Water Quality

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What Is Ground Water?

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Introduction

Ground water is the water found in the spaces and cracks between the particles of soil, sand, gravel and bedrock. As part of a continuous cycle, called the hydrologic cycle, ground water becomes exposed to pollution from human activities (Figure 1). Learning the processes, which make ground water available for use, helps us to understand how human activities can threaten the quality of this Indiana resource.

In the hydrologic cycle, water continually moves from the atmosphere, land, and surface waters. Water evaporates from the oceans, rivers, and lakes into the atmosphere. It then returns to the earth's surface as rain, snow and hail. When precipitation falls, it may evaporate directly to the atmosphere, be absorbed by plants, or seep into the ground. See Figure 2 for the breakdown of Indiana's annual precipitation.

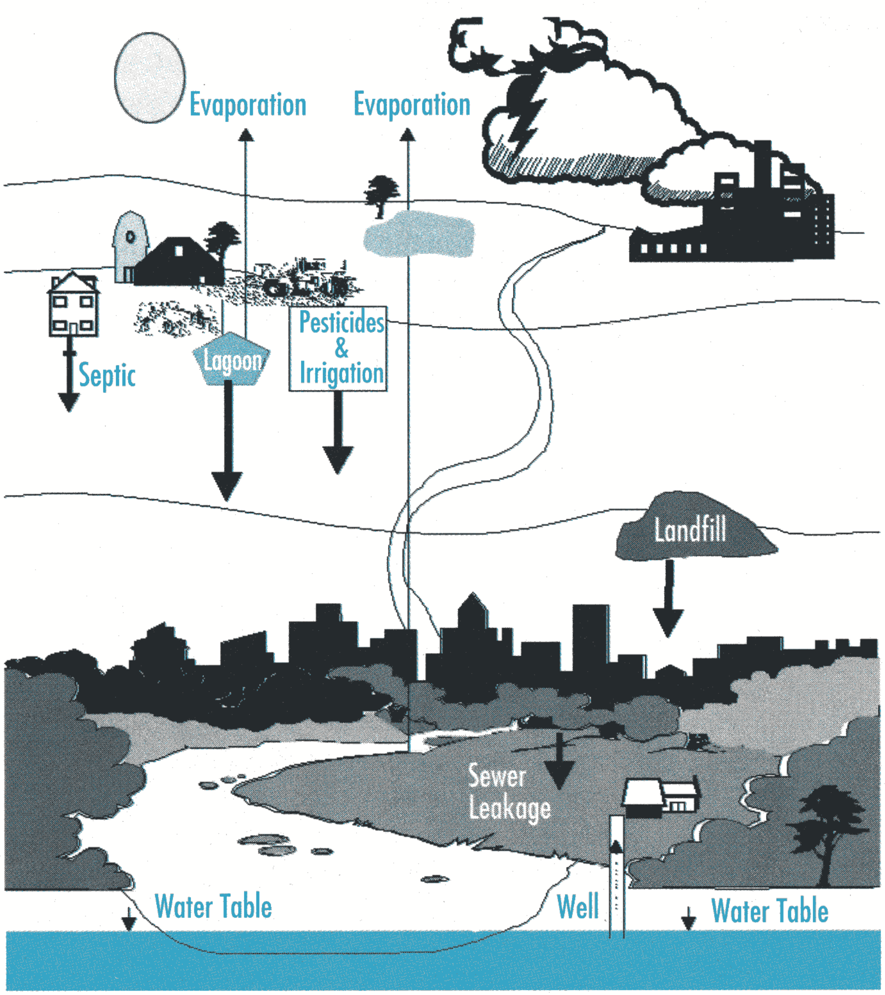

Figure 1. The hydrologic cycle and sources of ground water contamination.

Ground water

Water entering the soil can remain near the soil surface to evaporate or be taken up by plants by a process called transpiration. Both evaporated and transpired water return to the atmosphere. The remaining water enters the soil and moves sideways or downward out of the plant's root zone. Water moving sideways will become surface water,

