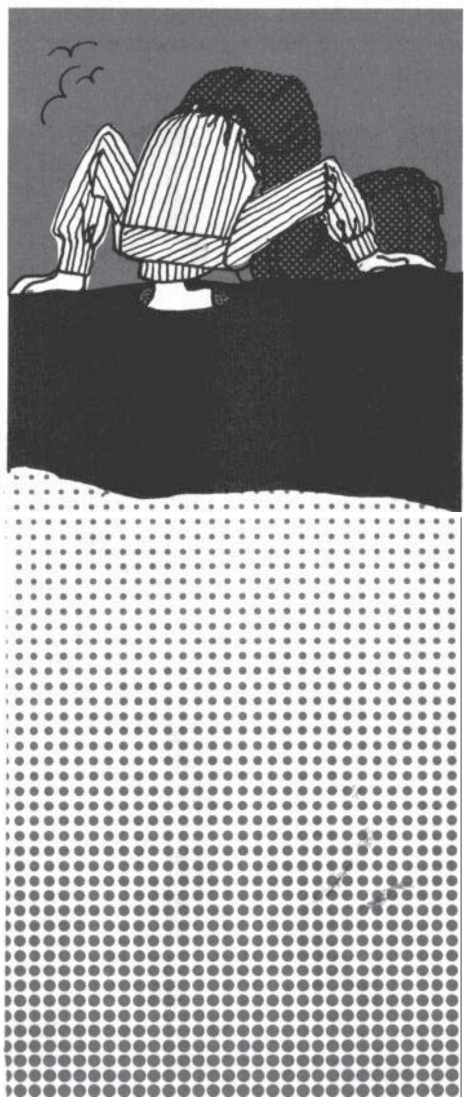
This guide is intended to help you take an active and positive role in protecting your community's ground-water supplies. It will introduce you to the natural cycle that supplies the earth with ground Water, briefly explain how ground water can become contaminated, examine ways to protect our vulnerable ground-water supplies, and, most important of all, describe the roles you and your community can play in protecting valuable ground-water supplies.





CHAPTER I. Introduction

Many people have never heard of ground water. That's not really so surprising since it isn't readily visible-ground water can be considered one of our "hidden" resources.



What Is Ground Water, and Where Does It Come From?

Actually, ground water occurs as part of what can be called the oldest recycling program-the **hydrologic cycle.** The hydrologic cycle involves the continual movement of water between the earth and the atmosphere through evaporation and precipitation. As rain and snow fall to the earth, some of the water runs off the surface into lakes, rivers, streams, and the oceans; some evaporates; and some is absorbed by plant roots. The rest of the water soaks through the ground's surface and moves downward through the **unsaturated zone,** where the open spaces in rocks and soil are filled with a mixture of air and water, until it reaches the **water table.** The water table is the top of the **saturated zone,** or the area in which all interconnected spaces in rocks and soil are filled with water. The water in the saturated zone is called **ground water,** In areas where the water table occurs at the ground's surface, the ground water discharges into marshes, lakes, springs, or streams and evaporates into the atmosphere to form clouds, eventually falling back to earth again as rain or snow-thus beginning the cycle all over again.

Where Is Ground Water Stored?

Ground water is stored under many types of geologic conditions. Areas where ground water exists in sufficient quantities to supply wells or springs are called **aquifers,** a term that literally means "water bearer." Aquifers store water in the spaces between particles of sand, gravel, soil, and rock as well as cracks, pores, and channels in relatively solid rocks. An aquifer's storage capacity is controlled largely by its **porosity,** or the relative amount of open space present to hold water. Its ability to transmit water, or **permeability, is** based in part on the size of these spaces and the extent to which they are connected.

Basically, there are two kinds of aquifers: **confined** and **unconfined.** If the aquifer is sandwiched between layers of relatively impermeable materials (e.g., clay), it is called a confined aquifer Confined aquifers are frequently found at greater depths than unconfined aquifers. In contrast, unconfined aquifers are not sandwiched between these layers of relatively impermeable materials, and their upper boundaries are generally closer to the surface of the land.

Does Ground Water Move?

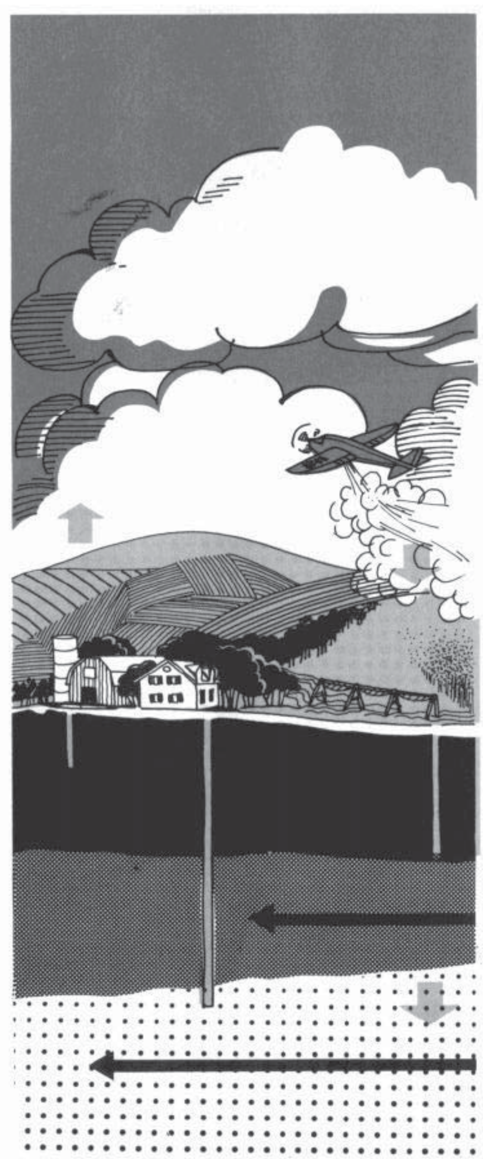
Ground water can move sideways as well as up or down. This movement is in response to gravity, differences in elevation, and differences in pressure. The movement is usually quite slow, frequently as little as a few feet per year although it can move as much as several feet per day in more permeable zones. Ground water can move even more rapidly in karst aquifers, which are areas in water soluble limestone and similar rocks where fractures or cracks have been widened by the action of the ground water to form sinkholes, tunnels, or even caves.

How Is Ground Water Used?

According to the U.S. Geological Survey, ground-water use increased from about 35 billion gallons a day in 1950 to about 87 billion gallons a day in 1980. Approximately one-fourth of all fresh water used in the nation comes from ground water. Whether it arrives via a public water supply system or directly from a private well, ground water ultimately provides approximately 35 percent of the drinking water supply for urban areas and 95 percent of the supply for rural areas, quenching the thirst and meeting other household needs of more than 117 million people in this nation.

Overall, more than one-third of the water used for agricultural purposes is drawn from ground water Arkansas, Nebraska, Colorado, and Kansas use more than 90 percent of their ground-water withdrawals for agricultural activities. In addition, approximately 30 percent of all ground water is used for industrial purposes.

Ground-water use varies among the states, with some states, such as Hawaii, Mississippi, Florida, Idaho, and New Mexico, relying on ground water to supply considerably more than three-fourths of their household water needs and other states, such as Colorado and Rhode Island, supplying less than one-quarter of their water needs with ground water.



CHAPTER II.
Ground-Water Quality

Until the 1970s, ground water was believed to be naturally protected from contamination. The layers of soil and particles of sand, gravel, crushed rocks, and larger rocks were thought to act as filters, trap ping contaminants before they could reach the ground water. Since then, however, every state in the nation has reported cases of contaminated ground water, with some instances receiving widespread publicity. We now know that some contaminants can pass through all of these filtering layers into the saturated zone to contaminate ground water

Between 1971 and 1985, 245 ground-water-related disease outbreaks, with 52,181 associated illnesses, were reported. Most of these diseases were short-term digestive disorders. About 10 percent of all ground-water public water supply systems are in violation of drinking water standards for biological contamination. In addition, approximately 74 pesticides, a number of which are known carcinogens, have been detected in the ground water of 38 states. Although various estimates have been made about the extent of ground-water contamination, these estimates are difficult to verify given the nature of the resource and the difficulty of monitoring its quality.

How Does Ground Water Become Contaminated?

