Pesticides are an important part of crop production. They are also useful tools in livestock production, landscape maintenance, and protection of our health and living spaces (both indoors and out). With the use of pesticides comes the responsibility to use proper application procedures, safety precautions, and best management practices. Everyone applying pesticides – whether treating a corn field, a lawn, or a building structure – is responsible for protecting the environment and our water resources.

**Water Contamination**

Water quality problems may arise when pesticides move out of target areas into surface waters from runoff or eroded sediment, or leach through the soil into groundwater. Improper storage or disposal of pesticides can also cause environmental contamination, as can the failure to apply pesticides according to label directions.

**Runoff** can be a significant problem on agricultural land or in turf or ornamental areas. It occurs when water does not move into the soil but instead “runs off” the surface and flows into streams and lakes. Runoff may also occur in urban areas when rain washes pesticides applied on lawns into street gutters. The pesticide-contaminated water then moves through storm drains, eventually flowing into nearby streams and rivers. Runoff waters may also carry eroded soil particles. Any pesticides adsorbed (see Pesticide Properties section, page 3) on these particles could contribute to the chemical runoff to surface waters. Pesticides dissolved in the runoff water may move considerable distances offsite.

**Leaching** occurs when pesticides dissolved in water move through the soil profile into the groundwater below. Leaching is more of a problem in areas where the geology allows for rapid movement of water to groundwater, such as gravelly or sandy soils and areas with a short depth to groundwater. If a pesticide is water soluble, it may move freely with water through the soil, ultimately reaching groundwater. However, if a pesticide is insoluble or tightly bound to soil particles, it is more likely to be retained in the upper soil profile. In this case small amounts may contaminate surface waters through runoff or erosion.

**Watersheds**

A watershed encompasses the land area and water bodies that drain into a single river or lake system. Watersheds are vital because they replenish groundwater and determine our source of drinking water. Because they comprise a large drainage area, however, they are vulnerable to contamination from many sources. To better understand water contamination, it’s important to know your watershed and how the water within it moves.

**Online Information about Iowa Watersheds**

**General** — See Environmental Protection Agency at: [www.epa.gov/safewater/publicoutreach/landscapeposter.html](http://www.epa.gov/safewater/publicoutreach/landscapeposter.html)

**Specific** — See Iowa Department of Natural Resources at: [http://www.iowadnr.gov/water/watershed/index.html](http://www.iowadnr.gov/water/watershed/index.html)

**Your local watershed** — See the Iowa DNR at: [http://www.iowadnr.gov/mapping/maps/watershed_atlas.html](http://www.iowadnr.gov/mapping/maps/watershed_atlas.html)
Water contamination depends on several factors. The source of contamination is often referred to as either a “point” or “nonpoint” source. Point source contamination can often be traced back to the original source, while nonpoint source contamination usually cannot be traced. Examples of point source contamination include mixing and loading sites, storage facilities, and sprayer cleanout areas.

Nonpoint source contamination involves pesticides applied over a larger area and at generally lower concentrations than point source contamination. Runoff or leaching are the two most common methods of nonpoint source pesticide contamination into water sources. Occasionally, nonpoint source contamination happens when pesticides drift from target sites onto water bodies or volatilize back into the atmosphere and are deposited later in precipitation.

The degree to which a pesticide moves offsite depends on many factors including: soil and landscape characteristics, climatic conditions, and pesticide properties.

**Soil and Landscape Characteristics**

Water movement is influenced by many different factors including soil characteristics, topography, and climate. Some sites are more vulnerable than others.

Soil texture classification is based on the amount of sand, silt, and clay forming the soil. Soils high in sand (“coarse-textured”) have high water infiltration rates and a low capacity to adsorb pesticides. Leaching is a greater concern than runoff in these soils. In contrast, soils with high amounts of clay (“fine-textured”) have lower water infiltration rates and a greater potential to adsorb pesticides. These soils are also more susceptible to compaction, which increases water runoff because of decreased infiltration rates. Thus, pesticides applied to clay soils are generally more susceptible to runoff than leaching.

