

GROUNDWATER PROTECTION

PROFESSIONAL DEVELOPMENT COURSE

5 PDHs or .5 CEU's or 5 Training Credits





Top, this crew is removing a pump from a contaminated groundwater well in hopes of re-building and cleaning the well to increase the water production. The water is then sent to the granular activated carbon (GAC) vessels in the lower picture for final cleaning before being delivered to water customers. This well was contaminated from the dry cleaning chemical known as Perc (PCE) or fugitive Tetrachloroethylene from a nearby Dry Cleaner facility.





Sampling of water is key to finding contamination in the water distribution system. To learn more about water sampling, visit our Water and Wastewater Sampling Course.



Technical Learning College's Scope and Function

Technical Learning College (TLC) offers affordable continuing education for today's working professionals who need to maintain licenses or certifications. TLC holds approximately eighty different governmental approvals for granting of continuing education credit.

TLC's delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. Most TLC's distance based or independent study courses are offered in a print based format and you are welcome to examine this material on your computer with no obligation. Our courses are designed to be flexible and for you do finish the material on your leisure. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and assignments. Most CEU courses allow students to submit lessons using e-mail or fax, however some courses require students to submit lessons by postal mail. (See the course description for more information.) Students have direct contact with their instructor—primarily by e-mail. TLC's CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling, i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored exams depending upon your state requirements.

Flexible Learning

At TLC, there are no scheduled online sessions you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus based student. You will work at your own pace, completing assignments in time frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

We will beat any other training competitor's price for the same CEU material or classroom training. Student satisfaction is guaranteed.

Course Structure

TLC's online courses combine the best of online delivery and traditional university textbooks. Online you will find the course syllabus, course content, assignments, and online open book exams. This student friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One

TLC Online offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members are assigned at the beginning of each course providing the academic support you need to successfully complete each course.

Satisfaction Guaranteed

Our Iron-Clad, Risk-Free Guarantee ensures you will be another satisfied TLC student.

We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 10,000 students.

Our administrative staff is trained to provide the best customer service in town. Part of that training is knowing how to solve most problems on the spot with an exchange or refund.

TLC Continuing Education Course Material Development

Technical Learning College (TLC's) continuing education course material development was based upon several factors; extensive academic research, advice from subject matter experts, data analysis, task analysis and training needs assessment process information gathered from other states.



We welcome you to complete the assignment in Word. You can easily find the assignment at www.abctlc.com. Once complete, just simply fax or e-mail the answer key along with the registration page to us and allow two weeks for grading. Once we grade it, we will mail a certificate of completion to you. Call us if you need any help.

Course Description

GROUNDWATER PROTECTION CEU TRAINING COURSE

This course 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.

This course will review the Environmental Protection Agency's Rules and Regulation relating to ground-water protection. This course will cover the basic requirements of the federal rule concerning groundwater protection and general pollution prevention operations.



Course Procedures for Registration and Support

All of Technical Learning College correspondence courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date. It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether to grant the request.

Instructions for Written Assignments

The Groundwater Protection distance course uses a multiple-choice answer key, Scantron, or equivalent answer sheet. The students must use a number two pencil, make dark marks, and erase completely to change an answer.

Feedback Mechanism (examination procedures)

Each student will receive a feedback form as part of their study packet. You will be able to find this form in the rear of the course or lesson.

Security and Integrity

All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified.

Grading Criteria

TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice.

Required Texts

The Groundwater Protection course comes complete with a copy of the EPA's Citizen's Guide to Groundwater Protection in student's packet. No other materials are needed.

Recordkeeping and Reporting Practices

TLC will keep all student records for a minimum of seven years. It is your responsibility to give the completion certificate to the appropriate agencies.

ADA Compliance

TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs.

Course content may vary from this outline to meet the needs of this particular group.

Educational Mission

The educational mission of TLC is:

To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the environmental education field,

To provide TLC students opportunities to apply and understand the theory and skills needed for operator certification,

To provide opportunities for TLC students to learn and practice environmental educational skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to environmental education,

To provide a forum for the collection and dissemination of current information related to environmental education, and to maintain an environment that nurtures academic and personal growth.



How about the pesticide residual from washing off pesticide tanks?

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Reproduced with permission from EPA 2001



Will over spraying have an effect on our groundwater?



Think of the many times a pesticide applicator has spilled or allowed concentrated pesticides to leak to the ground. Our research shows that over a normal pesticide applicators career, approximately 10,000 gallons of pesticide will reach the area of influence and eventually reach our drinking water supply.

Now this is just one of the many examples of hundreds of events that happen everyday to our drinking water supply.

What are you going to do to protect our drinking water supply and protect our children from these hazards?

CATEGORIES OF ACTIVITIES THAT IMPACT GROUNDWATER AND SOURCES OF DRINKING WATER

RUNOFF

Water washes away many substances which later seep into the ground and mixes with groundwater.

Examples of runoff including stormwater include:

AGRICULTURAL

- Animal Wastes
- Fertilizers
- Pesticides
- Sediments

URBAN

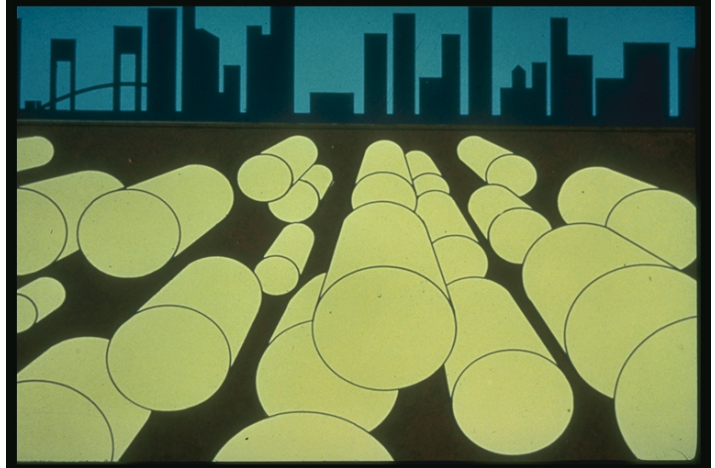
- Chemicals
- Grease and Oils
- Solvents

LANDFILL

- Garbage
- Leachate

CONSTRUCTION

- Contaminated Soil
- Stormwater Runoff
- Waste and Trash



LEAKING STORAGE TANKS (ULST)

Fuels and chemicals stored in underground or above ground tanks can leak into groundwater.

Examples of substances that are expensive and difficult to remove are:

- Chemicals
- Diesel Fuel
- Fertilizers
- Gasoline
- Heating Oil
- Pesticides
- Solvents



HOLDING PONDS

Surface ponds serve a number of purposes in rural or industrial areas but also threaten groundwater quality.

Some examples are:

ANIMAL WASTES

- Microbial Contaminants
- Toxic levels of Nitrogen and Phosphorus

MINE WASTES

- Acid Waters
- Heavy Metals, Arsenic, Lead, etc.
- Sediments

WASTEWATER LAGOONS

- Microbial Contaminants
- Toxic Levels of Nitrogen and Phosphorus



WASTES FROM HUMAN AND ANIMALS

Waste by-products from humans and animals can seep into the ground and stay in a concentrated form. Groundwater containing harmful waste by-products can not be used as drinking water.

Some examples of possible pollutant sources are:

- Animal Feeding Operations including Aqua-Culture
- Animal Waste Ponds
- Leaking Wastewater Lines
- Manure Spreading
- Septic Systems

WELLS

Wells are drilled into the ground for drinking water, irrigation water, to recharge (injection) the aquifer, and to dispose of low-concentrated wastes. Any of these wells can allow pollutants to reach groundwater. Wells not in use must be properly capped and sealed to prevent contamination to the groundwater.

COMMON SOURCES OF WELL POLLUTANTS

- Abandoned or improperly closed wells
- Injection wells
- Irrigation wells left uncapped when not in use

DRINKING WATER WELLS ARE SUSCEPTIBLE TO POLLUTANTS WHEN THE WELL

- Has an improperly cased/grouted pipe
- Is too shallow
- Is located within 50 feet to septic or leach fields
- Is too close to chemical or biological contaminants

3 Compartment Interceptor

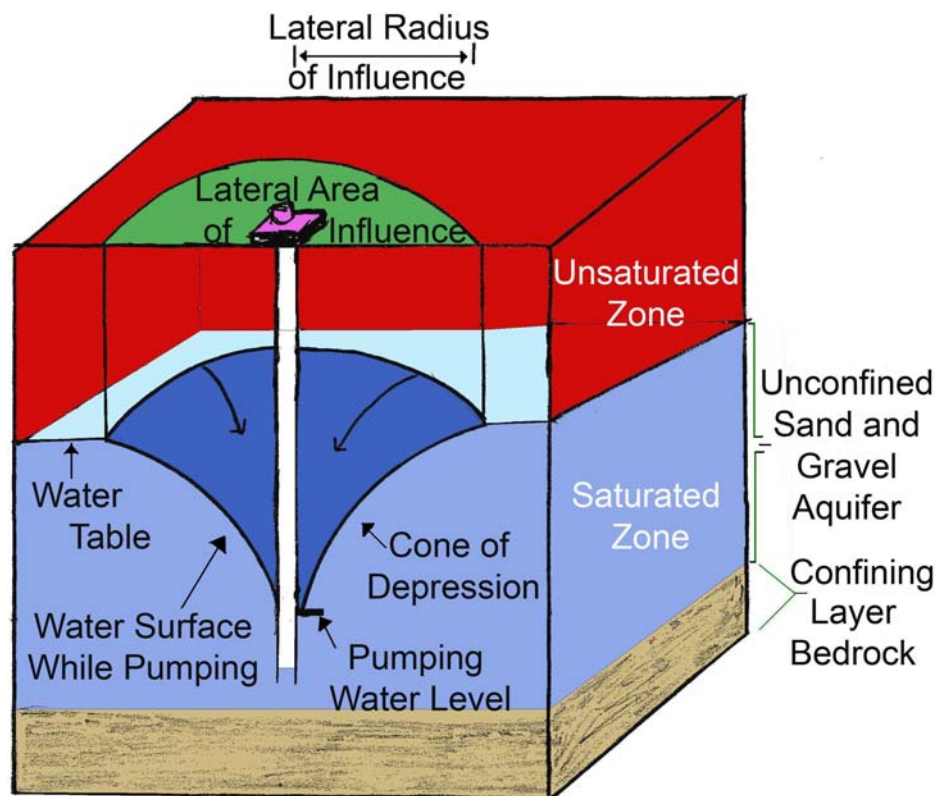
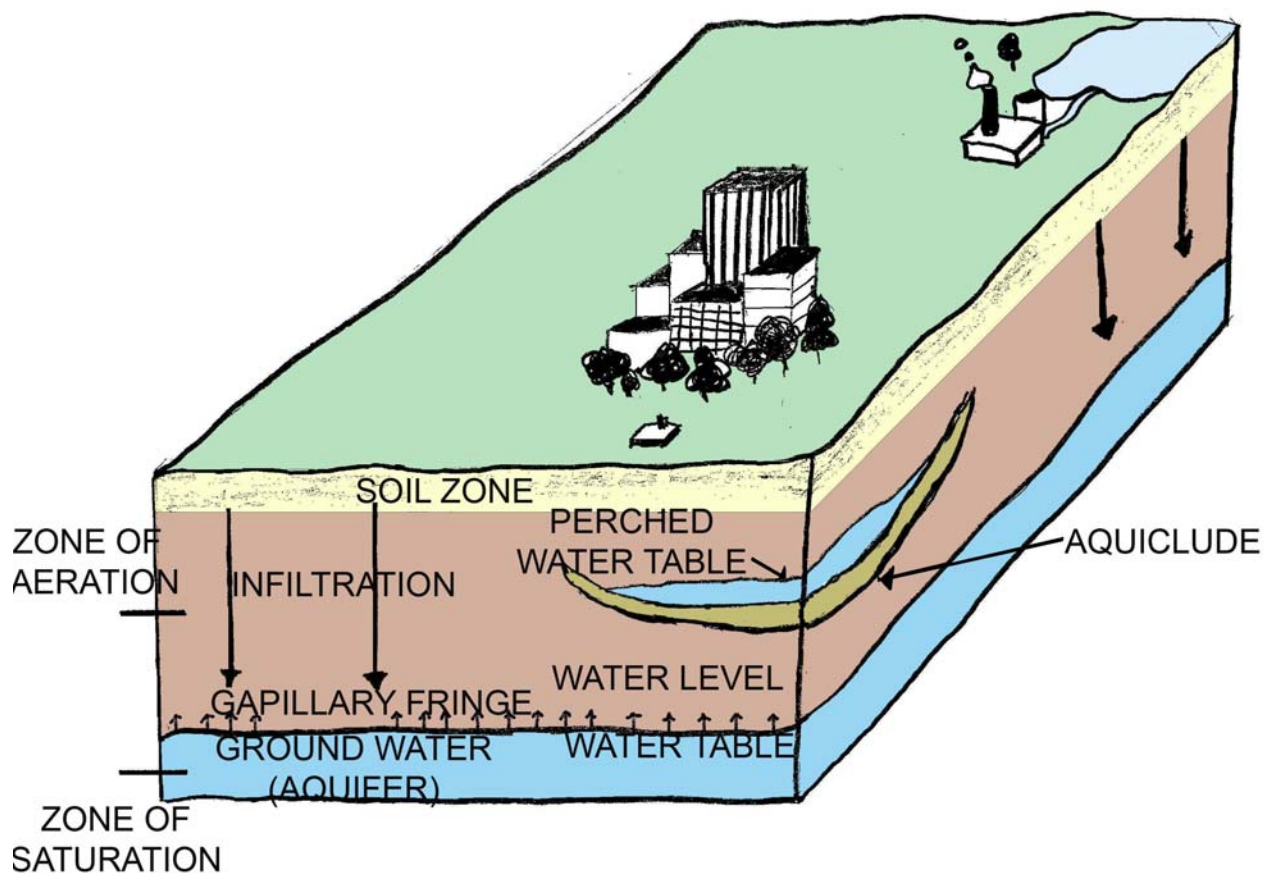




Paint and chemicals that were drained into a storm drain.