Ground-water contamination can originate on the surface of the ground, in the ground above the water table, or in the ground below the water table. Table 1 shows the types of activities that can cause ground-water contamination at each level. Where a contaminant originates is a factor that can affect its actual impact on ground-water quality For example, if a contaminant is spilled on the surface of the ground or injected into the ground above the water table, it may have to move through numerous layers of soil and other underlying materials before it reaches the ground water

As the contaminant moves through these layers, a number of processes are in operation (e.g., filtration, dilution, oxidation, biological decay) that can lessen the eventual impact of the substance once it finally reaches the ground water. The effectiveness of these processes also is affected by both

GROUND SURFACE	Infiltration of polluted surface water Land disposal of wastes Stockpiles Dumps Sewage sludge disposal	De-icing salt use & storage Animal feedlots Fertilizers & pesticides Accidental spills Airborne source particulates
ABOVE WATER TABLE	Septic tanks, cesspools, & privies Holding ponds & lagoons Sanitary landfills Waste disposal in excavations Underground storage tank leaks	Underground pipeline leaks Artificial recharge Sumps and dry wells Graveyards
BELOW WATER TABLE	Waste disposal in wells Drainage wells and canals Underground storage Mines	Exploratory wells Abandoned wells Water-supply wells Ground-water withdrawal

TABLE 1. Activities That Can Cause Ground-Water Contamination

the distance between the ground water and where the contaminant is introduced and the amount of time it takes the substance to reach the ground water. If the contaminant is introduced directly into the area below the water table, the primary process that can affect the impact of the contaminant is dilution by the surrounding ground water

In comparison with rivers or streams, ground water tends to move very slowly and with very little turbulence. Therefore, once the contaminant reaches the ground water, little dilution or dispersion normally occurs. Instead, the contaminant forms a concentrated plume that can flow along the same path as the ground water. Among the factors that determine the size, form, and rate of movement of the contaminant plume are the amount and type of contaminant and the speed of ground-water movement. Because ground water is hidden from view, contamination can go undetected for years until the supply is tapped for use.

What Kinds of Substances Can Contaminate Ground Water, and Where Do They Come From?

Substances that can contaminate ground water can be divided into two basic categories: substances that occur naturally and substances produced or introduced by man's activities. Substances that occur naturally include minerals such as iron, calcium, and selenium. Substances resulting from man's activities include synthetic organic chemicals and hydrocarbons (e.g., solvents, pesticides, petroleum products); landfill **leachates** (liquids that have dripped through the landfill and carry dissolved substances from the waste materials), containing such substances as heavy metals and organic decomposition products; salt; bacteria; and viruses. A significant number of today's ground-water contamination problems stem from man's activities and can be introduced into ground water from a variety of sources.

Septic Tanks, Cesspools, and Privies

A major cause of ground-water contamination in many areas of the United States is **effluent,** or outflow, from septic tanks, cesspools, and privies. Approximately one-fourth of all homes in the United States rely on septic systems to dispose of their human wastes. If these systems are improperly sited, designed, constructed, or maintained, they can allow contamination of the ground water by bacteria, nitrates, viruses, synthetic detergents, household chemicals, and chlorides. Although each system can make an insignificant contribution to ground water contamination, the sheer number of such systems and their wide spread use in every area that does not have a public sewage treatment system makes them serious contamination sources.

Surface Impoundments

Another potentially significant source of ground-water contamination is the more than 180,000 surface impoundments (e.g., ponds, lagoons) used by municipalities, industries, and businesses to store, treat, and dispose of a variety of liquid wastes and wastewater Although these impoundments are supposed to be sealed with compacted clay soils or plastic liners, leaks can and do develop.

Agricultural Activities

Agricultural activities also can make significant contributions to ground-water contamination with the millions of tons of fertilizers and pesticides spread on the ground and from the storage and disposal of livestock wastes. Homeowners, too, can contribute to this type of ground-water pollution with the chemicals they apply to their lawns, rosebushes, tomato plants, and other garden plants.

Landfills

There are approximately 500 hazardous waste land disposal facilities and more than

16,000 municipal and other landfills nationwide. To protect ground water, these facilities are now required to be constructed with clay or synthetic liners and leachate collection systems. Unfortunately these requirements are comparatively recent, and thousands of landfills were built, operated, and abandoned in the past without such safeguards. A number of these sites have caused serious ground-water contamination problems and are now being cleaned up by their owners, operators, or users; state governments; or the federal government under the Superfund program (see p. 8). In addition, a lack of information about the location of many of these sites makes it difficult, if not impossible, to determine how many others may now be contaminating ground water.

Underground Storage Tanks

Between five and six million underground storage tanks are used to store a variety of materials, including gasoline, fuel oil, and numerous chemicals. The average life span of these tanks is 18 years, and over time, exposure to the elements causes them to corrode. Now, hundreds of thousands of these tanks are estimated to be leaking, and many are contaminating ground water. Replacement costs for these tanks are estimated at $1 per gallon of storage capacity; a cleanup operation can cost considerably more.

Abandoned Wells

Wells can be another source of ground-water contamination. In the years before there were community water supply systerns, most people relied on wells to pro vide their drinking water. In rural areas this can still be the case. If a well is abandoned without being properly sealed, however it can act as a direct channel for contaminants to reach ground water.

Accidents and Illegal Dumping

Accidents also canresult in ground-water contamination. A large volume of toxic materials is transported throughout the country by truck, train, and airplane. Every day, accidental chemical or petroleum product spills occur that, if not handled properly, can result in ground-water contamination. Frequently, the automatic reaction of the first people at the scene of an accident involving a spill will be to flush the area with water to dilute the chemical. This just washes the chemical into the soil around the accident site, allowing it to work its way down to the ground water. In addition, there are numerous instances of ground-water contamination caused by the illegal dumping of hazardous or other potentially harmful wastes.

Highway De-icing

A similar flushing mechanism also applies to the salt that is used to de-ice roads and highways throughout the country every winter More than 11 million tons of salt are applied to roads in the United States annually, As ice and snow melt or rain subsequently falls, the salt is washed into the surrounding soil where it can work its way down to the ground water. Salt also can find its way into ground water from improperly protected storage stockpiles.

What Can Be Done After Contamination Has Occurred?

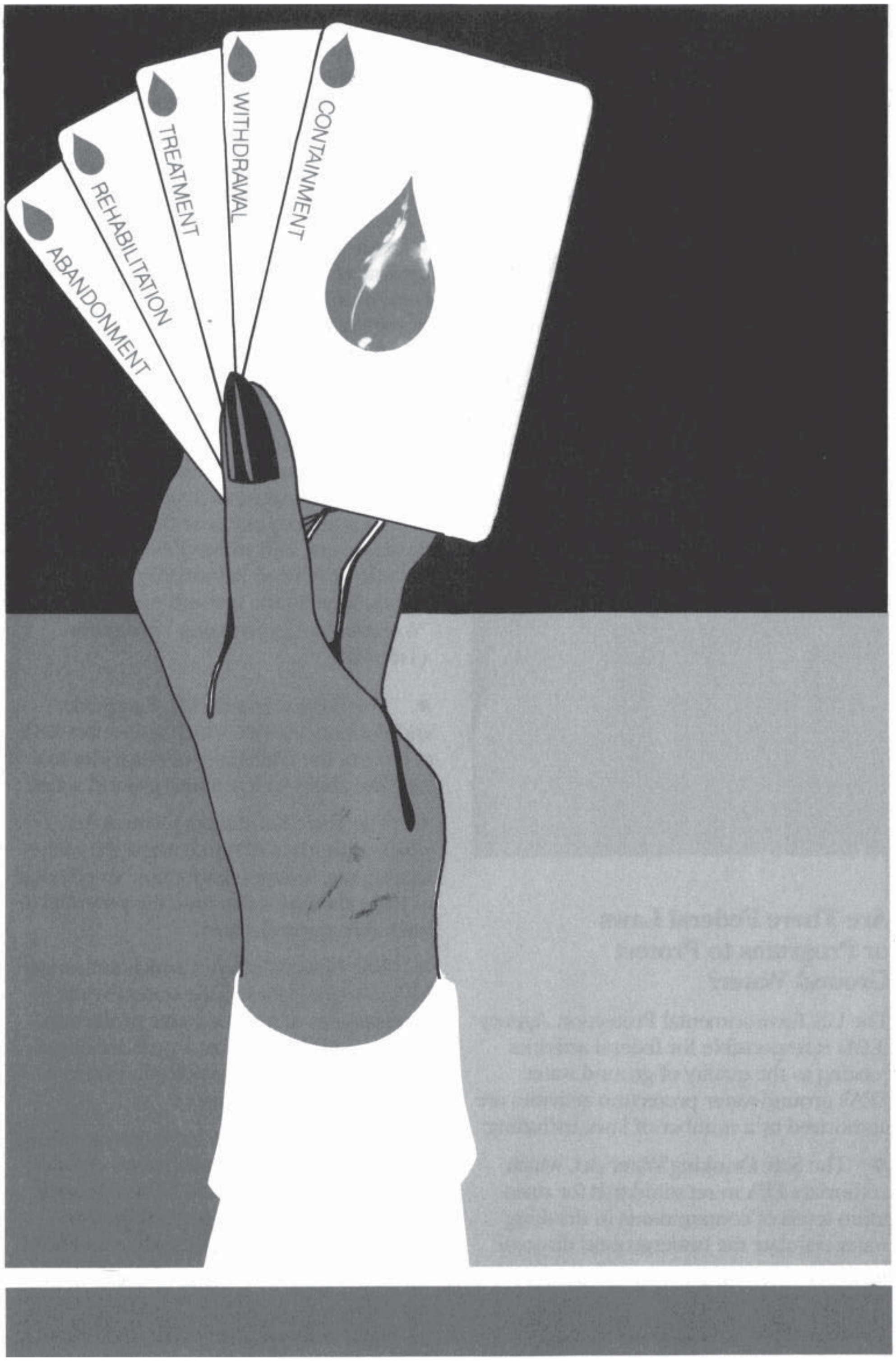
Unlike rivers, lakes, and streams that are readily visible and whose contamination frequently can be seen with the naked eye, ground water itself is hidden from view Its contamination occurs gradually and generally is not detected until the problem has already become extensive. This makes cleaning up contamination a complicated, costly, and sometimes impossible process.