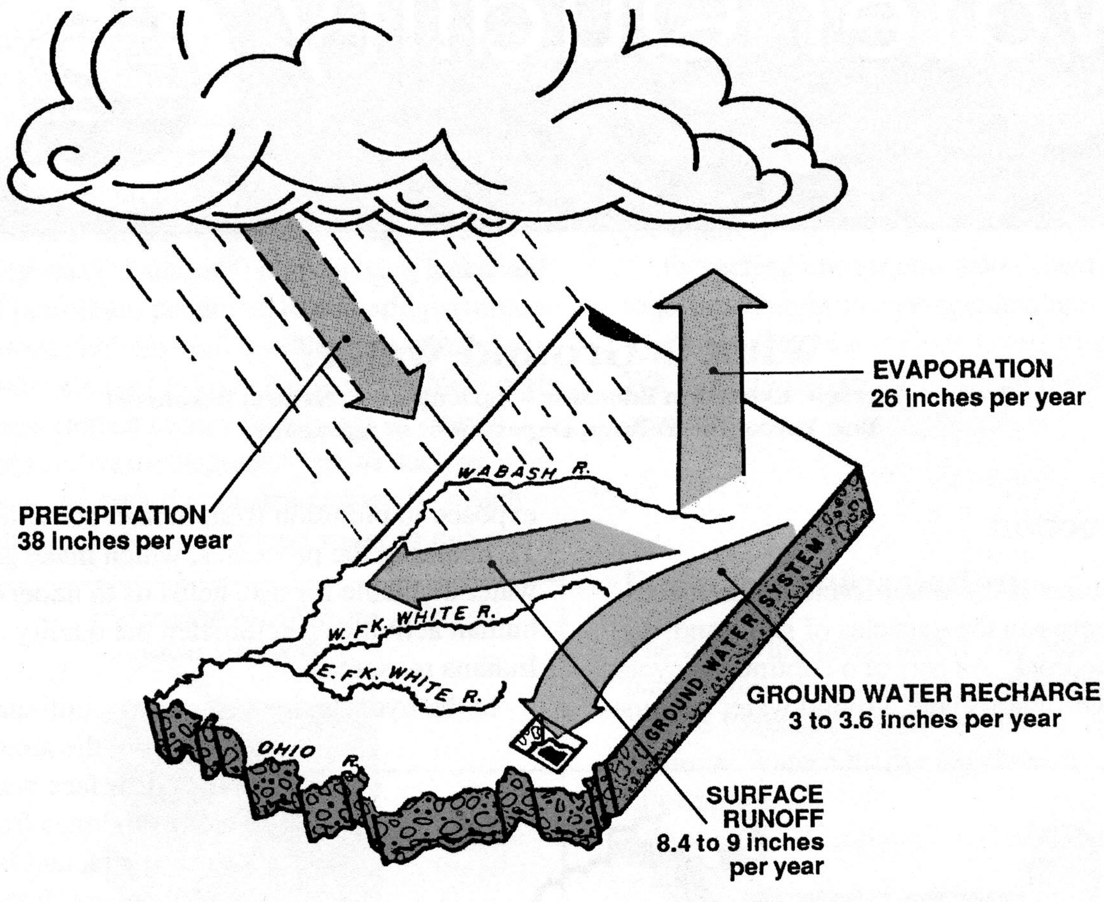

Figure 2. Distribution of average annual precipitation in Indiana.

through movement to streams or lakes, while the water moving downward becomes ground water.

Ground water fills the spaces between soil particles and rock. Close to the land's surface, the spaces are partly filled with water (soil water) and partly filled with air. Deeper in the ground, the area where the spaces are completely filled with water (ground water) is called the zone of saturation. The top of the zone is often the water table.

Ground water moves slowly through the soil spaces or rock fractures as compared to surface flow. Most ground water flow is measured in inches per day or feet per year. The amount of water held and the rate of water flow depend on a soil or rock formation's porosity and permeability.

Porosity is the amount of pore space in a formation and determines the amount of water a soil type can hold. Permeability, on the other hand, determines the rate of ground water flow. Permeability level depends on pore size and path of flow. Water moves freely in the large pores found in highly permeable sand and gravel. Clay, however, holds a great deal of water but has low permeability because water moves very slowly through its small pores.

Aquifers

Major zones under the earth's surface, filled with ground water, are called aquifers. Aquifers occur in either consolidated or unconsolidated ground formations. Consolidated formations contain ground water in the cracks of solid rock. The amount of water in a consolidated formation depends on the number and the size of the cracks. Consolidated limestone formations often have large caverns with much water in them. Unconsolidated aquifer formations, found in sand and gravel deposits, often contain large amounts of water. These are the most productive type of aquifer in Indiana.

Aquifers can also be unconfined or confined. An unconfined aquifer is found near the earth's surface bordered by the water table on top. The lower boundary will be a slowly permeable layer. A confined aquifer contains water bound by impermeable layers both above and below. Because this water is confined, it is usually under pressure (Figure 3).

Ground water use

In Indiana, water use is divided into six different areas. These include water used for: agriculture; public supply (water works); industry (process and cooling water, waste disposal, sand and gravel operations); energy production (power generation, coal mining, heating and cooling); miscellaneous (ski resorts, fish and wildlife areas); and rural use (livestock watering, fish hatcheries).

Ground water supplies drinking water to the majority of Indiana residents. In addition to the public supply use seen in Table 1, approximately 29 percent of the state's population obtain their water from private wells. Increased demand from domestic, agricultural, and industrial users along with the increased pollution hazards have brought an increased interest in the quality and quantity of this Indiana resource.