Used motor oil filters pose a water threat.



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.

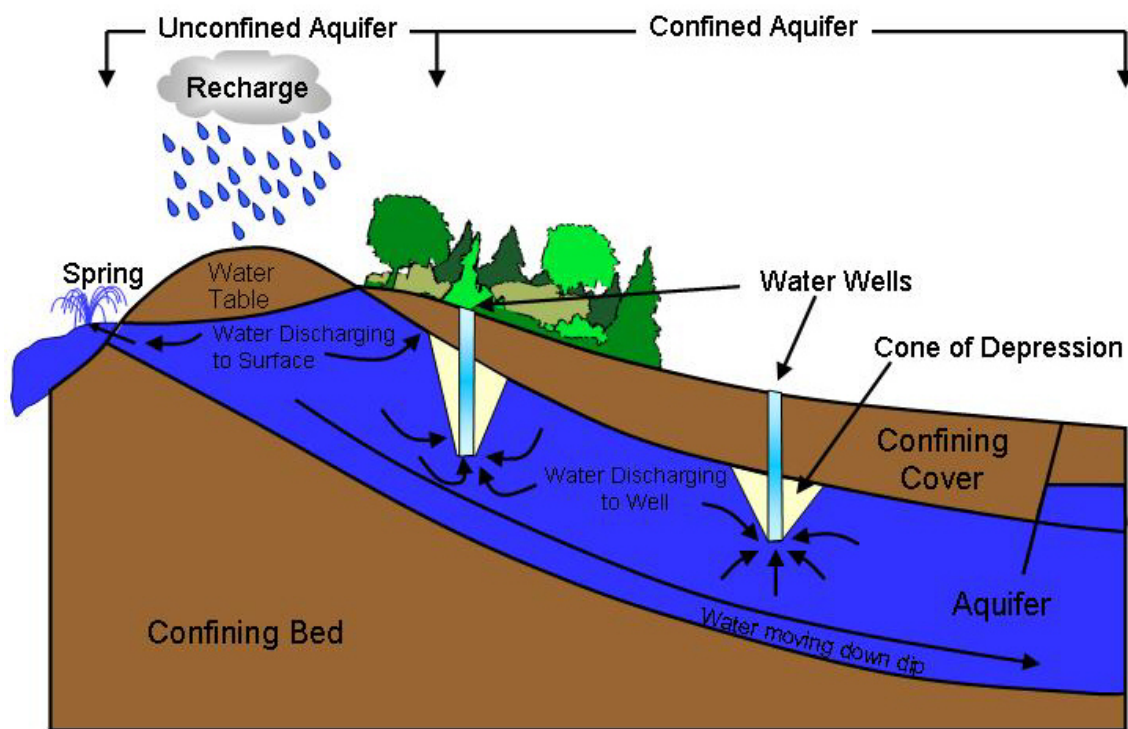
If your community relies on ground water to supply any portion of its fresh water needs, you, the citizen, will be directly affected by the success or failure of a ground-water protection program.

Equally important, you, the citizen, can directly affect the success or failure of your community's ground-water protection efforts.

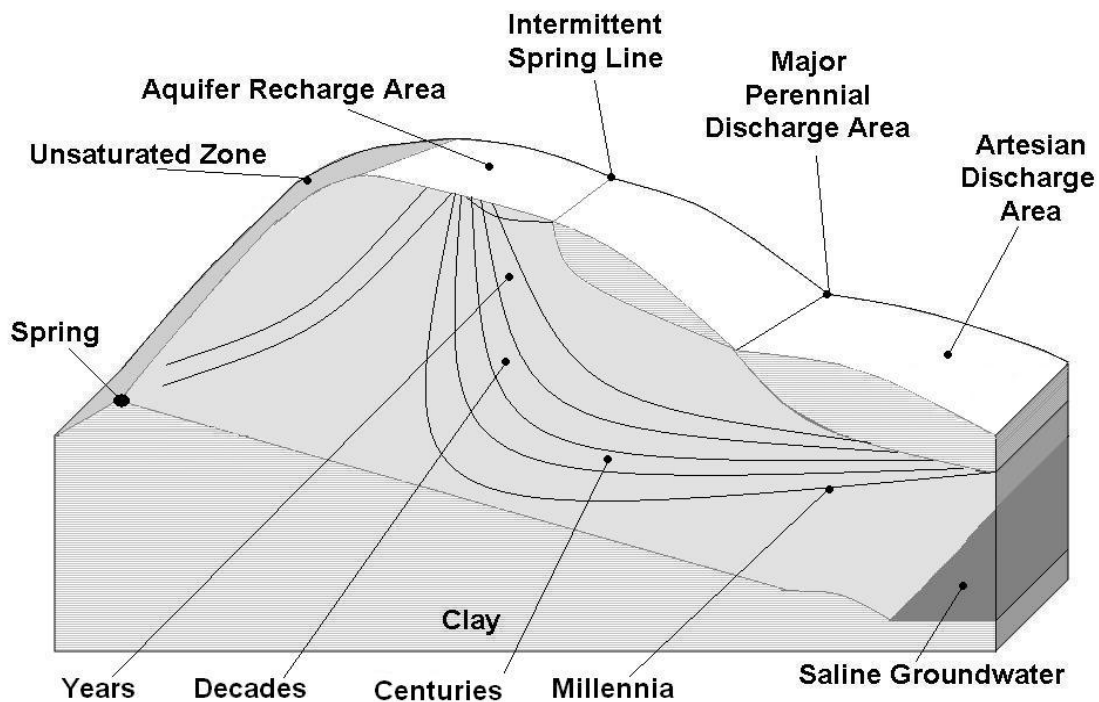
This guide is intended to help you take an active and positive role in protecting your community's ground-water supplies. It will introduce you to the natural cycle that supplies the earth with ground water, briefly explain how ground water can become contaminated, examine ways to protect our vulnerable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



Groundwater Transducer (pH, Temp. chemical detection, and D.O.) and depth probe. These tools are used to find the depth and pH of well water.

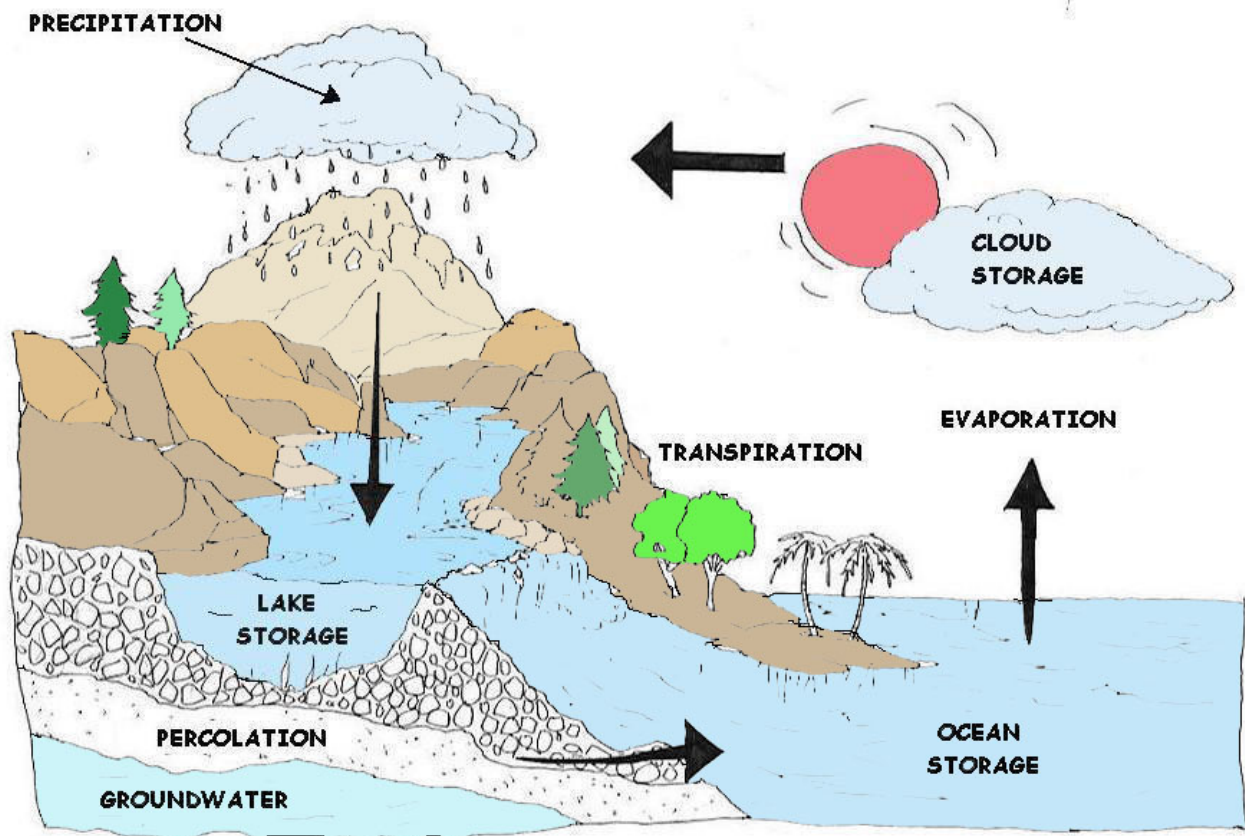


Aquifer Descriptions



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-half 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. Groundwater 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, trapping 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 I 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 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.