In general, a community whose ground-water supply has been contaminated has five options:

- Contain the contaminants to prevent their migration from their source.
- Withdraw the pollutants from the aquifer.
- Treat the ground water where it is withdrawn or at its point of use.
- Rehabilitate the aquifer by either immobilizing or detoxifying the contaminants while they are still in the aquifer.
- Abandon the use of the aquifer and find alternative sources of water

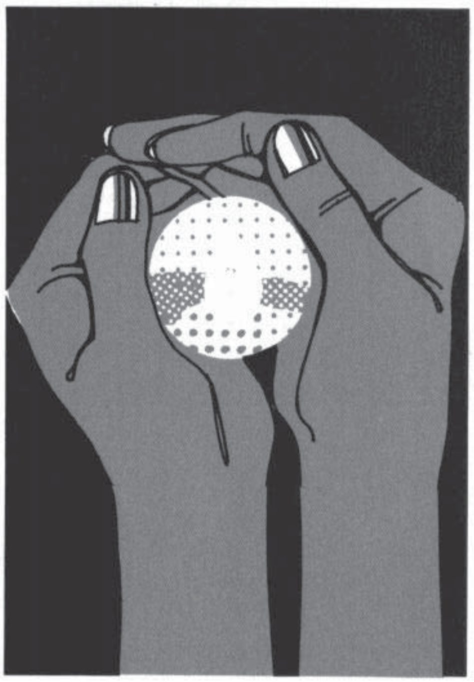
Which option is chosen by the community is determined by a number of factors, including the nature and extensiveness of the contamination, whether specific actions are required by statute, the geologic conditions, and the funds available for the purpose. All of these options are costly. For example, a community in Massachusetts chose a treatment option when the wells supplying its public water system were contaminated by more than 2,000 gallons of gasoline that had leaked into the ground from an underground storage tank less than 600 feet from one of the wells. The town temporarily provided alternative water supplies for its residents and then began a cleanup process that included pumping out and treating the contaminated water and then recharging the aquifer with the treated water. The cleanup effort alone cost more than $3 million.

Because of the high costs and technical difficulties involved in the various containment and treatment methods, many communities will choose to abandon the use of the aquifer when facing contamination of their ground-water supplies. This requires the community to either find other water supplies, drill new wells farther away from the contaminated area of the aquifer, deepen existing wells, or drill new wells in another aquifer if one is located nearby. As Atlantic City, New Jersey, found, these options also can be very costly for a community The wells supplying that city's public water system were contaminated by leachate from a landfill. The city estimated that development of a new wellfield would cost approximately $2 million.


ABANDONMENT
REHABILITATION
TREATMENT
WITHDRAWAL
CONTAINMENT

CHAPTER III.
Government Ground-Water Protection Activities

Given the importance of ground water as a source of drinking water for so many communities and individuals and the cost and difficulty of cleaning it up, common sense tells us that the best way to guarantee continued supplies of clean ground water is to prevent contamination.



Are There Federal Laws or Programs to Protect Ground Water?

The U.S. Environmental Protection Agency (EPA) is responsible for federal activities relating to the quality of ground water. EPA's ground-water protection activities are authorized by a number of laws, including:

- The Safe Drinking Water Act, which authorizes EPA to set standards for maximum levels of contaminants in drinking water, regulate the underground disposal of wastes in deep wells, designate areas that rely on a single aquifer for their water supply, and establish a nationwide program to encourage the states to develop programs to protect public water supply wells (i.e., wellhead protection programs).

- The Resource Conservation and Recovery Act, which regulates the storage, transportation, treatment, and disposal of solid and hazardous wastes to prevent contaminants from leaching into ground water from municipal landfills, underground storage tanks, surface impoundments, and hazardous waste disposal facilities.

- The Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), which authorizes the government to clean up contamination caused by chemical spills or hazardous waste sites that could (or already do) pose threats to the environment, and whose 1986 amendments include provisions authorizing citizens to sue violators of the law and establishing "community right-to-know" programs (Title III).

- The Federal Insecticide, Fungicide, and Rodenticide Act, which authorizes EPA to control the availability of pesticides that have the ability to leach into ground water.

- The Toxic Substances Control Act, which authorizes EPA to control the manufacture, use, storage, distribution, or disposal of toxic chemicals that have the potential to leach into ground water.

- The Clean Water Act, which authorizes EPA to make grants to the states for the development of ground-water protection strategies and authorizes a number of programs to prevent water pollution from a variety of potential sources.

The federal laws tend to focus on controlling potential sources of ground-water contamination on a national basis. Where federal laws have provided for general ground-water protection activities such as wellhead protection programs or development of state ground-water protection strategies, the actual implementation of these pro grams must be by the states in cooperation with local governments.

A major reason for this emphasis on local action is that protection of ground water generally involves making very specific decisions about how land is used. Local governments frequently exercise a variety of land-use controls under state laws.

Do the States Have Laws or Programs to Protect Ground Water?

According to a study conducted for EPA in 1988, most of the states have passed some type of ground-water protection legislation and developed some kind of ground-water policies. State ground-water legislation can be divided into the following subject categories:

- Statewide strategies - Requiring the development of a comprehensive plan to protect the state's ground-water resources from contamination.

- Ground-water classification - Identifying and categorizing ground-water sources by how they are used to determine how much protection is needed to continue that type of use.

- Standard setting - Identifying levels at which an aquifer is considered to be contaminated.

- Land-use management - Developing planning and regulatory mechanisms to control activities on the land that could contaminate an aquifer.

- Ground-water funds - Establishing specific financial accounts for use in the protection of ground-water quality and the provision of compensation for damages to underground drinking water supplies (e.g., reimbursement for ground-water cleanup, provision of alternative drinking water supplies).

- Agricultural chemicals - Regulating the use, sale, labeling, and disposal of pesticides, herbicides, and fertilizers.

- Underground storage tanks - Establishing criteria for the registration, construction, installation, monitoring, repair, closure, and financial responsibility associated with tanks used to store hazardous wastes or materials.

- Water-use management - Including ground-water quality protection in the criteria used to justify more stringent water allocation measures where excessive ground-water withdrawal could cause ground-water contamination.

Appendix 1 presents a matrix showing the types of ground-water protection legislation enacted by the states.

