



Information

DEPARTMENT OF ENTOMOLOGY • COLLEGE PARK, MD 20742 • (301) 405-3913

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Factors Affecting Groundwater Contamination

Pesticide Information Leaflet No. 8

Amy E. Brown, Ph.D.
Coordinator, Pesticide Education and Assessment Programs
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Groundwater is the source of water for wells and springs. It fills spaces between particles of soil or cracks in bedrock. Aquifers are geologic formations of permeable saturated zones of rock, sand, or gravel which carry enough water to yield usable amounts to wells. Aquifers are recharged by rainfall slowly seeping through the ground, or by surface waters with which they are interconnected. The factors that affect the likelihood of groundwater contamination are discussed in this leaflet.

CHEMICAL PROPERTIES

Solubility: As water seeps through the soil, it carries with it water soluble chemicals. This process is called leaching. The more water soluble a chemical is, the more likely it is to leach.

Adsorption: Many chemicals do not leach because they are adsorbed, or tightly held, by soil particles. Adsorption depends not only on the chemical properties of the pesticide, but also on the soil type and the amount of organic matter present.

Degradation: Pesticides are degraded, or broken down, by heat, sunlight, microorganisms, and a variety of physical and chemical properties. Most pesticide degradation takes place within the top few inches of soil. Pesticides that take a relatively long time to degrade are said to be persistent. The longer the compound persists in the soil, the longer it is available to leach into groundwater.

Volatility: Compounds that vaporize readily are said to be volatile. If a chemical is highly volatile and not very water soluble, it is likely to be lost to the atmosphere, and less likely to leach into groundwater. Highly volatile compounds may become groundwater contaminants, however, if they are also highly soluble in water.

SOIL PROPERTIES

Soil texture: The relative proportions of sand, silt, and clay determine the texture of a soil. Texture affects movement of water through soil, and thus also movement of dissolved chemicals such as pesticides. The coarser the soil, the faster the movement of percolating water, and the less opportunity for adsorption or evaporation. Soils with higher clay or organic matter content tend to hold water and dissolved chemicals longer. These soils also have more surface area onto which pesticides can be adsorbed.

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Soil permeability: Soils that allow water to move downward very quickly are highly permeable. Dissolved chemicals are carried along with the water and thus more likely to reach groundwater in soils that are highly permeable.

Organic matter content: The amount of organic matter in a soil affects the adsorption capacity of a soil and the amount of water the soil can hold. Soils with a high organic matter content tend to hold the water and dissolved chemicals in the root zone where they will be available to plants and to eventual degradation.

SITE CONDITIONS

Depth to groundwater: The shallower the depth to groundwater, the less soil there is to act as a filter, and the fewer opportunities there are for degradation and adsorption of chemicals.

Rainfall: If rainfall is high and soils are permeable, water carrying dissolved chemicals may take only a few days to percolate downward to the groundwater.

Geologic conditions: The permeability of the geologic layers between the soil and groundwater also affects the probability of contamination. Highly permeable materials, such as gravel deposits, allow water and dissolved compounds to freely percolate down to groundwater. Layers of clay are much less permeable and thus inhibit the movement of water and chemicals. Karst, or limestone formations with sinks or separations in the rock, underlies soils in western Maryland; these sinks can act as direct entryways for contaminants.

Crop removal: When crops are harvested, pesticides and their residues that are absorbed within the plant or adsorbed to the plant's surface are removed from the treatment site. Most harvested food commodities are subjected to washing and processing procedures that remove or degrade much of the remaining pesticide residue. Although harvesting is more typically associated with food and feed products, pesticides can also be removed from the treatment site through such operations as tree and shrub pruning and turfgrass mowing. Use of treated grass clippings or other treated materials as mulch can transfer pesticides and their residues to new sites.

SUMMARY

The combination of factors which would indicate the greatest vulnerability of groundwater would be as follows:

a pesticide of
high solubility
low adsorption
persistence
and
a soil that is
sandy
low in organic matter
and
a site with
shallow depth to groundwater
karst or permeable layers
heavy rainfall

This leaflet has focused on the conditions that contribute to groundwater vulnerability. For a discussion of how to protect groundwater from contamination by pesticides, refer to Pesticide Information Leaflet Number 9.

Information in this leaflet was adapted from the Maryland Pesticide Applicator Training Series Core Manual; Ohio State Extension Bulletin 820; and the groundwater educational package developed by the New York State Water Resources Institute, Cornell Cooperative Extension, and Office of Pesticide Information and Coordination, University of California Cooperative Extension.