

Understanding Groundwater

A publication of the Hazardous Substance Research Centers' Technical Outreach Services for Communities (TOSC) Program.

Hazardous Substance Research Centers

The five regional Hazardous Substance Research Centers were established in 1989 and funded by the U.S. Environmental Protection Agency (U.S. EPA). The Centers' mission is to support and conduct innovative research and technology development in hazardous substance control, cleanup and management. The Centers have an interdisciplinary group of knowledgeable scientists and engineers who can offer technical advice, review sites, and help increase understanding of hazardous contamination.

For more information write B100A Engineering Research, Michigan State University, East Lansing, MI 48824, visit www.toscprogram.org or call

WHAT IS GROUNDWATER? WHY IS IT IMPORTANT?

Two thirds of the world's fresh water is underground. In the United States, there is more water underground than on the surface. This water is found in aquifers and appears at the surface as springs. Very often groundwater is interconnected with lakes and rivers.

Groundwater is extremely important in supplying fresh water to meet the needs of Americans. Groundwater is used as drinking water by 50 percent of the nation's population. Besides direct human use, groundwater is used for agriculture, manufacturing and commercial uses. Groundwater also maintains gradual discharge to rivers to maintain streamflow during dry weather periods.

Groundwater is present in the tiny spaces between soil particles or in cracks in rock, much like a sponge holds water. The underground areas of soil or rock where substantial quantities of water are found are called **aquifers**. These aquifers are the sources of wells and springs. It is the top of the water in these aquifers that forms the **water table**.

The water table may be only a foot below the ground surface or it may be hundreds of feet down. When the groundwater table meets the ground surface, natural springs are formed.

Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone. These materials are permeable because they have large connected spaces through which water can flow.

The water table may rise or fall depending on many factors. Heavy rains or melting snow may cause the water table to rise, or an extended period of dry weather may cause the water table to fall.

Groundwater is constantly discharging and recharging due the **hydrologic cycle**, in which rain falls to the the ground, some water flows to streams or lakes, some evaporates into the atmosphere, some is taken up (or released) by plants, and some seeps into the ground. As water begins to seep into the ground, it enters a zone containing both water and air in the pore spaces, which is referred to as the **unsaturated zone**.



The Great Lakes & Mid-Atlantic Center is a consortium of the University of Michigan, Michigan State University and Howard University

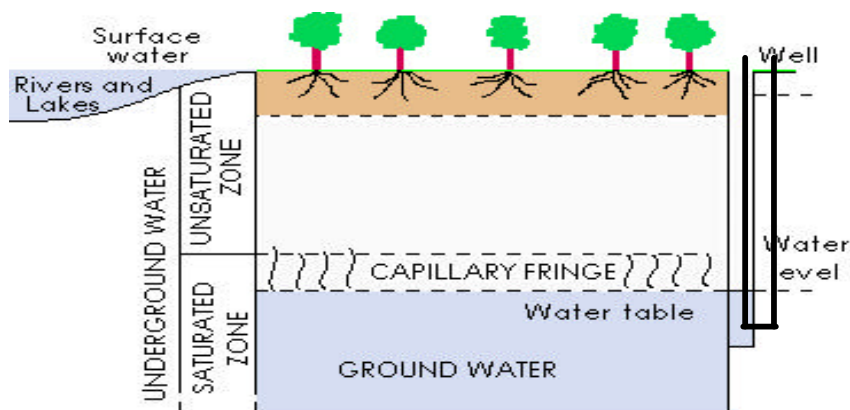


Fig. 1 — Groundwater occurs in a soil and rock zone below ground

Water moves through the unsaturated zone into the **saturated zone**, where all the interconnected spaces are filled with water. Aquifers are saturated zones of water that yield a substantial amount of water when pumped and used as wells.

How Does Groundwater Move?

Groundwater flows much more slowly than surface water such as rivers. Unlike surface water, that runs, mainly, in a straight line from high to low land, groundwater does not move through an open channel. Instead, groundwater moves between soil particles or through fractures in rock.

Because groundwater flows through these spaces, the amount of time water is in contact with soil particles is greatly increased compared to surface water. Because of this, the chemistry involved in groundwater is at times much more complex than for surface water.

How does groundwater become contaminated?

Groundwater becomes contaminated when people-made substances, or in some cases naturally-occurring substances, are dissolved in waters recharging the groundwater zone. These **contaminants** include the chemicals found in gasoline, oil, and road salts, and can cause groundwater to become unsafe for human consumption. Sources of contaminants include leaking storage tanks, hazardous waste sites, uncontrolled landfills, septic systems and both illegal and legal discharges to the environment.

Due to the slow movement of water through groundwater aquifers, contaminants are much less slowly flushed through than in lakes and streams.

Contamination of groundwater also occurs through natural means. Arsenic and lead in rock formations can migrate into groundwater.

Radon gas, which occurs from the radioactive decay of uranium in bedrock, can contaminate groundwater.

Groundwater becomes contaminated as contaminants move from a source, through the soil and into the groundwater. Contaminants vary in their ability to move through soil. For example, PCBs tend to “stick” to soil particles and do not pass readily into groundwater. Gasoline components, such as benzene, will tend to stay in the air pockets in the soil but can move into the groundwater if the water table enters the zone of contamination. Metals vary in their ability to move through soil. Low pH (acidic) groundwater can cause metals to leach, but the effect of high pH (alkaline) water on movement of metals is not completely understood.

THE BOTTOM LINE

Groundwater is essential to human life and human activities, but susceptible to damage through pollution and overuse. Because it is “hidden from view,” its damage may go undetected until it affects human health or the environment. Cleanup of groundwater can be costly and protracted.

The best way to guarantee continued supplies of clean ground water is to *prevent* contamination. Federal and state groundwater programs protect public water supplies from contaminants that could be harmful to human health. Other programs direct the cleanup of contaminated sites that may be polluting the groundwater. For more information about protection of groundwater, in Michigan contact Michigan Department of Environmental Quality.

FOR MORE INFORMATION

- ??EPA’s Groundwater site
(<http://www.epa.gov/seahome/groundwater/src/ground.htm>)
- (<http://www.epa.gov/safewater/protect/citguide.html>)
- ?? General overview of topic
(www.groundwater.org)