In addition to ground-water protection programs states may have developed under their own laws, one state ground-water protection program is required by federal law. The 1986 amendments to the Safe Drinking Water Act established the **wellhead protection** program and require each state to develop comprehensive programs to protect public water supply wells from contaminants that could be harmful to human health. Wellhead protection is simply protection of all or part of the area surrounding a well from which the well's ground water is drawn. This is called **a wellhead protection area** (WHPA). The size of the WHPA will vary from site to site depending on a number of factors, including the goals of the state's program and the geologic features of the area.

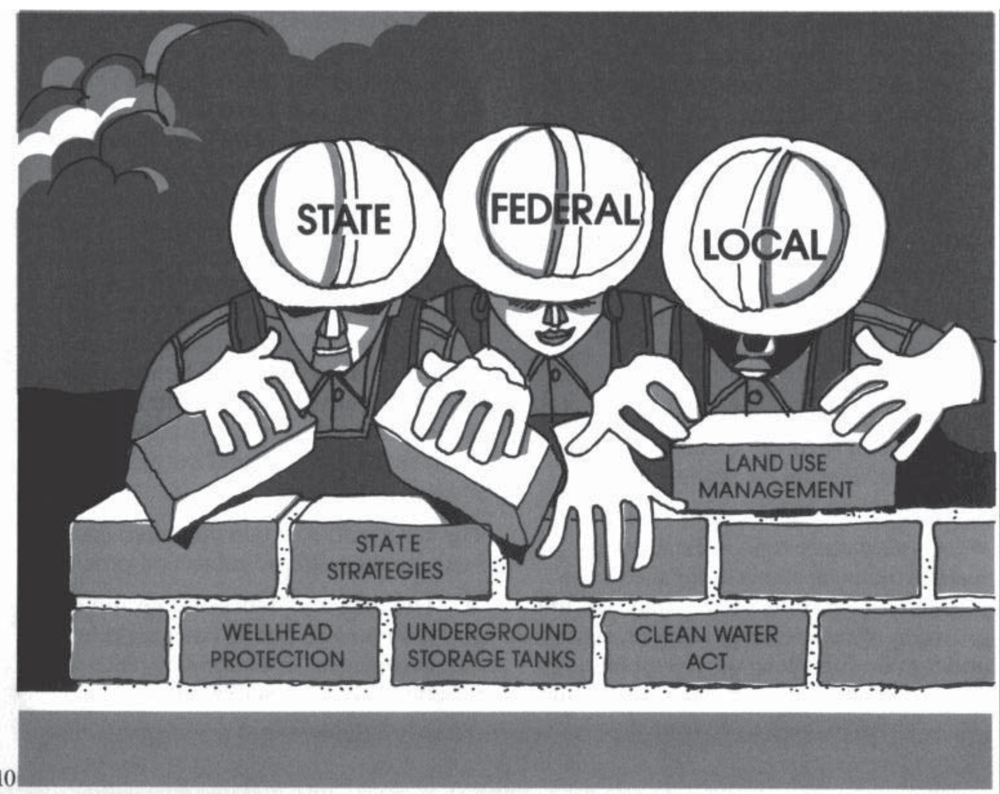
The law specifies certain minimum compo nents for the wellhead protection programs:

- The roles and duties of state and local governments and public water suppliers in the management of wellhead protection programs must be established.

- The WHPA for each wellhead must be delineated (i.e., outlined or defined).
- Contamination sources within each WHPA must be identified.
- Approaches for protecting the water supply within the WHPAs from the contamination sources (e.g., use of source controls, education, training) must be developed.
- Contingency plans must be developed for use if public water supplies become contaminated.
- Provisions must be established for proper siting of new wells to produce maximum water yield and reduce the potential for contamination as much as possible.
- Provisions must be included to ensure public participation in the process.

For a program to be successful, all levels of government must participate in the wellhead protection program. The federal government is responsible for approving state wellhead protection programs and for providing technical support to state and local governments. State governments must develop and implement wellhead protection programs that meet the requirements of the Safe Drinking Water Act. Although the responsibilities of local governments depend on the specific requirements of their state's program, these governments often are in the best position (and have the greatest incentive) to ensure proper protection of wellhead areas. They have the most to lose if their ground water becomes contaminated.

Although the Clean Water Act does not require states to develop ground-water protection strategies, the legislation does authorize states to take this action. As of 1989, all 50 states have at least begun to develop ground-water protection strategies, and some of these are in advanced stages. Proceeding at varying paces, the states are tailoring their efforts to fit their own perceived needs and budgets.



CHAPTER IV.
Citizen and Community Roles

In the first three chapters of this guide, you learned how dependent our nation is on ground water to provide water for drinking and other household uses, agriculture, and industry You also learned a little about the many substances that can contaminate our ground-water supplies, where they can come from, and how difficult and costly it is to try to clean up ground water once it has been contaminated. Finally, you were given some information about current national and state programs to protect ground water. This chapter will focus on what actions you and your community can take to protect your ground-water supplies.

What Information Do You and Your Community Need?

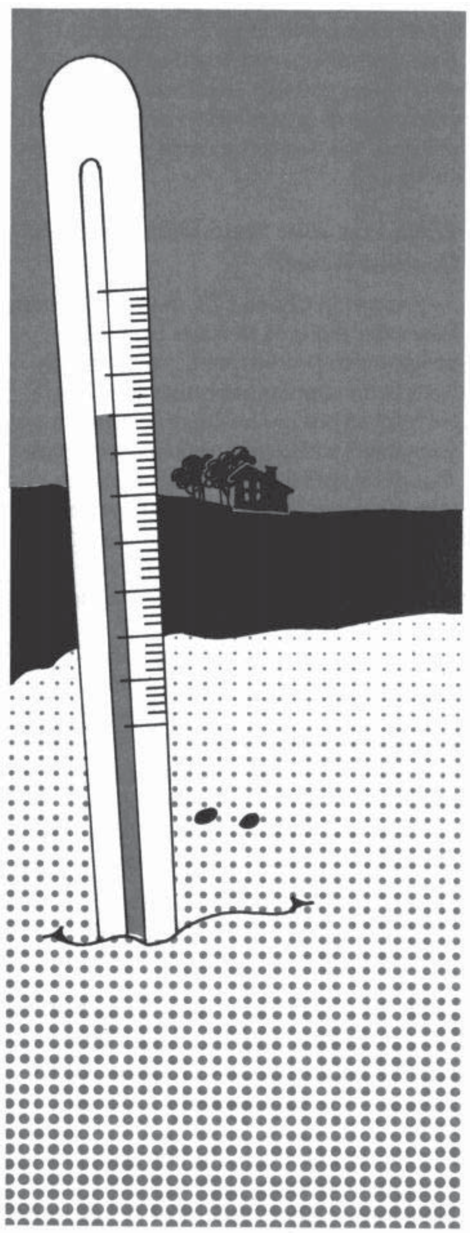
Because no two communities are exactly alike in terms of hydrogeologic conditions, resources, or problems, ground-water protection efforts should be tailored specifically to meet the needs of each community. Thus, before you can begin to help your community develop an effective program to manage its ground-water resources, you will need the answers to some very specific questions.

What Has Your State Done to Protect Ground Water?

As you saw in Chapter III, the Safe Drinking Water Act requires all states to develop programs to protect public water supply wells from contaminants that could be harmful to human health. Information on your state's wellhead protection program should be available from the agency in your state that is managing this program. **(Appendix 2** contains a list of the state agencies managing wellhead protection programs.) Chapter III also mentioned that all 50 states are in the process of developing comprehensive ground-water protection strategies. Such a strategy can provide you with information on who has what ground-water responsibility in the state and on how any existing state programs fit together A copy of your state's ground-water protection strategy should be available from the agency in your state that is managing this effort **(Appendix 2** also contains a list of these state agencies.)

Does Your Community's Drinking Water Come from Ground Water, and What Information Is Available About Your Community's Wells?

If your community's drinking water comes from ground water, you will need some basic information about your community's hydrogeologic setting, including the types of soil conditions and geologic formations and the type, location, and depth of the aquifer that stores the ground water In addition, information on the community's wells will be needed, including whether they are public or private, shallow or deep; their locations; and how they are constructed. It also could be important to know if sites have been identified for future wells. Potential sources for this information include your local library your local water supply agency, your state geological survey, a local office of the U.S. Geological Survey (USGS), a county agricultural extension agent, or even the geology or engineering department of a local university or college.