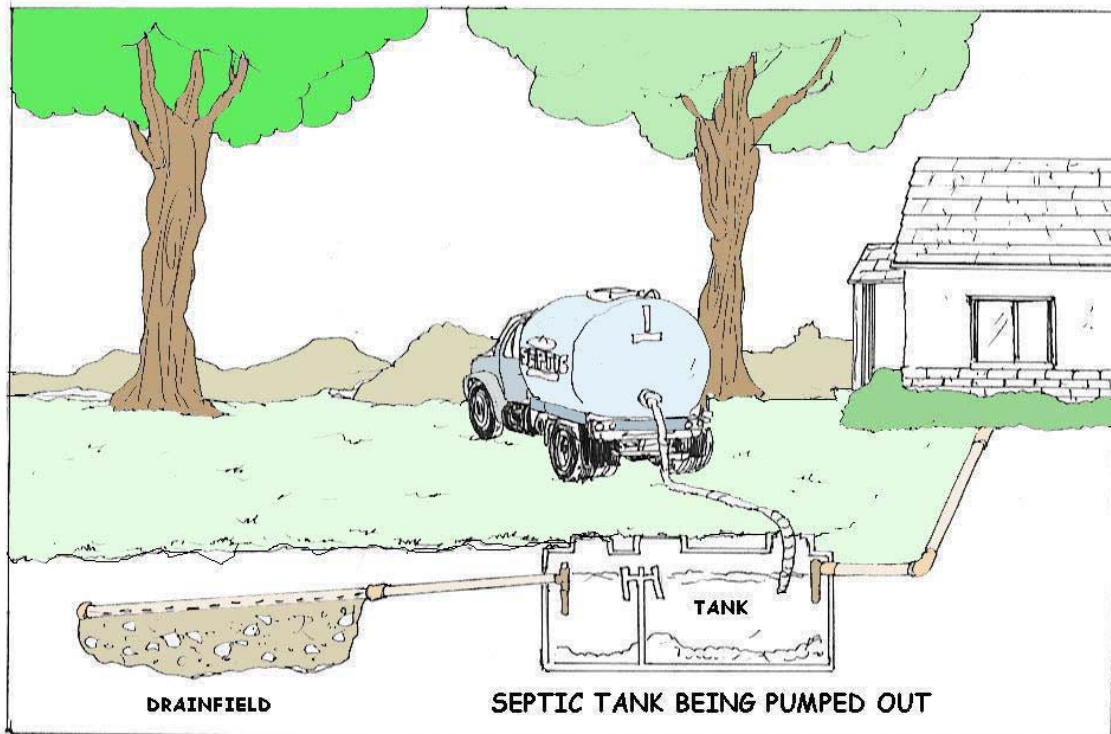
GROUND SURFACE	Infiltration of polluted surface water	De-icing salt use & storage
	Land disposal of wastes	Animal feedlots
	Stockpiles	Fertilizers & pesticides
	Dumps	Accidental spills
	Sewage sludge disposal	Airborne source particulates
ABOVE WATER TABLE	Septic tanks, cesspools, & privies	Underground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

TABLE 1. Activities That Can Cause Ground-Water Contamination

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 widespread 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 systems, most people relied on wells to provide 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 can result 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.

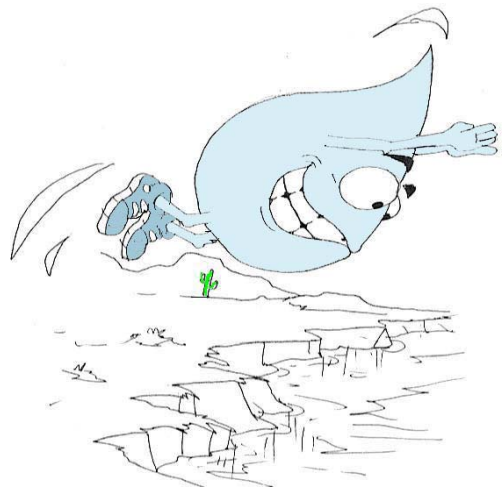
In general, a community whose ground-water supply has been contaminated has five options:

- 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.



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.

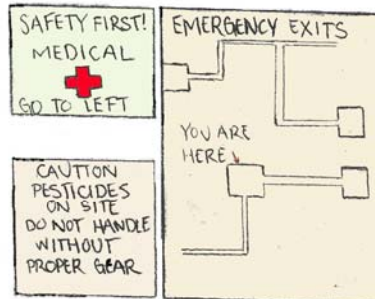
The federal laws tend to focus on controlling potential sources of ground-water contamination on a national basis. Where federal laws have provided for general ground-water protection activities such as wellhead protection programs or development of state ground-water protection strategies, the actual implementation of these programs 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 components for the wellhead protection programs:

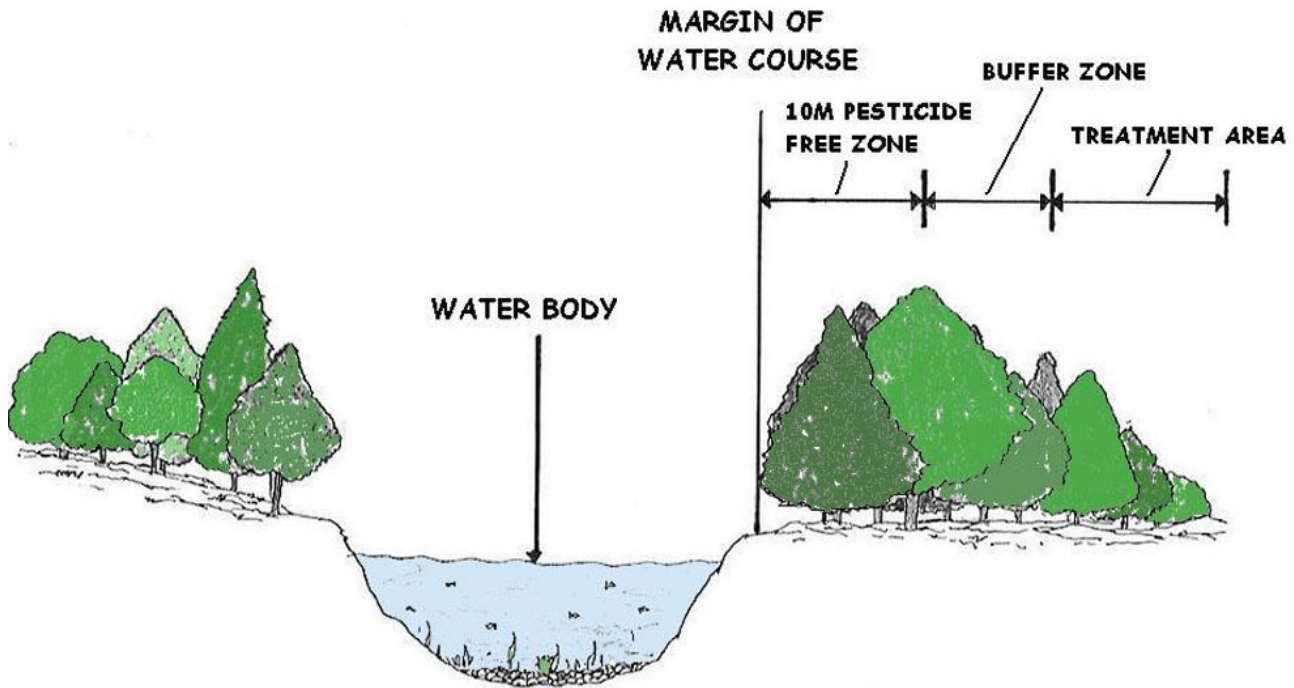
- The roles and duties of state and local governments and public water suppliers in the management of wellhead protection programs must be established.
- The WHPA for each wellhead must be delineated (i.e., outlined or defined).
- Contamination sources within each WHPA must be identified.
- Approaches 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 environmental 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 incentive 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 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, left-over paints or paint cans, mothballs, flea collars, weedkillers, household cleaners, and even a number of medicines contain materials that can be harmful to ground water and to the environment in general. (See **Appendix 1** 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 wastewater 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 micro-organisms 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.
- Gordon, 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.
- Macozzi, 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.
- National Research Council. *Ground Water Quality Protection: State and Local Strategies*. National Academy Press, Washington, D.C., 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, D.C., 1989.

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

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

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

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

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

Office of Underground Storage Tanks. *Musts for USGS. - 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, Susan. *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 were completed for all public water systems in each state back in 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 1-800-426-4791.

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.



Leachate from a landfill

Leachates are 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.



Using a video camera to see inside a groundwater well.



APPENDIX 1. POTENTIALLY HARMFUL COMPONENTS OF COMMON HOUSEHOLD PRODUCTS

Product

Antifreeze (gasoline or coolant systems)
 Automatic transmission fluid
 Battery acid (Electrolyte)
 Degreasers for driveways and garages
 Degreasers for engines and metal

Engine and radiator flushes
 Hydraulic fluid (brake fluid)
 Motor oils; and waste oils
 Gasoline and jet fuel
 Diesel fuel, kerosene, #2 heating oil
 Grease, lubes
 Rustproofers
 Car wash detergents
 Car waxes and polishes
 Asphalt and roofing tar
 Paints, varnishes, stains, dyes
 Paint and lacquer thinner

Paint and varnish removers, deglossers

Paint brush cleaners

Floor and furniture strippers
 Metal polishes
 Laundry soil and stain removers
 Spot removers and dry cleaning fluid

Other solvents
 Rock salt (Halite)
 Refrigerants
 Bug and tar removers
 Household cleansers, oven cleaners
 Drain cleaners
 Toilet cleaners
 Cesspool cleaners

Disinfectants
 Pesticides (all types)

Photochemicals

Printing ink
 Wood preservatives (creosote)
 Swimming pool chlorine
 Lye or caustic soda
 Jewelry cleaners

Toxic or Hazardous Components

methanol, ethylene glycol
 petroleum distillates, xylene
 sulfuric acid petroleum solvents, alcohols, glycol
 ether
 chlorinated hydrocarbons, toluene, phenols,
 dichloroperchloroethylene
 petroleum solvents, ketones, butanol, glycol
 ether
 hydrocarbons, fluorocarbons
 hydrocarbons
 hydrocarbons
 hydrocarbons
 hydrocarbons
 phenols, heavy metals
 alkyl benzene sulfonates
 petroleum distillates, hydrocarbons
 hydrocarbons
 heavy metals, toluene
 acetone, benzene, toluene, butyl, acetate, methyl
 ketones
 methylene chloride, toluene, acetone, xylene,
 ethanol, benzene, methanol
 hydrocarbons, toluene, acetone, methanol, glycol
 ethers, methyl ethyl ketones
 xylene
 petroleum distillates, isopropanol, petroleum
 naphtha
 petroleum distillates, tetrachloroethylene
 hydrocarbons, benzene, trichloroethylene, 1, 1, 1
 trichloroethane
 acetone, benzene
 sodium concentration
 1, 1, 2 trichloro - 1, 2, 2 trifluoroethane
 xylene, petroleum distillates
 xylenols, glycol ethers, isopropanol
 1, 1, 1 trichloroethane
 xylene, sulfonates, chlorinated phenols
 tetrachloroethylene, dichlorobenzene, methylene
 chloride
 cresol, xylenols
 naphthalene, phosphorus, xylene, chloroform,
 heavy metals, chlorinated hydrocarbons
 phenols, sodium sulfite, cyanine, silver halide,
 potassium bromide
 heavy metals, phenol-formaldehyde
 pentachlorophenols
 sodium hypochlorite
 sodium hydroxide
 sodium cyanide



Chemical separation and recycling of batteries, oils and paint is important to a groundwater protection program. This includes proper pesticide disposal and triple-rinsing pesticide containers. Be carefully on chemical application and always clean-up spills.

A yellow hazardous waste label with a red and black border. The text on the label includes:

HAZARDOUS WASTE

FEDERAL LAWS PROHIBIT IMPROPER DISPOSAL
IF FOUND, CONTACT THE NEAREST POLICE OR
PUBLIC SAFETY AUTHORITY OR THE
U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERATOR INFORMATION:

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____
EPA ID NO. _____ EPA WASTE NO. _____
ACCUMULATION START DATE _____ MANIFEST DOCUMENT NO. _____
EPA (RAILWAY OR HIGHWAY) 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.8, 15.9, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, 19.9, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 21.7, 21.8, 21.9, 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9, 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7, 23.8, 23.9, 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, 24.9, 25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7, 25.8, 25.9, 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 29.1, 29.2, 29.3, 29.4, 29.5, 29.6, 29.7, 29.8, 29.9, 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, 30.9, 31.1, 31.2, 31.3, 31.4, 31.5, 31.6, 31.7, 31.8, 31.9, 32.1, 32.2, 32.3, 32.4, 32.5, 32.6, 32.7, 32.8, 32.9, 33.1, 33.2, 33.3, 33.4, 33.5, 33.6, 33.7, 33.8, 33.9, 34.1, 34.2, 34.3, 34.4, 34.5, 34.6, 34.7, 34.8, 34.9, 35.1, 35.2, 35.3, 35.4, 35.5, 35.6, 35.7, 35.8, 35.9, 36.1, 36.2, 36.3, 36.4, 36.5, 36.6, 36.7, 36.8, 36.9, 37.1, 37.2, 37.3, 37.4, 37.5, 37.6, 37.7, 37.8, 37.9, 38.1, 38.2, 38.3, 38.4, 38.5, 38.6, 38.7, 38.8, 38.9, 39.1, 39.2, 39.3, 39.4, 39.5, 39.6, 39.7, 39.8, 39.9, 40.1, 40.2, 40.3, 40.4, 40.5, 40.6, 40.7, 40.8, 40.9, 41.1, 41.2, 41.3, 41.4, 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176.7, 176.8, 176.9, 177.1, 177.2, 177.3, 177.4, 177.5, 177.6, 177.7, 177.8, 177.9, 178.1, 178.2, 178.3, 178.4, 178.5, 178.6, 178.7, 178.8, 178.9, 179.1, 179.2, 179.3, 179.4, 179.5, 179.6, 179.7, 179.8, 179.9, 180.1, 180.2, 180.3, 180.4, 180.5, 180.6, 180.7, 180.8, 180.9, 181.1, 181.2, 181.3, 181.4, 181.5, 181.6, 181.7, 181.8, 181.9, 182.1, 182.2, 182.3, 182.4, 182.5, 182.6, 182.7, 182.8, 182.9, 183.1, 183.2, 183.3, 183.4, 183.5, 183.6, 183.7, 183.8, 183.9, 184.1, 184.2, 184.3, 184.4, 184.5, 184.6, 184.7, 184.8, 184.9, 185.1, 185.2, 185.3, 185.4, 185.5, 185.6, 185.7, 185.8, 185.9, 186.1, 186.2, 186.3, 186.4, 186.5, 186.6, 186.7, 186.8, 186.9, 187.1, 187.2, 187.3, 187.4, 187.5, 187.6, 187.7, 187.8, 187.9, 188.1, 188.2, 188.3, 188.4, 188.5, 188.6, 188.7, 188.8, 188.9, 189.1, 189.2, 189.3, 189.4, 189.5, 189.6, 189.7, 189.8, 189.9, 190.1, 190.2, 190.3, 190.4, 190.5, 190.6, 190.7, 190.8, 190.9, 191.1, 191.2, 191.3, 191.4, 191.5, 191.6, 191.7, 191.8, 191.9, 192.1, 192.2, 192.3, 192.4, 192.5, 192.6, 192.7, 192.8, 192.9, 193.1, 193.2, 193.3, 193.4, 193.5, 193.6, 193.7, 193.8, 193.9, 194.1, 194.2, 194.3, 194.4, 194.5, 194.6, 194.7, 194.8, 194.9, 195.1, 195.2, 195.3, 195.4, 195.5, 195.6, 195.7, 195.8, 195.9, 196.1, 196.2, 196.3, 196.4, 196.5, 196.6, 196.7, 196.8, 196.9, 197.1, 197.2, 197.3, 197.4, 197.5, 197.6, 197.7, 197.8, 197.9, 198.1, 198.2, 198.3, 198.4, 198.5, 198.6, 198.7, 198.8, 198.9, 199.1, 199.2, 199.3, 199.4, 199.5, 199.6, 199.7, 199.8, 199.9, 200.1, 200.2, 200.3, 200.4, 200.5, 200.6, 200.7, 200.8, 200.9, 201.1, 201.2, 201.3, 201.4, 201.5, 201.6, 201.7, 201.8, 201.9, 202.1, 202.2, 202.3, 202.4, 202.5, 202.6, 202.7, 202.8, 202.9, 203.1, 203.2, 203.3, 203.4, 203.5, 203.6, 203.7, 203.8, 203.9, 204.1, 204.2, 204.3, 204.4, 204.5, 204.6, 204.7, 204.8, 204.9, 205.1, 205.2, 205.3, 205.4, 205.5, 205.6, 205.7, 205.8, 205.9, 206.1, 206.2, 206.3, 206.4, 206.5, 206.6, 206.7, 206.8, 206.9, 207.1, 207.2, 207.3, 207.4, 207.5, 207.6, 207.7



A common sight, more and more areas of groundwater contamination.



An underground Storage Tank, a source of pollution. L.U.S.T.



This man is setting an explosive charge to dislodge corrosion and other debris from inside a groundwater well. This is referred to as “hydrofracturing”. Believe it or not, you cannot hear or feel the explosion because it is deep underground. Below is some of the debris that was dislodged from the explosion along with the remains of the explosive charge.



Groundwater Protection Glossary

ABANDONED WELL: Wells that have been or need to be sealed by an approved method.

ACTIVATED CARBON FILTRATION: Can remove organic chemicals that produce off-taste and odor. These compounds are not dangerous to health but can make the water unpleasant to drink. Carbon filtration comes in several forms, from small filters that attach to sink faucets to large tanks that contain removable cartridges. Activated carbon filters require regular maintenance or they can become a health hazard.

AIR GAP SEPARATION: A physical separation space that is present between the discharge vessel and the receiving vessel; for an example, a kitchen faucet.

AIR HAMMER: A pneumatic cylindrical hammering device containing a piston used on air rotary rigs. The air hammer's heavy piston moves up and down by the introduction of compressed air creating a hammering action on the bit.

AIR ENTRAINMENT: The dissolution or inclusion of air bubbles into water.

AIRLIFT: The lifting of water and/or cuttings to the surface by the injection of high pressure bursts of air. Airlift occurs continuously when drilling with air rotary and can be used for well development with a surging technique.

AIR PUMPING: Continuous airlifting to remove water from the well.

AIR ROTARY: A method of rotary well drilling that utilizes compressed air as the primary drilling fluid.

ALTERNATIVE DISINFECTANTS: Disinfectants - other than chlorination (halogens) - used to treat water, e.g. ozone, ultraviolet radiation, chlorine dioxide, and chloramine. There is limited experience and scientific knowledge about the by-products and risks associated with the use of alternatives.

ALGAE: Microscopic plants that are free-living and usually live in water. They occur as single cells floating in water, or as multicellular plants like seaweed or strands of algae that attach to rocks.

ALPHA AND BETA RADIOACTIVITY: Represent two common forms of radioactive decay. Radioactive elements have atomic nuclei so heavy that the nucleus will break apart, or disintegrate, spontaneously. When decay occurs, high-energy particles are released. These high-energy particles are called radioactivity. Although radioactivity from refined radioactive elements can be dangerous, it is rare to find dangerous levels of radioactivity in natural waters. An alpha particle is a doubly-charged helium nucleus comprised of two protons, two neutrons, and no electrons. A beta particle is a high-speed electron. Alpha particles do not penetrate matter easily, and are stopped by a piece of paper. Beta particles are much more penetrating and can pass through a millimeter of lead.

ANNULAR SPACE: The space between the borehole wall and either drill piping or casing within a well.

ANNULUS: See Annular Space.

AMMONIA: A chemical made with Nitrogen and Hydrogen and used with chlorine to disinfect water.

AQUICLUDE: A layer or layers of soils or formations which water cannot pass through (ex - solid bedrock or very stiff clay). The opposite of aquifer.

AQUIFER: A saturated layer or layers of soils or formations which water can pass through and be provided in usable quantities to supply wells or springs (ex – saturated semi consolidated sediment or saturated fractured bedrock.) An underground geologic formation capable of storing significant amounts of water.

AQUIFER PARAMETERS: Referring to such attributes as specific capacity, aquifer storage, transmissivity, hydraulic conductivity, gradient, and water levels. Refers to all of the components of Darcy's Law and related parameters.

ARTESIAN AQUIFER: A confined aquifer in which the pressure head results in a water elevation higher than the land surface.

ARTESIAN WELL: A well constructed within an artesian aquifer. When an artesian well is opened it will flow naturally.

AS NITROGEN: An expression that tells how the concentration of a chemical is expressed mathematically. The chemical formula for the nitrate ion is NO_3 , with a mass of 62. The concentration of nitrate can be expressed either in terms of the nitrate ion or in terms of the principal element, nitrogen. The mass of the nitrogen atom is 14. The ratio of the nitrate ion mass to the nitrogen atom mass is 4.43. Thus a concentration of 10 mg/L nitrate expressed as nitrogen would be equivalent to a concentration of 44.3 mg/L nitrate expressed as nitrate ion. When dealing with nitrate numbers it is very important to know how numeric values are expressed.

AUGER RIG: A drilling rig, which drives a rotating spiral flange to drill into the earth.

BACKFLOW PREVENTION: To stop or prevent the occurrence of, the unnatural act of reversing the normal direction of the flow of liquid, gases, or solid substances back in to the public potable (drinking) water supply. See Cross-connection control.

BACKFLOW: To reverse the natural and normal directional flow of a liquid, gases, or solid substances back in to the public potable (drinking) water supply. This is normally an undesirable effect.

BACKSIPHONAGE: A liquid substance that is carried over a higher point. It is the method by which the liquid substance may be forced by excess pressure over or into a higher point.

BACTERIA: Small, one-celled animals too small to be seen by the naked eye. Bacteria are found everywhere, including on and in the human body. Humans would be unable to live without the bacteria that inhabit the intestines and assist in digesting food. Only a small percentage of bacteria cause disease in normal, healthy humans. Other bacteria can cause infections if they get into a cut or wound. Bacteria are the principal concern in evaluating the microbiological quality of drinking water, because some of the bacteria-caused diseases that can be transmitted by drinking water are potentially life-threatening.

BAILER: A device used to withdrawal water or sediment from a well utilizing a check valve type mechanism.

BARITE: Processed barium sulfate, often used to increase drilling fluid densities in mud rotary.

BENTONITE: High quality clay composed primarily of montmorillonite. Used to thicken drilling mud in mud rotary drilling and used to form seals in well construction or abandonment.

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)
A level of technology based on the best existing control and treatment measures that are economically achievable within the given industrial category or subcategory.

BEST MANAGEMENT PRACTICES (BMPs): Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the U.S. BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPT)
A level of technology represented by the average of the best existing wastewater treatment performance levels within an industrial category or subcategory.

BEST PROFESSIONAL JUDGMENT (BPJ): The method used by a permit writer to develop technology-based limitations on a case-by-case basis using all reasonably available and relevant data.

BIT: The primary cutting edge of a drill string.

BLANK CASING: A section of well casing that is solid.

BLOWDOWN: The discharge of water with high concentrations of accumulated solids from boilers to prevent plugging of the boiler tubes and/or steam lines. In cooling towers, blowdown is discharged to reduce the concentration of dissolved salts in the recirculating cooling water.

BOREHOLE DEVIATION: A boreholes' orientation deviates from vertical while drilling.

BOREHOLE GEOPHYSICS: A surveying technique of utilizing specialized tools to measure various physical parameters of the aquifer, formation, and well.

BOREHOLE: The hole that is formed when drilling into the earth.

BOULDER: An individual rock or solid mass of rock larger than 10 inches in diameter.

BREAK POINT CHLORINATION : The process of chlorinating the water with significant quantities of chlorine to oxidize all contaminants and organic wastes and leave all remaining chlorine as free chlorine.

BRIDGING: The tendency of sediment, filter, or seal media to create an obstruction if installed in too small an annulus or too rapidly. Also can occur within filter packs requiring development.

BROMINE: Chemical disinfectant (HALOGEN) that kills bacteria and algae.

BUCKET AUGER: A single cylindrical type of auger flight consisting of offset cutting blades at the bottom. A bucket auger rig rotates the bucket and its blades cut into the earth and fill the bucket with cuttings, which are dumped on the surface as needed.

BUFFER: Chemical that resists pH change, e.g. sodium bicarbonate

BUTTON BIT: A bit that is constructed with raised (typically carbide) buttons that strengthen the bit and aid in crushing and grinding efficiency. A button bit may be of a roller, hammer, or percussion type.

CABLE TOOL: (Also called Percussion Drilling) A method of drilling which utilizes the consecutive lifting and dropping of a heavy drill string via a system of cables.

CALCIUM HARDNESS: A measure of the calcium salts dissolved in water.

CAPILLARY ACTION: The occurrence of an upward movement of fluid into previously unsaturated soil due to adhesion and surface tension which develops between the fluid and soil particles.

CAPILLARY FRINGE: The uppermost portion of an aquifer where the vadose zone ends. The capillary action of soils permits moisture to extend upwards into the vadose zone within the capillary fringe.

CARBONATE ROCK: Rock that is composed primarily of calcium carbonate.

CASING DRIVER: A percussion or hammering device used to force casing into the subsurface.

CASING: A column of specially designed pipe of metal or plastic material installed in wells in order to keep a borehole open to permit serviceability of and/or construction and completion of a well within it.

CATHEAD: A specially designed auxiliary reel that normally utilizes heavy rope rather than steel cable. Often used on cable tool or percussion drilling rigs for the operation of drive blocks.

CAUSTIC SODA: Also known as sodium hydroxide and is used to raise pH.

CAVERN: Large open spaces (>5ft.) encountered while drilling. More often associated with limestone formations in a karst environment.