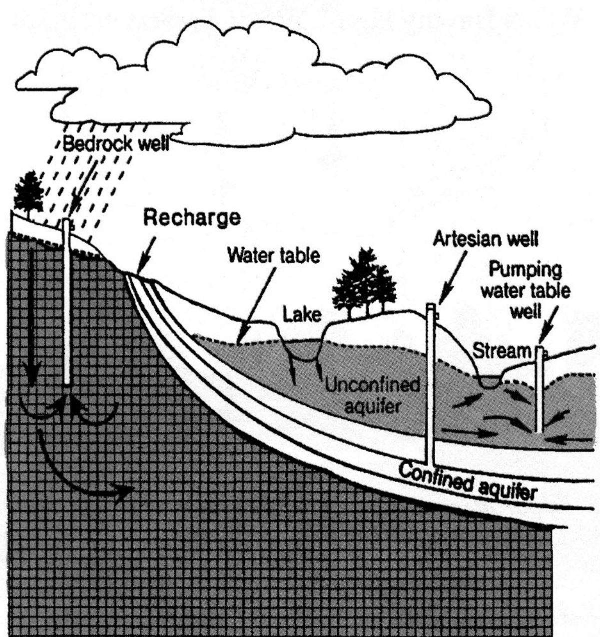

Figure 3. Confined and unconfined aquifers.

Table 1. Water usage in Indiana.
(units in million gallons)

	Ground	Surface	TOTALS
Energy	9,457	2,136,635	2,146,092
Industry	41,707	846,423	888,130
Agriculture	25,406	22,116	47,522
Public	124,692	109,692	234,384
Misc.	8,721	1,450	10,171
Rural	1,403	2,099	3,502
TOTALS	211,386	3,118,415	3,329,801

Ground water quality

Natural ground water quality varies widely from place to place. The natural makeup of water is affected by rock or soil particles moving along its path. The most common naturally occurring substances found in Indiana ground water are calcium, magnesium, bicarbonate, carbonate, fluoride, iron, chloride, sodium, and sulfate. As many as 50 minerals may naturally occur in ground water. Generally, these do not cause health problems. However, they may cause undesirable traits such as unpleasant taste, odor, or hardness to water.

Contaminants may be living organisms, mainly bacteria. Sulfur, iron and manganese-using bacteria cause the most common odor, taste, and discoloration problems. Occasionally, other types of bacteria, which indicate unsanitary conditions, are present. They indicate the possible presence of disease-causing agents.

Foreign substances dissolved in water at the land's surface, and carried down to the aquifer with the water, pollute ground water. The properties of the soil above the aquifer and the amount of the substance determine if it will pollute an aquifer. Since ground water moves very slowly, detection of a pollutant may take a long time. Widespread contamination often occurs before it is detected. Even after the contamination has stopped, the aquifer may take years to cleanse itself.

Human activity on the land can affect ground water quality (Figure 1). Some agricultural practices can potentially add nitrates and pesticides to ground water. Residential areas with septic systems may add nitrates, bacteria, viruses, and chemicals from household products. Industrial activities add chemicals and metals. Gasoline storage areas (including service stations) tend to have leaks and spills of petroleum products. Roads add petroleum leaked from vehicles, salt used to melt winter ice, and metals released from exhaust and vehicle parts. The largest impact comes from areas of heavy chemical use, waste disposal systems such as landfills or improperly constructed wells, which allow surface water and ground water to mix.

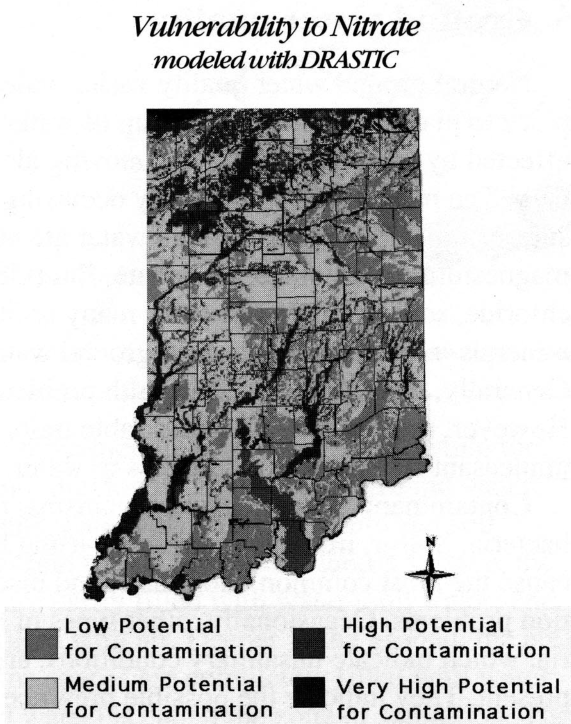

Figure 4. Areas in Indiana vulnerable to ground water contamination. The map shows a statewide estimate of ground water vulnerability, developed using the EPA's DRASTIC model.

Figure 4 shows those areas in Indiana vulnerable to ground water contamination. Aquifers located close to the land surface are less protected from contamination. Also, permeable materials pass pollutants faster, allowing them to spread through the aquifer.

Protecting our ground water from contamination requires thoughtful management and cooperation by citizens and the various levels of government. We must all do our part to preserve this natural resource.

For more information

The following publications and other water quality publications are available from your Purdue Cooperative Extension office. You may also access the National Water Quality Database for additional information at:
http://hermes.ecn.purdue.edu:8001/server/water/water.html

WQ-1 Water Testing Laboratories
WQ-3 How to Take a Water Sample
WQ-4 Why Test Your Water?
WQ-5 Interpreting Water Test Reports
WQ-6 Buying Home Water Treatment Equipment

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