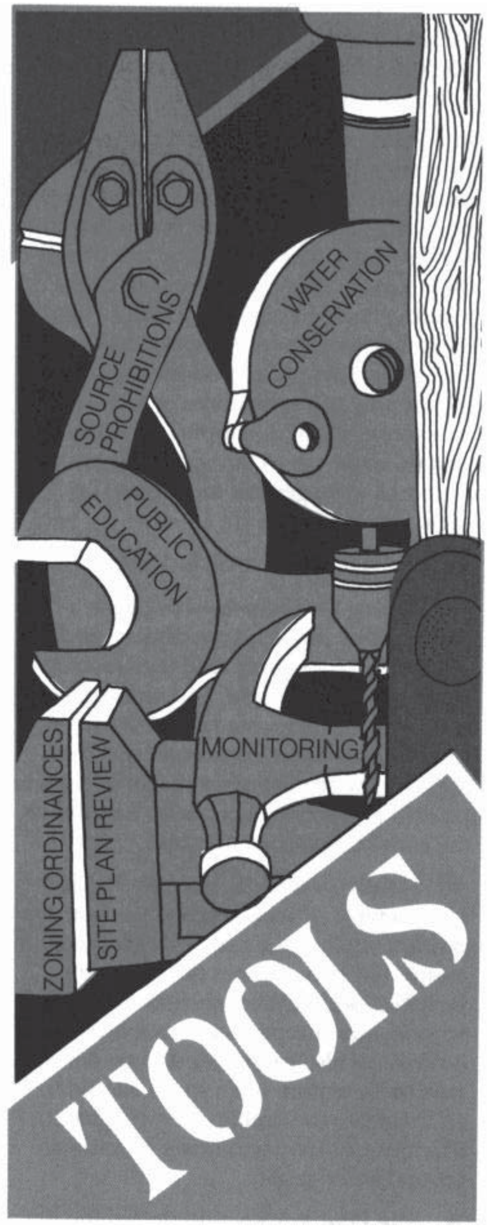


What Is the Current Quality of Your Ground-Water Supply, and What Actual or Potential Sources of Contamination Are Present in Your Community?

You will need to know if your water is currently free from bacterial and chemical pollution and what kinds of procedures are in place to test or monitor ground-water quality. Initial information on the quality of your community's ground water should be available from your local water supply agency or your local health department.

closely related to the issue of ground-water quality is determining whether there are activities in the community that produce or use toxic or hazardous substances and where underground storage tanks are located. Information on activities using or producing toxic or hazardous materials may be more difficult to obtain, but the community right-to-know provisions in the 1986 Superfund amendments may give you a starting point These provisions require the establishment of state planning commissions, emergency planning districts, and local emergency planning committees. They also require companies that use certain toxic or hazardous substances to report to these committees. Companies also are required to report serious environ mental releases immediately All of this information is required to be available to the public.

Another source of information on environmental releases is available in a data base developed by EPA called the Toxic Chemical Release Inventory that is publicly accessible through the National Library of Medicine. The data include the names, addresses, and public contacts of plants manufacturing, processing, or using the reported chemicals; the maximum amount stored onsite; the estimated quantity emitted into the air, discharged into bodies of water, injected underground, or released to land, methods used in waste treatment and their efficiency, and information on the transfer of chemicals offsite for treatment and disposal. (To obtain additional information on this data base, see Appendix 2.) On a local level, your community's fire department also may be helpful in providing information on both companies using toxic or hazardous materials and the location of underground storage tanks.



What Can Your Community Do to Protect Its Ground Water?

If your community relies on ground water for its water supplies, it has a strong incenive to protect that ground water Before a plan or program can be developed to protect ground water, it is important to identify existing or potential threats to the ground water. This will generally mean conducting an inventory to learn the location of facilities using, manufacturing, or storing materials that have the potential to pollute ground water.

How your community conducts this inventory will depend largely on the resources available, particularly the number of people available to do the work and funds. A number of communities, however, have had great success in using groups of volunteers to conduct their inventories. For example, the city of El Paso, Texas, has mobilized its senior citizens with the help of the federally funded Retired Senior Volunteer Program (RSVP) and the Texas Water Commission.

The inventory of existing or potential threats to the community's ground water may be quite long, and it is unlikely that your community will have the resources to address all of these threats. How do community officials decide which threats are the most serious or set priorities? One way is to assess these threats on the basis of their relative risks to the community's ground water This requires determining which of the specific pollutants are most likely to be released and reach the ground water in concentrations high enough to pose health risks.

In addition to having an incentive to protect its ground water, your community has a number of powers that can be used for that purpose. These include implementing zoning decisions; developing land-use plans; overseeing building and fire codes; implementing health requirements; supplying water, sewer, and waste disposal services; and using their police powers to enforce regulations and ordinances. A few communities have begun developing their own ground-water protection programs using a variety of management tools based on these powers.

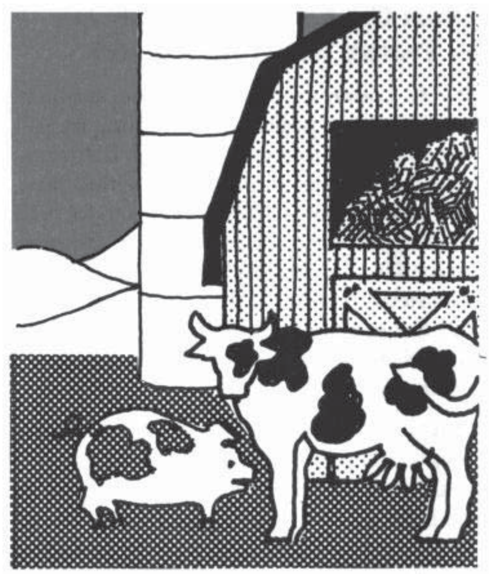
These management tools include:

- **Zoning Ordinances** - To divide a municipality into land-use districts and separate incompatible land uses such as residential, commercial, and industrial; zoning also defines the type of activity that can occur within a district and specifies appropriate regulations that can be used to prevent activities that could be harmful to the community's ground water.

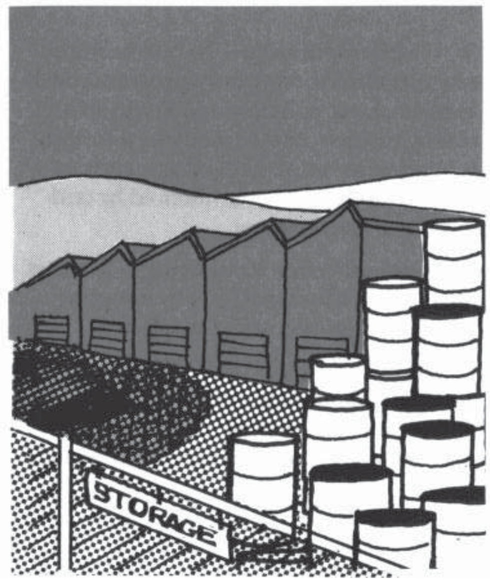
- **Subdivision Ordinances** - Applied when a piece of land is actually being divided into lots for sale or development to ensure that growth does not outpace available local facilities such as roads, schools, and fire protection; subdivision ordinances also can be used to set density standards, require open space set asides, and regulate the timing of development, all of which can have significant impacts on ground-water quality.

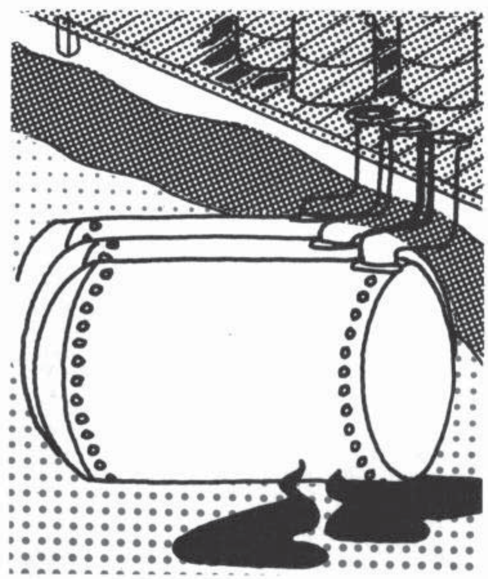
- **Site Plan Review** - To determine if a proposed development project is compatible with existing land uses in the surrounding area and if existing community facilities will be able to support the planned development; this review also can be used to determine compatibility of the proposed project with any ground-water protection goals.

