Public and Private Roles in Ground-Water Protection

Individual home and business owners can play a major part in ground-water protection programs by becoming knowledgeable about proper storage and disposal of materials that could contaminate the ground water. The most recognized sources of contaminants that cause problems for ground-water users include but are not limited to neighborhood dumps, animal wastes, leaking gasoline tanks, and pesticides. A major source of contaminants in the ground water of some rural karst areas is associated with the use of sinkholes as dumping stations. Contaminants associated with garbage dumped in sinkholes may drain through the sinkhole and recharge an aquifer that supplies water to a nearby community. Improper handling, storage, maintenance and disposal of waste materials not only threatens drinking-water quality, but constitute violations of State and Federal laws.

A Final Note

In karst terrain, a contaminant can enter a network of conduits in an aquifer and become a widespread health problem. Federal and local funding for ground-water cleanups and treatment may be available, but costs can exceed many millions of dollars. Costly remedial actions could be avoided or minimized when individuals are aware that ground water is vulnerable to contamination, particularly in karst. The practice of good "out-of-doors" housekeeping is necessary. From the standpoint of economic and environmental responsibility, it is critical that communities work together to protect the quality of ground-water resources so that current and future generations will continue to have clean water.

Questions and Answers Related to Wellhead Protection

Listed below are answers to some commonly asked questions that may be of concern to anyone living in or near a wellhead protection zone:

Q: ***How do I know if my home or business is located within a wellhead protection area?***
A: Call your local water supplier. Determine if your water comes from a spring or community wellfield with several wells. If you have your own waterwell, recognize what materials are potential contaminants and keep them away from the well.

Q: ***What are the most common contaminant sources that threaten ground water?***
A: The most common sources include pesticides, herbicides, fertilizers, household cleaners, motor oils, sewage overflow, dumps with leaking containers, street runoff, leaking septic systems, leaking underground gasoline tanks, and livestock waste. Proper storage and disposal of potentially contaminating materials should always be considered.

Q: ***I have an old water well on my property but I don't use it any more. Can I dump wastes down this well?***
A: Never throw any type of waste down an old well. The well may be directly connected to an aquifer that supplies water to your neighbor, and you could be contaminating his or her drinking water. Never dump waste or trash in a sinkhole on your property. In karst areas a sinkhole is probably connected to an aquifer that could supply drinking water for residents throughout the area.

Q: ***What can I do to help protect ground-water supplies?***
A: Make sure that all potential polluting materials on your property are inventoried, and stored, used, and disposed of in an environmentally safe manner. For example, do not store your cleaning fluids, gas cans, or antifreeze near an open well. Understand why and how your water supply and/or your neighbor's could be contaminated if potential contaminating materials enter the ground water.

For more information, contact:

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Copies of this report may be purchased from:

U.S. Geological Survey
Earth Science Information Center
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Box 25286, MS 517
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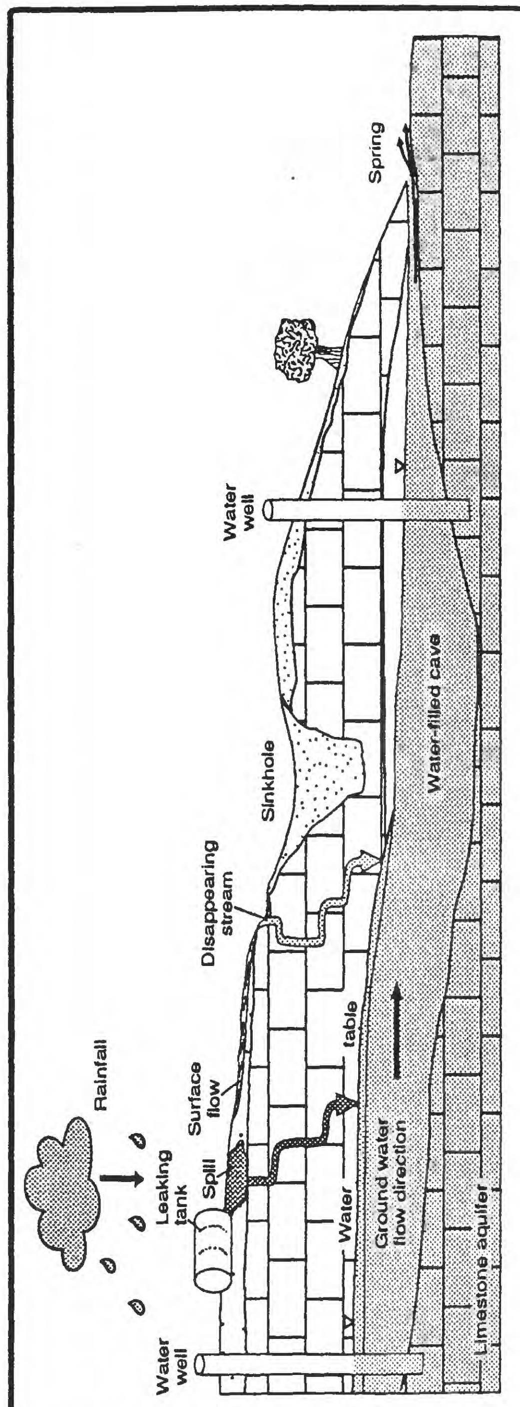