CEMENT GROUT: Cement of fine consistency, capable of being pumped. Used to seal in and around wells.

CENTRALIZER: Stand offs attached to well casing and screen to maintain annular space. In drilling, it has the same meaning as stabilizer or drill collar.

CHAIN OF CUSTODY (COC): A record of each person involved in the possession of a sample from the person who collects the sample to the person who analyzes the sample in the laboratory.

CIRCULATION: The continual flow of drilling fluid from injection to recovery and recirculation at the surface.

COBBLES: A rock smaller than a boulder but larger than a pebble. A cobble is greater than 2.5 inches in diameter and smaller than 10 inches in diameter.

COMPLETION (WELL COMPLETION): Refers to the final construction of the well including the installation of pumping equipment.

CONE OF DEPRESSION: That portion of the water table or potentiometric surface that experiences drawdown from a pumped well.

CONFINED AQUIFER: An aquifer that is isolated by confining layers on both its top and bottom. Pressures within a confined aquifer are normally greater than atmospheric pressure resulting in a potentiometric head.

CONFINING LAYER: An extensive layer of soil or formation that resists the movement of water from an aquifer below or above it. Confining layers isolate aquifers thereby confining them. May or may not be an aquiclude. (ex – Clay or silt rich layer)

CONSOLIDATED: Soil, sediment, or formation that is solidified or cemented together as a unit.

CONTAMINATION: A degradation in the quality of groundwater in result of the it's becoming polluted with unnatural or previously non-existent constituents.

CONTINUOUS SLOT SCREEN: A wire wrapped or plastic slotted screen in which the slot openings completely encircle the inner ribs of the screen.

CONVENTIONAL: A standard or common procedure to a group of more complex methods. (ex – Direct Rotary *conventional* vs. Reverse *non-conventional*)

CUTTING HEAD (CUTTER HEAD): The bit portion of auger flighting that serves as the primary cutting edge of the auger.

CUTTING SHOE: A hardened steel sleeve with a wedged or armored cutting edge that is installed on well casing that is to be driven into the earth.

CUTTINGS: Crushed rock, soil, or formation material generated by the drilling action of a bit.

DARCY'S LAW: ($Q=KIA$) A fundamental equation used in the groundwater sciences to determine aquifer characteristics, where Q =Flux, K =Hydraulic Conductivity (Permeability), I = Hydraulic Gradient (change in head), and A = Cross Sectional Area of flow.

DEVELOPMENT: The cleaning of the well and bore once construction is complete.

DIRECT ROTARY: The conventional method of rotary drilling involving the rotation of a drill string and standard use of drilling fluid to penetrate the earth.

DISCHARGE HEAD: See Total Dynamic Head.

DISSOLUTION -- The chemical and physical process of dissolving rock. Typically, limestone or carbonate rocks can be dissolved via the percolation or movement of groundwater that, in its infancy, is slightly acidic. As time goes on, the rock may also be physically worn away by the rapid movement of groundwater through the interconnected open spaces created by the initial chemical dissolving process.

DRAG BIT: A style of drill bit used in rotary drilling when soil or formation conditions are loosely consolidated and are comprised of fine-grained sediments.

DRAWDOWN: The change in water level from static to pumping level.

DRILL COLLAR: A section of the drill string that provides sufficient mass and diameter to maintain vertical borehole alignment and consistent borehole diameter.

DRILL FOAM: Surfactant used in air rotary drilling and well development.

DRILL PIPE: Sections of the drill string that are connected one to another in order to achieve a desired length while also providing a pathway for the circulation of drilling fluid.

DRILL STEM: The complete drill string or, in cable drilling, the equivalent of a drill collar.

DRILL STRING: The complete drilling assembly in rotary drilling including drill pipe, subs, collars, and bit.

DRILLER: A specially trained individual that operates the drilling rig.

DRILLING FLUID: Fluid circulated through the borehole in rotary drilling methods used to lift cuttings to the surface, provide borehole stability, and cool the bit. Drilling Fluid may consist of mud, water, air, foam, or other additives.

DRILLING PERMIT: A certificate of approval to drill and construct a well often required by the state or local regulating authority.

DRILLING PRESSURE: The pressure exerted within the borehole during drilling. The pressure required to circulate drilling fluid to the surface.

DRIVE BLOCK: A heavy collar that attaches over the drill pipe and is dropped successively to advance casing into the earth. Used primarily in cable tool or percussion drilling methods.

DRIVE CLAMP: A fitting that is attached to the top of a drill string or stem serving as a striking surface for driving casing into the earth.

DRIVE UNIT: The portion of a rotary rig that provides the rotation to the drill string. (ex – top drive or table drive unit) Also may be called the drive head.

DRIVING: The installation of a well or casing via forcing of it into the earth by repeated striking.

FAULT: A break in the earth's crust where movement has occurred.

FAULTING: A geological process involving the breaking and displacement of rock or formation through movements within the earth's crust along a fault.

FLIGHTING: The spiral flanged drill pipe used in auger drilling.

FLOATING SUB: A collapsible section of drill pipe shorter than primary drill pipe. Used to provide a cushion between the drive unit and the drill string.

FORMATION: A series of layers, deposits, or bodies of rock, which are geologically similar and related in depositional environment or origin. A formation can be clearly distinguished relative to bounding deposits or formations due to its particular characteristics and composition.

FRACTURE: A discrete break in a rock or formation.

FRACTURED AQUIFER: An aquifer within and otherwise massive block that has been made permeable due to the concentrated presence of fractures typically resultant of faulting or concentrated joints.

GEOTECHNICAL: Characteristics of soil, rock, or formation such as grain size, shear strength, porosity, and compressibility, etc. Of particular concern to a geologist or engineer relative to soil or aquifer characteristics.

GPM: Gallons per minute.

GRAINSIZE: The dimension of particle classifications such as gravel, sand, silt, and clay. Often based on the unified soil classification system.

Unified Soil Classification System (USCS)			
	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL:			
COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND:			
COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40
FINE	.43 - .08	.02 - .003	No. 40 - No. 200
FINES:			
SILTS	< .08	< .003	< No. 200
CLAYS	< .08	< .003	< No. 200

GROUNDWATER: Water that percolates through and exists within saturated portions of the earth's crust and is replenished by the hydrologic cycle.

GROUT: A type of cement that is normally fine grained and used to effectively construct well seals and used in well abandonment. Grout may also be used to stabilize otherwise unstable boreholes, permitting continued drilling.

HAMMER BIT: The bit driven by the hammer to cut into rock or formation.

HAMMER: See Air Hammer

HARD ROCK: Consolidated formation or solid rock.

HARDNESS: A measure of the amount of calcium and magnesium salts in water. More calcium and magnesium lead to greater hardness. The term "hardness" comes from the fact that it is hard to get soap suds from soap or detergents in hard water. This happens because calcium and magnesium react strongly with negatively-charged chemicals like soap to form insoluble compounds.

HETEROTROPHIC PLATE COUNT: A test performed on drinking water to determine the total number of all types of bacteria in the water.

HOLLOW STEM (AUGER): An auger form of drilling in which the flighting is hollow.

HOLLOW STEM FLIGHT: The hollow spiral flanged drill pipe used on hollow stem auger rigs.

HYDRAULIC CONDUCTIVITY: A primary factor in Darcy's Law, the measure of a soil or formation's ability to transmit water, measured in gallons per day (gpd) See also Permeability and Darcy's Law.

HYDROLOGIC CYCLE: (Water Cycle) The continual process of precipitation (rain and snowfall), evaporation (primarily from the oceans), percolation (recharge to groundwater), runoff (surface water), and transpiration (plants) constituting the renew ability and recycling of each component.

IMPELLERS: The semi-open or closed props or blades of a turbine pump that when rotated generate the pumping force.

IN SERIES: Several components being connected one to the other without a bypass, requiring each component to work dependent on the one before it.

INFILTRATION: The percolation of fluid into soil or formation. See also percolation.

INFLATABLE PACKER: A rubber or fiber bladder device that is inflated to seal against either casing or borehole walls.

INORGANIC IONS: Present in all waters. Inorganic ions are essential for human health in small quantities, but in larger quantities they can cause unpleasant taste and odor or even illness. Most community water systems will commonly test for the concentrations of seven inorganic ions: nitrate, nitrite, fluoride, phosphate, sulfate, chloride, and bromide. Nitrate and nitrite can cause an illness in infants called methemoglobinemia. Fluoride is actually added to the drinking water in some public water systems to promote dental health. Phosphate, sulfate, chloride, and

bromide have little direct effect on health, but high concentrations of inorganic ions can give water a salty or briny taste.

JARS (DRILLING JARS): Metal sections of a drill string that when released provide a jarring force or action to aid in removing drill string. Used primarily in cable tool or percussion drilling methods.

JETTING: The process of injecting high velocity streams of water and/or air through a system of nozzles or jets into the well screen and filter pack for well development.

KARST TOPOGRAPHY: The visual presence of karst on the surface.

KARST: The presence of caverns, voids, sink holes as characteristic features of a weathered limestone or other carbonate formation on or beneath the surface.

KELLY: A multi-faceted section of drill pipe driven by a kelly drive (table or top drive).

LINE SHAFT TURBINE: See vertical turbine.

LOGGED (LOGGING): The assessment and documentation of geological and water production data obtained while drilling progresses or following drilling through the use of borehole geophysical logging tools.

mg/L: Stands for "milligrams per liter." This is a common unit of chemical concentration. It expresses the mass of a chemical that is present in a given volume of water. A milligram (one one-thousandth of a gram) is equivalent to about 18 grains of table salt. A liter is equivalent to about one quart.

MICROORGANISMS: Very small animals and plants that are too small to be seen by the naked eye and must be observed using a microscope. Microorganisms in water include algae, bacteria, viruses, and protozoa. Algae growing in surface waters can cause off-taste and odor by producing the chemicals MIB and geosmin. Certain types of bacteria, viruses, and protozoa can cause disease in humans. Bacteria are the most common microorganisms found in treated drinking water. The great majority of bacteria are not harmful. In fact, humans would not be able to live without the bacteria that inhabit the intestines. However, certain types of bacteria called coliform bacteria can signal the presence of possible drinking water contamination.

MILLILITER: One one-thousandth of a liter. A liter is a little more than a quart. A milliliter is about two drops from an eye dropper.

MUD CAKE: A film of mud drilling fluid that builds up on borehole walls adding to borehole stability and limits the groundwater's ability to enter the borehole while drilling.

MUD CAKING: The process of building up the mud cake.

MUD ENGINEER: A specially trained individual who's responsible for maintaining proper drilling fluid densities and viscosity.

MUD PIT: Single or multiple subsurface or surface containment system used for settling cuttings out of drilling fluid and for recirculation of drilling fluid.

MUD PUMP: A specially designed pump that can pass particles of mud and cuttings (drilling fluid) at variable pressures, serving as the primary component in a mud rotary drilling system (similar to a grout or cement pump).

MUD ROTARY: The method of rotary drilling with mud circulation as the drilling fluid.

NATURAL GRAVEL PACK (NATURALLY PACKED): Refers to a well that has no gravel pack installed but is simply allowed to develop a filter pack composed of the aquifer particles itself. Usually coarse grained and hard rock aquifers are naturally packed.

OIL TUBE: A tubular enclosure that houses the line shaft and bearings of a vertical turbine pump. Oil is allowed to pass through the oil tube in order to lubricate the pumps drive shaft and bearings.

OVERBURDEN: Normally a thin loosely consolidated or unconsolidated sediment overlying competent formation.

PATHOGENS: Disease-causing pathogens; waterborne pathogens A pathogen may contaminate water and cause waterborne disease.

pCi/L: Picocuries per liter A curie is the amount of radiation released by a set amount of a certain compound. A picocurie is one quadrillionth of a curie.

PIPELINE APPURTENANCE: Pressure reducers, bends, valves, regulators (which are a type of valve), etc.

PERCHED WATER TABLE: Normally small areas where percolating groundwater is caused to rest above the primary water table and within the vadose zone, caused by a localized presence of a relatively impermeable layer of sediment.

PERCOLATION: The process of fluid penetrating or slowly flowing through soil, rock, or formation. See also infiltration.

PERCUSSION RIG: See Cable Tool

PERFORATED SCREEN: Well screen that has openings mechanically cut into it.

PERFORMANCE CURVE: A graphical representation of a pumps efficiency relative to gpm and feet of head.