- **Design Standards** - To regulate the design, construction, and ongoing operation of various land-use activities by imposing specific physical requirements, such as the use of double-walled tanks to store chemicals underground.



- **Operating Standards** - To ensure the safety of workers, other parties, and the environment by specifying how an activity is to be conducted, these can take the form





of best management practices (BMPs) that define a set of standard operating procedures for use in a particular activity to limit the threat to the environment (e.g., limits on pesticide applications or animal feedlot operations).

- **Source Prohibitions -** To prohibit the storage or use of dangerous materials in a defined area; these can take the form of prohibitions of certain activities or of restrictions on the use of certain materials.

- **Purchase of Property or Development Rights -** To guarantee community control over the activities on lands that feed water into an aquifer, this may involve outright purchase of the land or of a more limited interest, such as surface-use rights.

- **Public Education -** To build community support for regulatory programs, such as controls on pollution sources in special zoning districts, and to motivate voluntary ground-water protection efforts, such as water conservation or household hazardous waste management.

- **Ground-Water Monitoring -** To assess the quality of local aquifers by sampling public and private wells for selected contaminants.

- **Household Hazardous Waste Collection -** To alleviate the threat to ground water from the disposal in regular trash pick ups, sewers, or septic systems of household products that contain hazardous substances or other materials that can be harmful to ground water, such as paints, solvents, or pesticides.

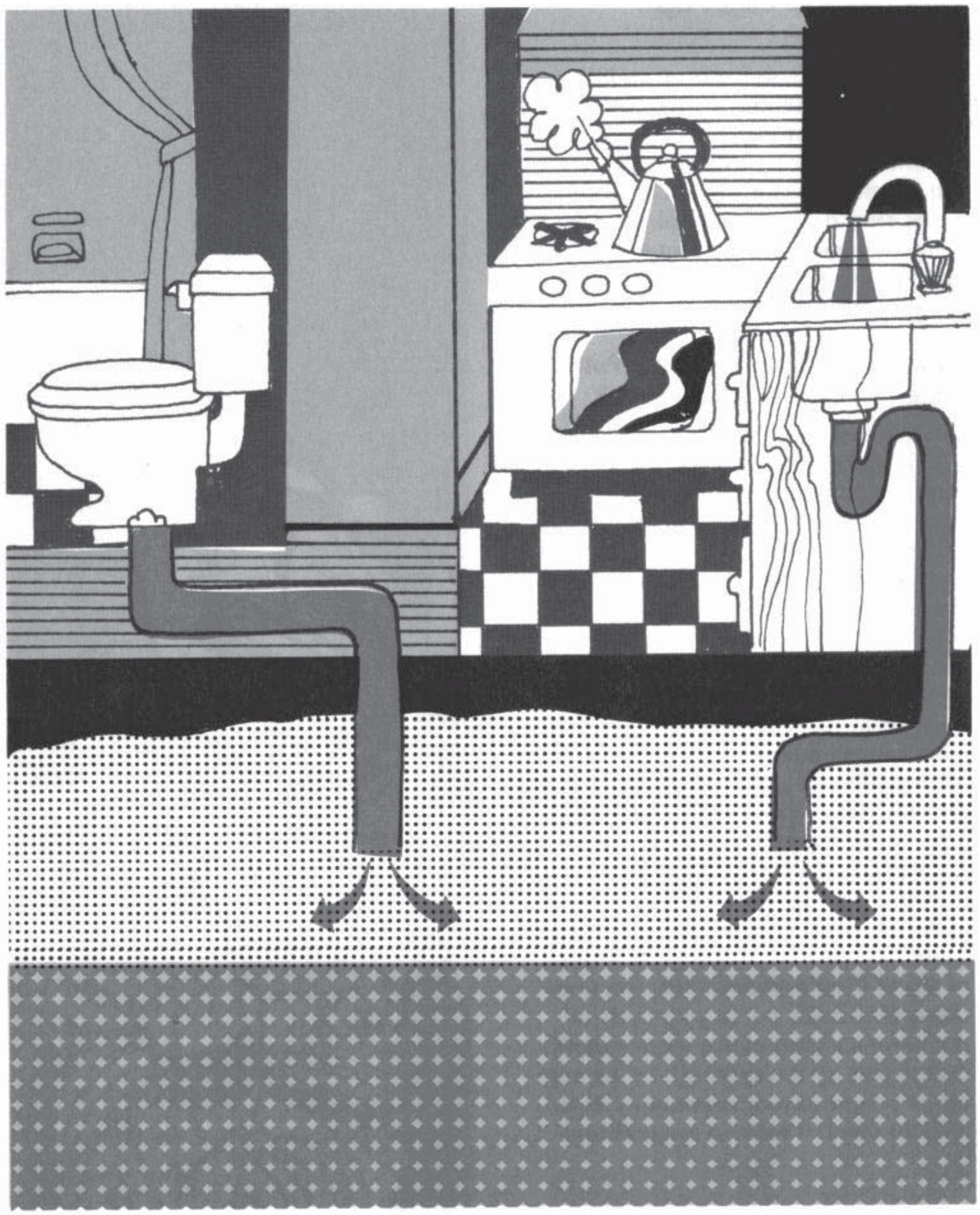
- **Water Conservation -** To reduce the total quantity of water withdrawn from ground-water aquifers and to protect against contamination by reducing the rate at which contaminants can spread in the aquifer (e.g., excessive withdrawals from an aquifer located near the ocean can draw salt water into the aquifer and contaminate wells).

How Can You Clean Up Your Own Act?

So far, the emphasis has been on how you can help your community to protect its ground water through the development of community-wide policies and programs. But ground-water protection also begins at home. How do your personal habits affect your community's ground-water quality? What can you, as an individual, do to protect your community's ground water?

How Do You Dispose of the Polluting Materials Used in Your Home?

You may be surprised to learn that the way you dispose of products you use at home can contribute to the contamination of your community's ground water. You may be even more surprised to learn that a number of the products you use at home contain hazardous or toxic substances. The truth is, however, that products like motor oil, pesticides, leftover paints or paint cans, mothballs, flea collars, weedkillers, house. hold cleaners, and even a number of medicines contain materials that can be harmful to ground water and to the environment in general. (See **Appendix 3** for a list of the types of products commonly found around homes and their potentially harmful components.) The average American disposes of approximately one pound of this type of waste each year So, although the amount of any of these substances that you pour down your drain, put in your trash, or dump on the ground may seem insignificant to you, try multiplying it by the number of people in your community. That amount may not seem so insignificant



Don't Pour It Down the Drain! Anything you pour down your drain or flush down your toilet will enter your septic system or your community's sewer system. Using this method to dispose of products that contain harmful substances can affect your septic system's ability to treat human wastes. Once in the ground, these harmful substances can eventually contaminate the ground water. In addition, most community waste water treatment plants are not designed to treat many of these substances. Thus, they can eventually be discharged into bodies of surface water and cause contamination.

Don't Put It in the Trash! Community landfills also generally are not equipped to handle hazardous materials. As rain and snow pass through the landfill, the water can become contaminated by these products and eventually carry them into the ground water and surface water

Don't Dump It on the Ground! Hazardous wastes that are dumped on or buried in the ground can contaminate the soil and either leach down into the ground water or be carried into a nearby body of surface water by runoff during rainstorms.

Do Use and Dispose of Harmful Materials Properly! There are very few options for disposing of hazardous products used in your home, so the first step may be to limit your use of such products. Whenever possible, substitute a nonhazardous product. When that is not possible, buy only as much as you need. Larger quantities may be less expensive, but they leave you with the problem of disposing of them safely. Finally, urge community officials to sponsor periodic household hazardous waste collection days if they have not established this policy By helping your community to centralize collection of hazardous household wastes for appropriate disposal, you will be helping your community to make a major contribution toward protecting its ground water The saying "Garbage in, garbage out" applies to more than computer data bases.

How Do You Take Care of Your Septic System?