Basic concepts of ground-water and surface-water flow in karst terrain.

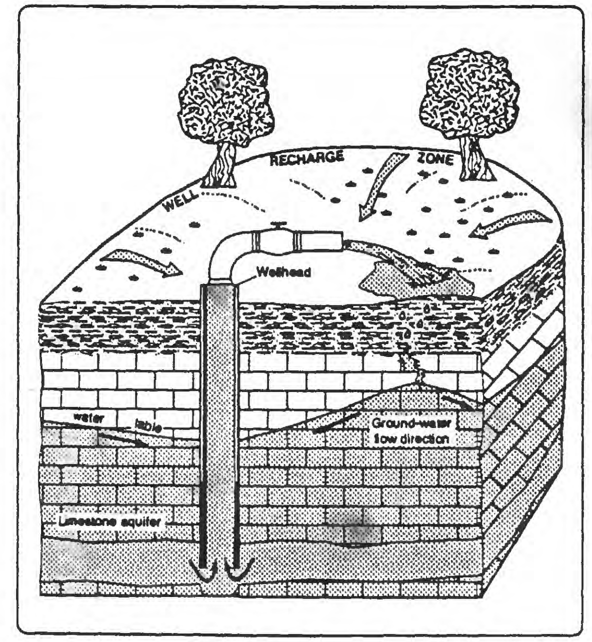
Photographs by G.E. Hileman; illustrations by J.E. Banton

Open-File Report 95-376

Ground-Water Quality Protection

Why It's Important To You

By ANK WEBBERS



Prepared by the
U.S. GEOLOGICAL SURVEY

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1995

Introduction

Ground water is a valuable resource often used for industry, commerce, agriculture, and most importantly drinking water. In the 1980's, ground water provided 35 percent of the municipal water supplies in the United States and 95 percent of the rural, domestic drinking water. Except for turning on the faucet, most of us who use water often take for granted its availability and don't really know where our water comes from or recognize why it may be so vulnerable to contamination.

In the 1970's and 1980's, the United States Environmental Protection Agency (USEPA) established national guidelines for safe drinking-water standards in response to a large number of reports of diseases caused by contaminated ground water. The USEPA developed the concept of ***Wellhead Protection*** which focuses on protecting and preserving the quality of ground-water supplies. Following USEPA guidelines, many states, including Tennessee, established local Wellhead Protection programs and rules for ground-water supplies that were used by the public. The Wellhead Protection programs are based on a thorough knowledge of the geologic and hydrologic characteristics of ground-water occurrence and flow. Scientists of the U.S. Geological Survey (USGS) and other organizations use their skills and expertise to provide such information to communities that depend primarily on ground water for their drinking-water supply.

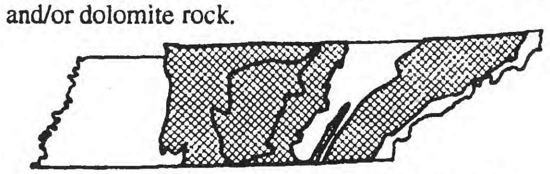
Purpose

This brochure acquaints the reader with some of the common characteristics of ground water in ***carbonate*** (limestone and dolomite) rocks in Tennessee. It also emphasizes the importance of protecting the quality of these water supplies for present and future use.

Some Basics About Ground Water in Carbonate Aquifers

Ground water is a term that refers to the water occurring below ground in zones where open space is saturated or filled with water. Any zone that allows the movement of water and can supply a usable quantity of water to a well or spring is called an ***aquifer***. An aquifer can be composed of loose sediment or cemented rock. In aquifers composed of sands and gravel, water flows through the openings between the grains, whereas in cemented aquifers, water can only flow through an available network of connected fractures or cracks in the rock. Aquifers are replenished by infiltrating rainfall or surface streams that can penetrate overlying soils. The ***water table*** (ground-water surface) in an aquifer rises in response to **recharge** from rainfall and streams, and falls in response to drought, pumping conditions, or other withdrawals. Any changes that occur in the elevation of the water table reflect a net recharge to or **discharge** from the aquifer.