PERMEABILITY: A measure of a soil or formation's capacity to transmit water, typically in volume per time units. Equivalent to Darcy's hydraulic conductivity.

PERMEABLE: Soil or formation of which water can pass through.

pH : A measure of the acidity of water. The pH scale runs from 0 to 14 with 7 being the mid point or neutral.. A pH of less than 7 is on the acid side of the scale with 0 as the point of greatest acid activity. A pH of more than 7 is on the basic (alkaline) side of the scale with 14 as the point of greatest basic activity. pH (**Power of Hydroxyl Ion Activity**).

pH OF SATURATION: The ideal pH for perfect water balance in relation to a particular total alkalinity level and a particular calcium hardness level, at a particular temperature. The pH where the Langelier Index equals zero.

PHENOL RED: Chemical reagent used for testing pH in the range of 6.8 - 8.4.

PICOCURIE: A unit of radioactivity. "Pico" is a metric prefix that means one one-millionth of one one-millionth. A picocurie is one one-millionth of one one-millionth of a Curie. A Curie is that quantity of any radioactive substance that undergoes 37 billion nuclear disintegrations per second. Thus a picocurie is that quantity of any radioactive substance that undergoes 0.037 nuclear disintegrations per second.

PIEZOMETRIC SURFACE: See potentiometric surface.

PILOT BIT: A bit used on auger rigs to cut a pilot hole ahead of the cutter head when drilling into more resistant formations.

PITLESS ADAPTER: A fitting installed on a section of column pipe and well casing permitting piping from the well to be installed below grade. (Often requires a special permit for construction)

PLATFORM: The portion of the drilling rig where a driller and crew operate the drill rig.

PLUG: A removable cap installed behind the pilot and cutter bits on hollow stem auger flighting.

PLUNGER: See Surge-block.

POLLUTION: To make something unclean or impure. See Contaminated.

PORE SPACE: The interstitial space between sediments and fractures that is capable of storing and transmitting water.

POROSITY: A factor representing a rock, soil, or formations percentage of open space available for the percolation and storage of groundwater.

POTABLE: Good water which is safe for drinking or cooking purposes. Non-Potable: A liquid or water that is not approved for drinking.

POTENTIOMETRIC SURFACE: An imaginary surface representing the height a column of water will reach at any location within a confined aquifer. The measured surface of a confined aquifer related to the aquifer's pressure head.

PRESSURE HEAD: The height of a column of water capable of being maintained by pressure. See also Total Head, Total Dynamic Head.

PRODUCING ZONE: A specific productive interval.

PRODUCTIVE INTERVAL: The portion or portions of an aquifer in which significant water production is obtained within the well.

PROTOZOA: Microscopic animals that occur as single cells. Some protozoa can cause disease in humans. Protozoa form cysts, which are specialized cells like eggs that are very resistant to chlorine. Cysts can survive the disinfection process, then "hatch" into normal cells that can

cause disease. Protozoa must be removed from drinking water by filtration, because they cannot be effectively killed by chlorine.

PUMP SURGING: A process of well development whereby water is pumped nearly to the surface and then is allowed to fall back into the well. The process creates a backwashing action that cleans the well and nearby formation.

PUMPING LIFT: The height to which water must be pumped or lifted to, feet of head.

RADIOCHEMICALS: (Or radioactive chemicals) Occur in natural waters. Naturally radioactive ores are particularly common in the Southwestern United States, and some streams and wells can have dangerously high levels of radioactivity. Total alpha and beta radioactivity and isotopes of radium and strontium are the major tests performed for radiochemicals. The federal drinking water standard for gross alpha radioactivity is set at 5 picocuries per liter.

RADIUS OF INFLUENCE: The distance away from a pumping well that water levels are affected by a well's cone of depression.

RAWHIDING: See Pump Surging.

REAM: The process of enlarging a borehole.

REAMER BIT: A special bit designed to ream existing boreholes.

RECHARGE: The infiltration component of the hydrologic cycle. Often used in the context of referring to: The infiltration of water back into an aquifer, resulting in the restoration of lost storage and water levels which had been decreased due to pumping and/or natural discharges from the aquifer.

RECIRCULATING SYSTEM: A system of constructed or surface mud pits that settle out cuttings from drilling fluid to be circulated back down the borehole.

REVERSE MUD ROTARY: A non-conventional drilling method in which drilling fluid is injected through the borehole annulus downward through the bit and circulated back to the surface through the drill string.

REVERSE OSMOSIS: Forces water through membranes that contain holes so small that even salts cannot pass through. Reverse osmosis removes microorganisms, organic chemicals, and inorganic chemicals, producing very pure water. For some people, drinking highly purified water exclusively can upset the natural balance of salts in the body. Reverse osmosis units require regular maintenance or they can become a health hazard.

RIBBED STABILIZER: A stabilizer or drill collar that has cutting ribs attached to its side. Ribs are normally installed in vertical or spiral arrangements.

ROLLER BIT: A rotary drill bit having rotating cutting heads.

ROTARY RIG: A conventional rotary drill rig. Can be either an air or mud rotary rig.

SAMPLING LOCATION: A location where soil or cuttings samples may be readily and accurately collected.

SATURATED ZONE: Where an unconfined aquifer becomes saturated beneath the capillary fringe.

SEAL: For wells: to abandon a well by filling up the well with approved seal material including cementing with grout from a required depth to the land surface.

SEDIMENT: Grains of soil, sand, gravel, or rock deposited by and generated by water movement.

SHAKER: A device used in mud containment systems that vibrates various sized screens as drilling fluid passes through it, thereby separating cuttings from drilling fluid and providing a good sampling location.

SHROUD: A baffle or piece of pipe installed over a pump to force water to pass the pumps motor.

SIEVE ANALYSIS: The process of sifting soil or formation samples through a series of screens to determine percentages of particle sizes.

SLURRY: A mixture of crushed rock and water.

SODA ASH: Chemical used to raise pH and total alkalinity (sodium carbonate)

SODIUM BICARBONATE: Commonly used to increase alkalinity of water and stabilize pH.

SODIUM BISULFATE: Chemical used to lower pH and total alkalinity (dry acid).

SODIUM HYDROXIDE: Also known as caustic soda, a by-product chlorine generation and often used to raise pH.

SOIL MOISTURE: A relative consideration of the degree to which a soil is saturated.

SOLDER: A fusible alloy used to join metallic parts.

SOLID STEM (AUGER): An auger that is constructed of solid stem drill flights.

SPECIFIC CAPACITY (Sc): A measure of a well's pumping performance in gallons per minute per foot of drawdown.

SPIDER: A bearing or flange used in vertical turbine pumps to stabilize the drive shaft or shaft tube and seal column joints.

SPIRAL FLANGE: A continuous blade that wraps spirally around auger flighting.

SPLIT SPOON: A sampling device that is driven into the earth and operated by a wire line for the retrieval of soil or formation samples.

STABLE: Reference to formation, soil, or sediments of sufficient strength to remain in place under its own weight and existing pressures.

STABILIZE: Actions taken to enhance borehole stability or vertical rotational when drilling.

STABILIZER: The portion of a drill string used to stabilize rotation.

STRATIFIED: Layered.

SUB: A small section of drill pipe used to connect larger sections.

SUBMERSIBLE PUMP: A turbine pump that has the motor attached directly to it and therefore is operated while submerged.

SURFACE SEAL: The upper portion of a wells construction where surface contaminants are adequately prevented from entering the well, normally consisting of surface casing and neat cement grout.

SURFACTANT: A primary component in detergents and soaps used to make foam drilling fluid in air rotary methods.

SURGE-BLOCK: A disc shaped device that fits tightly into a well and is moved up and down to agitate the water column in order to develop a well.

SURGING: The process of purging a well rapidly for well development.

SWAB: See Surge-block.

SWING ARM: A large moveable arm on a bucket auger rig that pulls the bucket auger out away from the drilling rig for dumping.

TABLE DRIVE: A drilling rig that uses a rotating table within the platform to turn a kelly driven drill string.

TABLE: The back portion of a drill rig where the drill pipe is inserted (or driven if a table drive), adjacent to or within the driller's platform.

TARGET DEPTH: The proposed construction depth of a well prior to drilling.

TCE, trichloroethylene: A solvent and degreaser used for many purposes; for example dry cleaning, it is a common groundwater contaminant.

TELESCOPING KELLY: A kelly with successively smaller sized pipe within itself that drops out as a borehole is drilled. This permits that drilling may proceed without adding drill pipe. Normally found on bucket auger rigs.

TELESCOPING: The successive decrease in borehole size with depth.

TITRATION: A method of testing by adding a reagent of known strength to a water sample until a specific color change indicates the completion of the reaction.

TOP DRIVE: A rotary type drill head that moves freely up and down the rigs mast while driving the drill string.

TOTAL ALKALINITY: A measure of the acid-neutralizing capacity of water which indicates its buffering ability, i.e. measure of its resistance to a change in pH. Generally, the higher the total alkalinity, the greater the resistance to pH change.

TOTAL DISSOLVED SOLIDS (TDS) The accumulated total of all solids that might be dissolved in water.

TOTAL DYNAMIC HEAD: The pressure (psi) or equivalent feet of water, required for a pump to lift water to its point of storage overcoming elevation head, friction loss, line pressure, drawdown and pumping lift.

TREATED WATER: Disinfected and/or filtered water served to water system customers. It must meet or surpass all drinking water standards to be considered safe to drink.

TRIHALOMETHANES (THM): Four separate compounds including chloroform, dichlorobromomethane, dibromochloromethane, and bromoform. The most common class of disinfection by-products created when chemical disinfectants react with organic matter in water during the disinfection process. See Disinfectant Byproducts.

TRICONE BIT: A roller bit with three independent rolling bits with teeth or buttons that intermesh for efficient rock crushing and cutting.

TURBIDITY: A measure of the cloudiness of water caused by suspended particles.

TURBINE PUMP: A pump that utilizes rotating impellers on a shaft that generate centrifugal force for pumping water.

UNCONFINED AQUIFER: An aquifer that exists under atmospheric pressure and is not confined.

UNCONSOLIDATED: Sediment that is not cemented or is loosely arranged.

UNDER-REAM: The process of reaming, from within the borehole, a section of an existing smaller borehole area.

UNSATURATED ZONE: That portion of the subsurface, including the capillary fringe that is not saturated but may contain water in both vapor and liquid form. See also Vadose Zone.

UNSTABLE: Sediment or other material that cannot exist without rapidly decomposing or collapsing in on itself. (ex. unconsolidated sediment)

VADOSE ZONE: A portion of the subsurface above the water table that is not saturated but contains water in both vapor and liquid form. The portion of the subsurface where water percolates through to the saturated zone. See also Unsaturated Zone.

VARIABLE DISPLACEMENT PUMP: A pump that will produce different volumes of water dependent on the pressure head against it.

VERTICAL TURBINE: A type of variable displacement pump in which the motor or drive head is mounted on the wellhead and rotates a drive shaft connected to the pump impellers.

VOID: An opening, gap, or space within rock or sedimentary formations formed at the time of origin or deposition.

VORTEX: The helical swirling of water moving towards a pump.

VIRUSES: Are very small disease-causing microorganisms that are too small to be seen even with microscopes. Viruses cannot multiply or produce disease outside of a living cell.

VOLATILE ORGANIC COMPOUNDS: (VOCs) Solvents used as degreasers or cleaning agents. Improper disposal of VOCs can lead to contamination of natural waters. VOCs tend to evaporate very easily. This characteristic gives VOCs very distinct chemical odors like gasoline, kerosene, lighter fluid, or dry cleaning fluid. Some VOCs are suspected cancer-causing agents.

WASHOUT: The rapid erosion of aquifer material from the borehole walls while a well is being drilled, which often results in a loss of circulation.

WATER COURSE: An opening within a cable tool drill string that allows fluid to flow in and out of the drill string thereby minimizing friction loss to the slurry.

WATER TABLE: The measured water level surface of an unconfined aquifer.

WATER QUALITY CRITERIA: Comprised of both numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or States for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

WATER QUALITY STANDARD: A statute or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, and an antidegradation statement.

WEATHERED: The existence of rock or formation in a chemically or physically broken down or decomposed state. Weathered material is in an unstable state.

WELL ABANDONMENT: The process of sealing a well by approved means. The filling of a well to the surface with cement grout.

WELL HEAD: The upper portion of the well that is constructed on the land surface, including the well manifold. Also a term used to refer to the area near the well that is subject to wellhead protection.