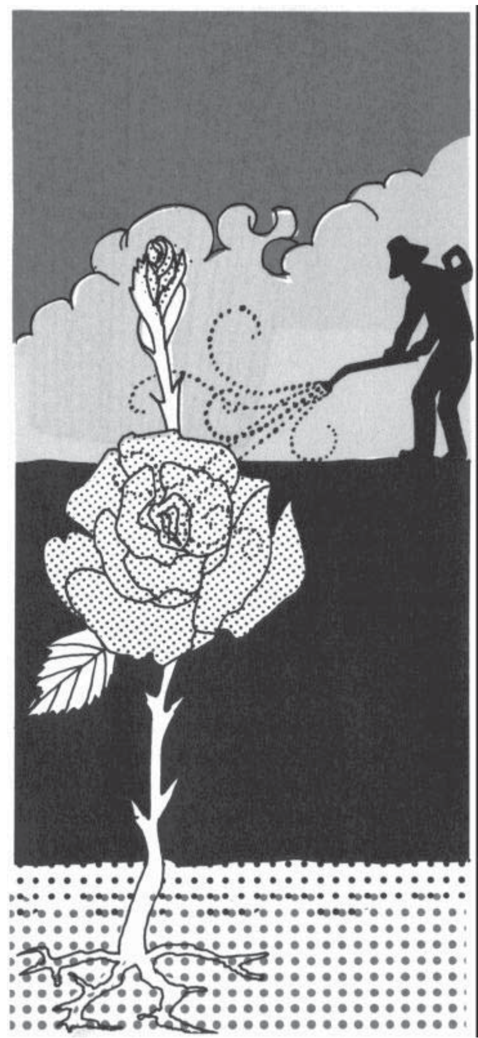
Your septic system is designed to have its effluent discharge into a drainage field where it undergoes some decomposition by microorganisms in the soil as it works its way down to the ground water. If your system is not pumped out frequently enough, solid materials can leave the tank and enter the drainage field. Any substances poured down your drains also will enter that drainage field-and eventually the ground water

To prevent ground-water contamination from your septic system:

- Have your septic system inspected annually and pumped out regularly no chemical or other additive can be a substitute for this, and these septic system chemicals actually can prevent your septic system from functioning properly
- Be cautious about what you put into your system; substances like coffee grounds, cigarette butts, sanitary items, or fats do not break down easily in septic systems, and chemicals like paints, solvents, oil, and pesticides will go from your septic system into the ground water.
- Limit the amount of water entering your system by using water-saving fixtures and appliances.

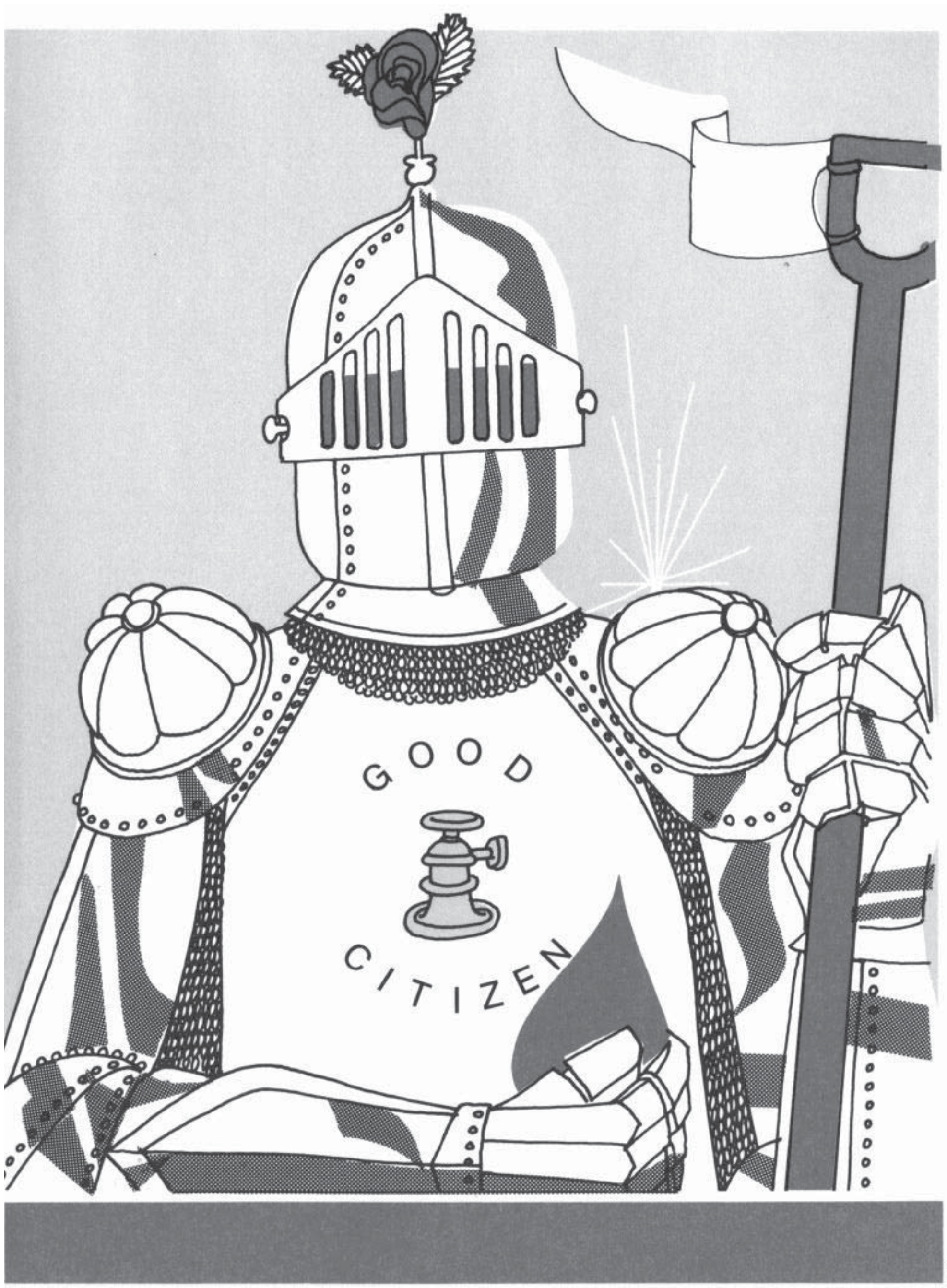
How Does Your Garden Grow?

If you are a homeowner, you probably take a lot of pride in your home and the yard surrounding it. You may apply fertilizers to make your grass thick and green, your flowers colorful, and your vegetable crop abundant You also may use pesticides to keep bugs from ruining what the fertilizers have helped to produce. What you may not know, however, is that many of these fertilizers and pesticides contain hazardous chemicals that can travel through the soil and contaminate ground water. If you feel you must use these chemicals, use them in moderation. This is not a case of “more is better.” Your county extension agent can provide information on natural ways to control lawn, garden, and tree pests that can reduce reliance on chemicals.



What Else Can You Do?

Get informed and get involved! Around the country, citizens are getting involved in their communities, volunteering their time and energy and making a difference. If you think one person can't change the system, help form a group. You, alone or as part of a group, can help to educate your family, friends, and neighbors about the importance of ground water to your community, And, after you've cleaned up your own act, you can help your community clean up its act.



REFERENCES

Born, Stephen M., Douglas A. Yanggen, and Alexander Zaporozec. *A Guide to Groundwater Quality Planning and Management for Local Governments.* Wisconsin Geological and Natural History Survey, Madison, WI, 1987.

Concern, Inc. *Groundwater: A Community Action Guide.* Washington, D.C., 1989.

Cross, Brad L. and Jack Schulze. *City of Hurst (A Public Water Supply Protection Strategy).* Texas Water Commission, Austin, TX, 1989.

Curtis, Christopher and Teri Anderson. *A Guidebook for Organizing a Community Collection Event: Household Hazardous Waste.* Pioneer Valley Planning Commission and Western Massachusetts Coalition for Safe Waste Management, West Springfield, MA, 1984.

Curtis, Christopher, Christopher Walsh, and Michael Przybyla. *The Road Salt Management Handbook: Introducing a Reliable Strategy to Safeguard People & Water Resources.* Pioneer Valley Planning Commission, West Springfield, MA, 1986.

Cordon, Wendy. *A Citizen's Handbook on Groundwater Protection.* Natural Resources Defense Council, New York, NY, 1984.

Harrison, Ellen Z. and Mary Ann Dickinson. *Protecting Connecticut's Groundwater: A Guide to Groundwater Protection for Local Officials.* Connecticut Department of Environmental Protection, Hartford, CT, 1984.

Hrezo, Margaret and Pat Nickinson. *Protecting Virginia's Groundwater: A Handbook for Local Government Officials.* Virginia Polytechnic Institute and State University, Blacksburg, VA, 1986.