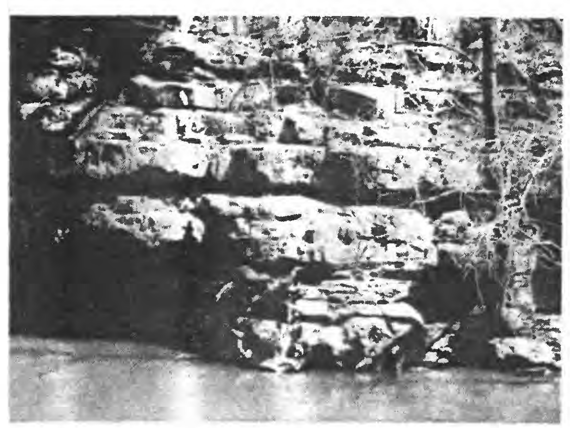
The aquifers in Tennessee are composed of several different rock types. Approximately two thirds of the State is underlain by cemented aquifers of limestone and/or dolomite rock.



Location of carbonate aquifers in Tennessee.

Typical Features of Carbonate Rock

Land forms that develop in carbonate terrain are referred to as ***karst***, and are characterized by gently rolling hills, with depressions and sinkholes. Some sinkholes are created by collapse of overlying soils into underground cavities in the carbonate rock. Sinkholes also form by the weathering and dissolving of surface carbonate rocks. Drainage from sinkholes occurs through the underground network of ***conduits*** (tunnels) formed by the dissolving reaction of mildly acidic ground water and carbonate rock. As the rock dissolves, small fractures and cracks become larger and may connect to form an extensive subterranean drainage system. Under certain conditions caves may form, and if the water table falls, surface streams may disappear into the underground tunnels.



Carbonate rock exhibiting fractures and caves. Note water table has dropped to stream level.

Studies of water moving through underground tunnels have shown that ground water can travel up to several miles in a single day! In karst terrain it is not unusual for a disappearing surface stream to reemerge elsewhere as a natural spring. In the event that a potential migrating contaminant can enter a stream, it is highly likely that the same contaminant may resurface at a spring.

Example of a Vulnerable Water Supply

In northwestern Middle Tennessee, approximately 40,000 residents of the Fort Campbell Military Reservation rely primarily on Boiling Spring, a spring that issues from carbonate rock, for their water supply. Boiling Spring has an average discharge of about 5 million gallons per day and receives its water from the surface runoff, streams, and ground water in adjacent areas ***up gradient*** (at higher elevations) of the spring. The area where surface runoff, precipitation, or stream flow seeps into the ground water and moves to a water supply well or spring, like Boiling Spring is referred to as the ***recharge zone***. Any contaminants present in the recharge zone could easily be transported in waters contributing to spring discharges or supply wells. Contamination in the recharge zone of karst aquifers could potentially harm the quality of ground-water supplies like Boiling Spring. The ability to define the recharge zone as well as protect it from potential contamination is very important.

Techniques Used To Define Recharge Areas in Karst Terrain

Scientists use several methods to define the recharge zone of springs or well fields in karst terrain. Field techniques include (1) introducing harmless dye tracers into the aquifer at points upgradient of the water supply, (2) measuring water levels in wells in the surrounding area, and (3) measuring the gains and losses of water in local streams near the water supply.

Dye tracing is considered the most successful method for confirming ground-water flow directions in karst aquifers. Harmless dyes which are injected in sinkholes or wells and detected later at the water supply help demonstrate that an underground connection exists between the two points.

Maps of the water table are useful for interpreting the general direction of ground-water flow in most aquifers. The maps are made by plotting measured water levels in wells to determine elevations of the water table at several points in an area. In karst terrain, the direction of ground-water flow may temporarily change if the amount of recharge received in a particular region of an aquifer exceeds that in another region. This can result in a local reversal of ground-water flow.

Measuring depth to water in an observation well.

The measurement of flow rates in streams also provides useful information on the source of recharge water to springs and well fields. By determining the changes in flow per square mile of drainage areas, scientists can determine where streams contribute water to or receive water from an aquifer.

Collecting a streamflow rate measurement.