WELL HEAD PROTECTION: Programs designed to maintain the quality of groundwater used as public drinking water sources, by managing the land uses around the well field. A government program that encourages the limitation and elimination of activities, near and within a wells recharge area, which present a potential risk to the wells water supply.

WELL MANIFOLD: The piping, valves, and metering equipment used to connect the well to the distribution system, installed on the wellhead.

WELL SCREEN: A section of well casing that contains openings which permit water to enter the well but limit or prevent sediment from entering the well while pumping.

WELL SEAL: The watertight cap or seal installed within and between the well casing and pumping equipment. The metal or plastic plug or seal, which the pumping column rests on the top of casing.

WHOLE EFFLUENT TOXICITY: The total toxic effect of an effluent measured directly with a toxicity test.

YIELD: The volume of water measured in flow rates that are produced from the well.

ZONE OF AERATION: See Saturated Zone or Vadose Zone

ZONE OF SATURATION: See Saturated Zone



References

Benenson, Abram S., editor. 1990. *Control of Communicable Diseases in Man*. 15th ed. Baltimore:Victor Graphics, Inc.

Foster, Laurence, M.D. 1985. "Waterborne Disease - It's Our Job to Prevent It". PIPELINE newsletter, Oregon Health Division, Drinking Water Program, Portland, Oregon 1(4): 1-3.

Foster, Laurence, M.D. 1990. "Waterborne Disease," *Methods for the Investigation and Prevention of Waterborne Disease Outbreaks*. Ed. Gunther F.Craun. Cincinnati: U.S. Environmental Protection Agency.

Groundwater Protection CEU Training Course Assignment

All of the groundwater protection questions will come from the Environmental Protection Agency's Citizen's Guide to Groundwater Protection. You will need a copy of this booklet in order to successfully complete this course. The booklet is in the front of this manual, the answer key is in the rear.

If you should need any assistance, please go to TLC's Assignment Page and go to the Assistance Page, e-mail or fax all concerns and the final test to info@tlch2o.com.

You are expected to circle the correct answer on the enclosed answer key. Please include your name and address on your exam. Answer key and Registration form are in the rear of this section.

CHAPTER I. Introduction

1. Actually ground water occurs as part of what can be called the oldest recycling program - the _____.
 - A. Ground water
 - B. Hydrologic cycle
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
2. The _____ involves the continual movement of water between the earth and the atmosphere through evaporation and precipitation.
 - A. Ground water
 - B. Hydrologic cycle
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
3. 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 _____.
 - A. Ground water
 - B. Hydrologic cycle
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
4. The rest of the water soaks through the ground's surface and moves downward through the _____, where the open spaces in rocks and soil are filled with a mixture of air and water, until it reaches the water table.
 - A. Ground water
 - B. Hydrologic cycle
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above

Answer key and Registration form are in the rear of this section.

5. The water table is the top of the _____, or the area in which all interconnected spaces in rocks and soil are filled with water.
- A. Ground water
 - B. Hydrologic cycle
 - C. Saturated zone
 - D. Water table
 - E. None of the Above
6. The water in the saturated zone is called _____.
- A. Ground water
 - B. Saturated zone
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
7. In areas where the _____ 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.
- A. Ground water
 - B. Saturated zone
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
8. Ground water is stored under many types of _____.
- A. Geologic conditions
 - B. Hydrologic cycle
 - C. Unsaturated zone
 - D. Water table
 - E. None of the Above
9. Areas where ground water exists in sufficient quantities to supply wells or springs are called aquifers, a term that literally means "_____."
- A. Water bearer
 - B. Confined aquifer
 - C. Permeability
 - D. Aquifer's
 - E. None of the Above
10. _____ store water in the spaces between particles of sand, gravel, soil, and rock as well as cracks, pores, and channels in relatively solid rocks.
- A. Karst aquifers
 - B. Confined aquifer
 - C. Permeability
 - D. Aquifers
 - E. None of the Above

11. An _____ is controlled largely by its porosity, or the relative amount of open space present to hold water.
- A. Karst aquifers
 - B. Confined aquifer
 - C. Permeability
 - D. Aquifer's storage capacity
12. An aquifer's ability to transmit water, or _____, is based in part on the size of these spaces and the extent to which they are connected.
- A. Karst aquifers
 - B. Confined aquifer
 - C. Permeability
 - D. Aquifer's
 - E. None of the Above
13. There are two kinds of aquifers: _____ and unconfined.
- A. Karst aquifers
 - B. Confined
 - C. Permeability
 - D. Aquifers
 - E. None of the Above
14. If the aquifer is sandwiched between layers of relatively impermeable materials (e.g., clay), it is called a _____.
- A. Karst aquifers
 - B. Confined aquifer
 - C. Permeability
 - D. Aquifer's
 - E. None of the Above
15. Confined aquifers are frequently found at greater depths than _____. 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.
- A. Karst aquifers
 - B. Unconfined aquifers
 - C. Permeability
 - D. Aquifer's
 - E. None of the Above
16. Ground water can move sideways as well as up or down. This movement is in response to _____, differences in elevation, and differences in pressure.
- A. Karst aquifers
 - B. Confined aquifer
 - C. Permeability
 - D. Gravity
 - E. None of the Above

17. 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 _____.

- A. Karst aquifers
- B. Confined aquifer
- C. Permeable zones
- D. Aquifer's
- E. None of the Above

18. Ground water can move even more rapidly in _____, 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.

- A. Karst aquifers
- B. Confined aquifer
- C. Permeability
- D. Aquifer's
- E. None of the Above

19. According to the U.S. Geological Survey, _____ use increased from about 35 billion gallons a day in 1950 to about 87 billion gallons a day in 1980.

- A. Ground-water
- B. Confined aquifer
- C. Permeability
- D. Aquifer's
- E. None of the Above

20. Approximately one-half of all fresh water used in the nation comes from _____.

- A. Karst aquifers
- B. Confined aquifer
- C. Ground water
- D. Aquifer's
- E. None of the Above

21. Whether fresh water arrives via a _____ 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.

- A. Public water supply system
- B. Confined aquifer
- C. Ground water
- D. Aquifer's
- E. None of the Above

CHAPTER II. Ground-Water Quality

Until the 1970s, ground water was believed to be naturally protected from contamination.

22. The _____ and larger rocks were thought to act as filters, trapping contaminants before they could reach the ground water.

- A. Substances
- B. Layers of soil and particles of sand, gravel, crushed rocks
- C. Water table
- D. Ground-water

23. Since then, however, every state in the nation has reported cases of contaminated ground water, with some instances receiving _____.
- A. Widespread publicity
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
24. We now know that some _____ can pass through all of these filtering layers into the saturated zone to contaminate ground water.
- A. Substances
 - B. Contaminants
 - C. Water table
 - D. Ground-water
 - E. None of the Above
25. Between 1971 and 1985, 245 ground-water related disease outbreaks, with 52,181 associated illnesses, were reported. Most of these diseases were _____.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
26. About 10 percent of all ground-water public water supply systems are in violation of drinking water standards for _____. In addition, approximately 74 pesticides, a number of which are known carcinogens, have been detected in the ground water of 38 states.
- A. Substances
 - B. Contaminant
 - C. Biological contamination
 - D. Ground-water
 - E. None of the Above
27. Although various estimates have been made about the extent of _____ contamination, these estimates are difficult to verify given the nature of the resource and the difficulty of monitoring its quality.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
28. _____ contamination can originate on the surface of the ground, in the ground above the water table, or in the ground below the water table.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above

29. Where a contaminant _____ is a factor that can affect its actual impact on ground-water quality.
- A. Substances
 - B. Contaminant
 - C. Originates
 - D. Ground-water
 - E. None of the Above
30. If a contaminant is spilled on the surface of the ground or _____ 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.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
31. 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 _____ once it finally reaches the ground water.
- A. Substances
 - B. Contaminant
 - C. Eventual impact of the substance
 - D. Ground-water
 - E. None of the Above
32. The effectiveness of these processes also is affected by both the _____ the ground water and where the contaminant is introduced and the amount of time it takes the substance to reach the ground water.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
33. If the _____ 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.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
34. In comparison with rivers or streams, _____ tends to move very slowly and with very little turbulence.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above

35. Once the contaminant reaches the ground water, _____ normally occurs.
- A. Substances
 - B. Contaminant
 - C. Little dilution or dispersion
 - D. Ground-water
 - E. None of the Above
36. Instead, the contaminant forms a _____ that can flow along the same path as the ground water.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Concentrated plume
 - E. None of the Above
37. Among the factors that determine the size, form, and rate of movement of the _____ plume are the amount and type of contaminant and the speed of ground-water movement.
- A. Substances
 - B. Contaminant
 - C. Water table
 - D. Ground-water
 - E. None of the Above
38. Because ground water is hidden from view, _____ can go undetected for years until the supply is tapped for use.
- A. Substances
 - B. Contamination
 - C. Water table
 - D. Ground-water
 - E. None of the Above
39. Substances that can _____ can be divided into two basic categories: substances that occur naturally and substances produced or introduced by man's activities.
- A. Surface impoundments
 - B. e.g., solvents, pesticides, petroleum products
 - C. Contaminate ground water
 - D. Septic systems
 - E. None of the Above
40. _____ that occur naturally include minerals such as iron, calcium, and selenium.
- A. Surface impoundments
 - B. e.g., solvents, pesticides, petroleum products
 - C. Ground-water contamination
 - D. Septic systems
 - E. None of the Above

41. Substances resulting from man's activities include synthetic organic chemicals and hydrocarbons _____; 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. Surface impoundments
- B. e.g., solvents, pesticides, petroleum products
- C. Ground-water contamination
- D. Septic systems
- E. None of the Above

42. A significant number of today's _____ problems stem from man's activities and can be introduced into ground water from a variety of sources.

- A. Surface impoundments
- B. e.g., solvents, pesticides, petroleum products
- C. Ground-water contamination
- D. Septic systems
- E. None of the Above

43. A major cause of ground-water contamination in many areas of the United States is _____, or outflow, from septic tanks, cesspools, and privies.

- A. Surface impoundments
- B. e.g., solvents, pesticides, petroleum products
- C. Ground-water contamination
- D. Septic systems
- E. None of the Above

44. Approximately one fourth of all homes in the United States rely on _____ to dispose of their human wastes.

- A. Surface impoundments
- B. e.g., solvents, pesticides, petroleum products
- C. Ground-water contamination
- D. Septic systems
- E. None of the Above

45. If these systems are improperly sited, designed, constructed, or maintained, they can allow _____ of the ground water by bacteria, nitrates, viruses, synthetic detergents, household chemicals, and chlorides.

- A. Surface impoundments
- B. e.g., solvents, pesticides, petroleum products
- C. Contamination
- D. Septic systems
- E. None of the Above

46. Each system can make an _____ to ground-water contamination, the sheer number of such systems and their widespread use in every area that does not have a public sewage treatment system makes them serious contamination sources.

- A. Surface impoundments
- B. Insignificant contribution
- C. Ground-water contamination
- D. Septic systems
- E. None of the Above

47. Another potentially significant source of ground-water contamination is the more than 180,000 _____ (e.g., ponds, lagoons) used by municipalities, industries, and businesses to store, treat, and dispose of a variety of liquid wastes and wastewater.
- A. Surface impoundments
 - B. e.g., solvents, pesticides, petroleum products
 - C. Ground-water contamination
 - D. Septic systems
 - E. None of the Above
48. Although these _____ are supposed to be sealed with compacted clay soils or plastic liners, leaks can and do develop.
- A. Impoundments
 - B. e.g., solvents, pesticides, petroleum products
 - C. Ground-water contamination
 - D. Septic systems
 - E. None of the Above
49. 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 _____.
- A. Leachate collection systems
 - B. Disposal of livestock wastes
 - C. Apply to their lawns, rosebushes, tomato plants, and other garden plants
 - D. 500 hazardous waste land disposal facilities
 - E. None of the Above
50. Homeowners, too, can contribute to this type of ground-water pollution with the chemicals they _____.
- A. Leachate collection systems
 - B. Disposal of livestock wastes
 - C. Apply to their lawns, rosebushes, tomato plants, and other garden plants
 - D. 500 hazardous waste land disposal facilities
 - E. None of the Above
51. There are approximately _____ and more than 16,000 municipal and other landfills nationwide.
- A. Leachate collection systems
 - B. Disposal of livestock wastes
 - C. Apply to their lawns, rosebushes, tomato plants, and other garden plants
 - D. 500 hazardous waste land disposal facilities
 - E. None of the Above
52. To protect ground water, these facilities are now required to be constructed with clay or synthetic liners and _____.
- A. Leachate collection systems
 - B. Disposal of livestock wastes
 - C. Apply to their lawns, rosebushes, tomato plants, and other garden plants
 - D. 500 hazardous waste land disposal facilities
 - E. None of the Above

53. Unfortunately, these requirements are comparatively recent, and thousands of landfills were built, _____without such safeguards.