Jaffe, Martin and Frank Dinovo. *Local Groundwater Protection.* American Planning Association, Chicago, IL, 1987.

Loomis, George and Yael Calhoon. “Natural Resource Facts: Maintaining Your Septic System.” University of Rhode Island, Providence, RI, 1988.

Maine Association of Conservation Commissions. *Ground Water. . . Maine's Hidden Resource.* Hallowell, ME, 1985.

Massachusetts Audubon Society. “Groundwater and Contamination: From the Watershed into the Well.” Groundwater Information Flyer #2. Lincoln, MA, 1984.

Massachusetts Audubon Society. “Local Authority for Groundwater Protection.” Groundwater Information Flyer #4. Lincoln, MA, 1984.

Massachusetts Audubon Society. “Mapping Aquifers and Recharge Areas.” Groundwater Information Flyer #3. Lincoln, MA, 1984.

Massachusetts Audubon Society. “Road Salt and Groundwater Protection.” Groundwater Information Flyer #9. Lincoln, MA, 1987.

McCann, Alyson and Thomas P. Husband. “Natural Resources Facts: Household Hazardous Waste.” University of Rhode Island, Providence, RI, 1988.

Mecozzi, Maureen. *Groundwater: Protecting Wisconsin's Buried Treasure.* Wisconsin Department of Natural Resources, Madison, WI, 1989.

Miller, David W. *Groundwater Contamination: A Special Report.* Geraghty & Miller Inc., Syosset, NY, 1982.

Mullikin, Elizabeth B. *An Ounce of Prevention: A Ground Water Protection Handbook for Local Officials.* Vermont Departments of Water Resources and Environmental Engineering, Health, and Agriculture, Montpelier, VT, 1984.

Murphy, Jim. “Groundwater and Your Town: What Your Town Can Do Right Now.” Connecticut Department of Environmental Protection, Hartford, CT.

REFERENCES (continued)

National Research Council. *Ground Water Quality Protection: State and Local Strategies.* National Academy Press, Washington, DC., 1986.

New England Interstate Water Pollution Control Commission. "Groundwater: Out of Sight Not Out of Danger" Boston, MA, 1989.

Noake, Kimberly D. *Guide to Contamination Sources for Wellhead Protection.* Draft. Massachusetts Department of Environmental Quality Engineering, Boston, MA, 1988.

Office of Drinking Water *A Local Planning Process for Groundwater Protection.* U.S. EPA, Washington, DC., 1989.

Office of Ground-Water Protection. *Guidelines for Delineation of Wellhead Protection Areas.* U.S. EPA, Washington, DC., 1987.

Office of Ground-Water Protection. *Survey of State Ground Water Quality Protection Legislation Enacted From 1985 Through 1987.* U.S. EPA, Washington, DC., 1988.

Office of Ground-Water Protection. *Wellhead Protection: A Decision-Makers' Guide.* U.S. EPA, Washington, DC., 1987.

Office of Ground-Water Protection. *Wellhead Protection Programs: Tools for Local Governments.* U.S. EPA Washington, DC., 1989.

Office of Pesticides and Toxic Substances. *Citizen's Guide to Pesticides.* U.S. EPA, Washington, DC., 1989.

Office of Underground Storage Tanks. *Musts for USTs: A Summary of the New Regulations for Underground Storage Tank Systems.* U.S. EPA, Washington, D.C., 1988.

Ohio Environmental Protection Agency. *Ground Water.* Columbus, OH.

Redlich, Swan. *Summary of Municipal Actions for Groundwater Protection in the New England/New York Region.* New England Interstate Water Pollution Control Commission, Boston, MA, 1988.

Southern Arizona Water Resources Association. "Water Warnings: Our Drinking Water. . . . It Takes Everyone to Keep It Clean." Tucson, AZ.

Sponenberg, Torsten D. and Jacob H. Kahn. *A Groundwater Primer for Virginians.* Virginia Polytechnic Institute and State University, Blacksburg, VA 1984.

Texas Water Commission. "On Dangerous Ground: The Problem of Abandoned Wells in Texas." Austin, TX, 1989.

Texas Water Commission. *The Underground Subject: An Introduction to Ground Water Issues in Texas.* Austin, TX, 1989.

U.S. Environmental Protection Agency. *Seminar Publication: Protection of Public Water Supplies from Ground-Water Contaminants.* Center for Environmental Research Information, Cincinnati, OH, 1985.

Waller, Roger M. *Ground Water and the Rural Homeowner.* U.S. Geological Survey, Reston, VA, 1988.

APPENDIX

NEW INFORMATION FOR THE 1999 REPRINTED EDITION

Appendices 1 and 2 are not included in this edition since they are outdated. The following information replaces them:

New Drinking Water Protection Information for Communities
As a result of new requirements in the 1996 amendments to the Safe Drinking Water Act, states are now implementing Source Water Assessment Programs, which build on existing wellhead protection programs. In these assessments, states will identify the most significant potential sources of contamination for each public water system - whether served by ground water or surface water. These assessments, which should be completed for all public water systems in each state by 2003 and made available to the public, will provide valuable information for communities on priority drinking water protection needs.

Contacts for more information
For additional information about the source water assessment and ground water protection programs in your state, contact the agency in your state that manages the environmental and/or the public health protection programs. These contacts and links to specific states and EPA regions can be found on the EPA's web page at www.epa.gov/safewater/protect.html or by calling the Safe Drinking Water Hotline at l-800-426-4791.

For local information on ground water protection efforts in your community, contact your local environmental or public health office. Contact information can be found by looking in the government section of your telephone directory. If your drinking water comes from a water company or local government, contact them for information as well. Contact information can be found on your water bill or in the telephone directory.

APPENDIX 1. POTENTIALLY HARMFUL COMPONENTS OF COMMON HOUSEHOLD PRODUCTS

Product	Toxic or Hazardous Components
Antifreeze (gasoline or coolant systems)	methanol ethylene glycol
Automatic transmission fluid	petroleum distillates, xylene
Battery acid (electrolyte)	sulfuric acid
Degreasers for driveways and garages	petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	petroleum solvents, ketones, butanol, glycol ether
Hydraulic fluid (brake fluid)	hydrocarbons, fluorocarbons
Motor oils and waste oils	hydrocarbons
Gasoline and jet fuel	hydrocarbons
Diesel fuel, kerosene, #2 heating oil	hydrocarbons
Grease, lubes	hydrocarbons
Rustproofers	phenols, heavy metals
Car wash detergents	alkyl benzene sulfonates
Car waxes and polishes	petroleum distillates, hydrocarbons
Asphalt and roofing tar	hydrocarbons
Paints, varnishes, stains, dyes	heavy metals, toluene
Paint and lacquer thinner	acetone, benzene, toluene, butyl, acetate, methyl ketones
Paint and varnish removers, deglossers	methylene chloride, toluene, acetone, xylene, ethanol benzene, methanol
Paint brush cleaners	hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Floor and furniture strippers	xylene
Metal polishes	petroleum distillates, isopropanol, petroleum naptha
Laundry soil and stain removers	petroleum distillates, tetrachloroethylene
Spot removers and dry cleaning fluid	hydrocarbons, benzene, trichloroethylene, 1,1,l trichloroethane
other solvents	acetone, benzene
Rock salt (Halite)	sodium concentration
Refrigerants	1,1,2 trichloro - 1,2,2 triflourothane
Bug and tar removers	xylene, petroleum distillates
Household cleansers, oven cleaners	xylenols, glycol ethers, isopropanol
Draincleaners	1,1,l trichloroethane
Toilet cleaners	xylene, sulfonates, chlorinated phenols
Cesspool cleaners	tetrachloroethylene, dichlorohenzene, methylene chloride
Disinfectants	cresol, xylenols
Pesticides (all types)	napthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons
Photochemicals	phenols, sodium sulfite, cyanine, silver halide, potassium bromide
Printing ink	heavy metals, phenol-formaldehyde
Wood preservatives (creasote)	pentachlorophenols
Swimming pool chlorine	sodium hypochlorite
Lye or caustic soda	sodium hydroxide
Jewelry cleaners	sodiumcyanide

Reprinted from "Natural Resources Facts: Household Hazardous Wastes," Fact Sheet No. 88-3, Department of Natural Science, University of Rhode Island, August 1988.