- A. Leachate collection systems
- B. Disposal of livestock wastes
- C. Operated, and abandoned in the past
- D. 500 hazardous waste land disposal facilities
- E. None of the Above

54. 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 _____.

- A. Leachate collection systems
- B. Disposal of livestock wastes
- C. Serious ground-water contamination problems
- D. 500 hazardous waste land disposal facilities
- E. None of the Above

55. In addition, a lack of information about the location of many of these sites makes it difficult, if not impossible, _____how many others may now be contaminating ground water.

- A. Can cost
- B. Exposure to
- C. To determine
- D. Also can result
- E. None of the Above

56. Between five and six million underground storage tanks are used _____a variety of materials, including gasoline, fuel oil, and numerous chemicals.

- A. Can cost
- B. Exposure to
- C. To store
- D. Also can result
- E. None of the Above

57. The average life span of these tanks is 18 years, and over time, _____the elements causes them to corrode.

- A. Can cost
- B. Exposure to
- C. To determine
- D. Also can result
- E. None of the Above

58. Hundreds of thousands of these tanks are estimated to be leaking, and many are contaminating ground water. _____for these tanks are estimated at \$1 per gallon of storage capacity; a cleanup operation can cost considerably more.

- A. Can cost
- B. Exposure to
- C. To determine
- D. Also can result
- E. None of the Above

59. Wells can be another source of ground-water contamination. In the years before there were community water supply systems, most people relied on wells _____ their drinking water.

- A. Can cost
- B. Exposure to
- C. To provide
- D. Also can result
- E. None of the Above

60. In rural areas this _____ 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.

- A. Can still be
- B. Exposure to
- C. To determine
- D. Also can result
- E. None of the Above

61. Accidents _____ in ground-water contamination. A large volume of toxic materials is transported throughout the country by truck, train, and airplane.

- A. If not handled properly
- B. Also can result in
- C. Will be to flush the area
- D. Allowing it to work its way
- E. None of the Above

62. Every day accidental chemical or petroleum product spills occur that, if not handled properly, _____ ground-water contamination.

- A. If not handled properly
- B. Can result in
- C. Will be to flush the area
- D. Allowing it to work its way
- E. None of the Above

63. Frequently, the automatic reaction of the first people at the scene of an accident involving a spill _____ with water to dilute the chemical.

- A. If not handled properly
- B. Also can result in
- C. Will be to flush the area
- D. Allowing it to work its way
- E. None of the Above

64. This just washes the chemical into the soil around the accident site, _____ 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.

- A. If not handled properly
- B. Also can result in
- C. Will be to flush the area
- D. Allowing it to work its way
- E. None of the Above

65. A similar flushing mechanism also applies to the salt _____ de-ice roads and highways throughout the country every winter.

- A. If not handled properly
- B. That is used to
- C. Will be to flush the area
- D. Allowing it to work its way
- E. None of the Above

66. 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 _____ down to the ground water.

- A. If not handled properly
- B. Also can result in
- C. It can work its way
- D. Allowing it to work its way
- E. None of the Above

67. Salt also can find its way into ground water _____

- A. Itself is hidden from view.
- B. And sometimes impossible process.
- C. Or drill new wells in another aquifer if one is located nearby.
- D. Contamination of their ground-water supplies.
- E. None of the Above

68. Unlike rivers, lakes, and streams that are readily visible and whose contamination frequently can be seen with the naked eye, ground water _____

- A. Itself is hidden from view.
- B. And sometimes impossible process.
- C. Or drill new wells in another aquifer if one is located nearby.
- D. Contamination of their ground-water supplies.
- E. None of the Above

69. Its contamination occurs gradually and generally is not detected until the problem has already become extensive. This makes cleaning up contamination a complicated, costly, _____

- A. Itself is hidden from view.
- B. And sometimes impossible process.
- C. Or drill new wells in another aquifer if one is located nearby.
- D. Contamination of their ground-water supplies.
- E. None of the Above

70. 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 _____

- A. Itself is hidden from view.
- B. And sometimes impossible process.
- C. Or drill new wells in another aquifer if one is located nearby.
- D. Contamination of their ground-water supplies.
- E. None of the Above

71. 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, _____
- A. Itself is hidden from view.
 - B. And sometimes impossible process.
 - C. Or drill new wells in another aquifer if one is located nearby.
 - D. Contamination of their ground-water supplies.
 - E. None of the Above

CHAPTER III. Government Ground-Water Protection Activities

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 following.

72. The _____, 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).

- A. Safe Drinking Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act
- E. Toxic Substances Control Act

73. The _____, 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.

- A. Safe Drinking Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act
- E. Toxic Substances Control Act

74. The _____, 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).

- A. Clean Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act
- E. Toxic Substances Control Act

75. The _____, which authorizes EPA to control the availability of pesticides that have the ability to leach into ground water.

- A. Safe Drinking Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act

76. The _____ which authorizes EPA to control the manufacture, use, storage, distribution, or disposal of toxic chemicals that have the potential to leach into ground water.

- A. Safe Drinking Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act
- E. Toxic Substances Control Act

77. The _____, 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.

- A. Clean Water Act
- B. Federal Insecticide, Fungicide, and Rodenticide Act
- C. Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- D. Resource Conservation and Recovery Act
- E. Toxic Substances Control Act

78. The _____ tend to focus on controlling potential sources of ground-water contamination on a national basis.

- A. Federal laws
- B. Local governments
- C. Statewide strategies
- D. Ground-water classification
- E. None of the Above

79. Where _____ 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 programs must be by the states in cooperation with local governments.

- A. Federal laws
- B. Local governments
- C. Statewide strategies
- D. Ground-water classification
- E. None of the Above

80. A major reason for this emphasis on _____ is that protection of ground water generally involves making very specific decisions about how land is used.

- A. Federal laws
- B. Local action
- C. Statewide strategies
- D. Ground-water classification
- E. None of the Above

81. _____ frequently exercise a variety of land-use controls under state laws.

- A. Federal laws
- B. Local governments
- C. Statewide strategies
- D. Ground-water classification
- E. None of the Above

82. _____ Requiring the development of a comprehensive plan to protect the state's ground-water resources from contamination.
- A. Federal laws
 - B. Local governments
 - C. Statewide strategies
 - D. Ground-water classification
 - E. None of the Above
83. _____ Identifying and categorizing ground-water sources by how they are used to determine how much protection is needed to continue that type of use.
- A. Standard setting
 - B. Ground-water funds
 - C. Ground-water classification
 - D. Land-use management
 - E. None of the Above
84. _____ Identifying levels at which an aquifer is considered to be contaminated.
- A. Standard setting
 - B. Ground-water funds
 - C. Ground-water classification
 - D. Land-use management
 - E. None of the Above
85. _____ Developing planning and regulatory mechanisms to control activities on the land that could contaminate an aquifer.
- A. Standard setting
 - B. Ground-water funds
 - C. Ground-water classification
 - D. Land-use management
 - E. None of the Above
86. _____ 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).
- A. Standard setting
 - B. Ground-water funds
 - C. Ground-water classification
 - D. Land-use management
 - E. None of the Above
87. _____ Regulating the use, sale, labeling, and disposal of pesticides, herbicides, and fertilizers.
- A. WHPA
 - B. Underground storage tanks
 - C. Agricultural chemicals
 - D. Water-use management
 - E. None of the Above

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

- A. WHPA
- B. Underground storage tanks
- C. Agricultural chemicals
- D. Water-use management
- E. None of the Above

89. _____ 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.

- A. WHPA
- B. Underground storage tanks
- C. Agricultural chemicals
- D. Water-use management
- E. None of the Above

90. 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 (_____).

- A. WHPA
- B. Underground storage tanks
- C. Agricultural chemicals
- D. Water-use management
- E. None of the Above

91. The size of the _____ 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.

- A. WHPA
- B. Underground storage tanks
- C. Agricultural chemicals
- D. Water-use management
- E. None of the Above

The law specifies certain minimum components for the wellhead protection programs:

92. The roles and duties of state and local governments and public water suppliers in the management of wellhead protection programs _____.

- A. Processed
- B. Must be established
- C. Must be delineated
- D. Must be identified
- E. None of the Above

93. The WHPA for each wellhead _____ (i.e., outlined or defined).

- A. Processed
- B. Must be established
- C. Must be delineated
- D. Must be identified
- E. None of the Above

94. Contamination sources within each WHPA _____.
A. Processed
B. Must be established
C. Must be delineated
D. Must be identified
E. None of the Above
95. Approaches for protecting the water supply within the WHPAs from the contamination sources (e.g., use of source controls, education, training) _____.
A. Processed
B. Must be established
C. Must be developed
D. Must be identified
E. None of the Above
96. Contingency plans _____ for use if public water supplies become contaminated.
A. Processed
B. Must be established
C. Must be developed
D. Must be identified
E. None of the Above
97. _____ must be established for proper siting of new wells to produce maximum water yield and reduce the potential for contamination as much as possible.
A. Provisions
B. Must be established
C. Must be delineated
D. Must be identified
E. None of the Above
98. Provisions must be included to ensure public participation in the _____.
A. Process
B. Must be established
C. Must be delineated
D. Must be identified
E. None of the Above
99. For a program to be successful, all levels of government must participate in the wellhead protection program. The _____ is responsible for approving state wellhead protection programs and for providing technical support to state and local governments.
A. Federal government
B. State governments
C. Local governments
D. State's program
100. _____ must develop and implement wellhead protection programs that meet the requirements of the Safe Drinking Water Act.
A. Federal government
B. State governments
C. Local governments
D. State's program

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- | | | |
|---------------|---------------|----------------|
| 1. A B C D E | 35. A B C D E | 69. A B C D E |
| 2. A B C D E | 36. A B C D E | 70. A B C D E |
| 3. A B C D E | 37. A B C D E | 71. A B C D E |
| 4. A B C D E | 38. A B C D E | 72. A B C D E |
| 5. A B C D E | 39. A B C D E | 73. A B C D E |
| 6. A B C D E | 40. A B C D E | 74. A B C D E |
| 7. A B C D E | 41. A B C D E | 75. A B C D E |
| 8. A B C D E | 42. A B C D E | 76. A B C D E |
| 9. A B C D E | 43. A B C D E | 77. A B C D E |
| 10. A B C D E | 44. A B C D E | 78. A B C D E |
| 11. A B C D E | 45. A B C D E | 79. A B C D E |
| 12. A B C D E | 46. A B C D E | 80. A B C D E |
| 13. A B C D E | 47. A B C D E | 81. A B C D E |
| 14. A B C D E | 48. A B C D E | 82. A B C D E |
| 15. A B C D E | 49. A B C D E | 83. A B C D E |
| 16. A B C D E | 50. A B C D E | 84. A B C D E |
| 17. A B C D E | 51. A B C D E | 85. A B C D E |
| 18. A B C D E | 52. A B C D E | 86. A B C D E |
| 19. A B C D E | 53. A B C D E | 87. A B C D E |
| 20. A B C D E | 54. A B C D E | 88. A B C D E |
| 21. A B C D E | 55. A B C D E | 89. A B C D E |
| 22. A B C D E | 56. A B C D E | 90. A B C D E |
| 23. A B C D E | 57. A B C D E | 91. A B C D E |
| 24. A B C D E | 58. A B C D E | 92. A B C D E |
| 25. A B C D E | 59. A B C D E | 93. A B C D E |
| 26. A B C D E | 60. A B C D E | 94. A B C D E |
| 27. A B C D E | 61. A B C D E | 95. A B C D E |
| 28. A B C D E | 62. A B C D E | 96. A B C D E |
| 29. A B C D E | 63. A B C D E | 97. A B C D E |
| 30. A B C D E | 64. A B C D E | 98. A B C D E |
| 31. A B C D E | 65. A B C D E | 99. A B C D E |
| 32. A B C D E | 66. A B C D E | 100. A B C D E |
| 33. A B C D E | 67. A B C D E | |
| 34. A B C D E | 68. A B C D E | |

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