Soil organic matter can also influence water movement. Organic matter consists of residues of dead plants and animals in various stages of decomposition. A soil's organic matter content plays a major role in pesticide adsorption and availability, and affects soil water holding capacity and water infiltration rates. Soils high in organic matter typically have a greater potential to adsorb pesticides and have higher water holding capacities.

Landscape and topography affect water movement by influencing how fast water runs off. Steeper slopes can increase the rate of runoff and amount of sediment removed. Vegetative and residue cover on the soil help intercept and slow the rate of water flow, while exposed soils are much more likely to erode. Soil water content is also important as runoff occurs when the soil surface becomes saturated.
**Climatic Conditions**

Climatic conditions, particularly rainfall and to a lesser extent wind, can affect offsite movement of pesticides. Rainfall intensity and amount as well as the time between a pesticide application and rainfall event affect the amount of pesticide lost. The sooner rainfall occurs after a pesticide application, the greater the likelihood of pesticide leaching or runoff losses. The most critical period for offsite movement of pesticides is usually about 10 to 14 days after an application, but this will vary depending on how quickly a pesticide degrades or is adsorbed to soil particles. High intensity storms shortly after application pose the greatest risk for pesticide runoff losses.

**Pesticide Properties**

The primary pesticide properties affecting pesticide movement in the environment include solubility in water, adsorption by soil particles, volatilization potential, and persistence.

*Solubility* is the degree to which a chemical dissolves in a liquid (usually water) and is often expressed in parts per million (ppm). Pesticides with high water solubility have greater potential to leach.

*Adsorption* is the tendency of a pesticide to adhere (“adsorb”) to soil particles. This is often considered the key factor in determining if or how much a pesticide will leach or run off from an application site. A soil’s organic matter content is the major soil characteristic affecting pesticide adsorption. The degree to which a pesticide adsorbs to organic matter is represented by the organic carbon partition coefficient, or Koc. Pesticides with a high Koc value are more likely to adsorb to organic matter and less likely to leach or run off. Pesticides with low Koc values have a higher potential to leach.

*Volatilization* is the process of changing from a solid or liquid to a gas. Pesticides vary in their potential to volatilize; some are highly volatile while others rarely volatilize. Environmental conditions — especially temperature — play a role in how much volatilization may occur. Higher temperatures increase the likelihood that susceptible pesticides will volatilize. Low relative humidity, windy conditions, and the presence of plant cover (as opposed to applications made directly to the soil surface) may also increase volatilization, as could a soil’s moisture content. In general, volatilization occurs more rapidly from moist soils than dry soils.

*Persistence* refers to how long a pesticide will remain in the environment before breaking down (degrading). A pesticide’s persistence is usually expressed in terms of its half-life, which refers to the time it takes for half the original amount of pesticide to degrade to other products. The shorter the half-life of a product, the less time is required for it to degrade.

Information regarding the half-life, adsorption coefficient, and water solubility along with other chemical properties of pesticides can be found at the USDA-ARS Pesticide Properties Database website:

http://www.ars.usda.gov/Services/docs.htm?docid=14199
Best Management Practices to Protect Water Resources

Some management practices to reduce pesticide contamination of water sources include:

- Select pesticide products based on landscape and soil properties, environmental conditions, and the chemical characteristics of the pesticide.
- Follow proper pesticide application procedures. Read and follow label directions.
- Use integrated pest management (IPM) tactics to control pests, using pesticides only when and where necessary.
- Evaluate the location of water sources.
- Use buffer zones where no pesticide is applied around streams, ponds, wetlands, and wells. Adhere to any setback buffer requirements specified on the pesticide label.
- Establish grass waterways and vegetative buffer areas around streams and ponds to slow runoff water and trap eroded soil particles.
- Do not apply pesticides when conditions are most likely to promote runoff or excessive leaching.
- Do not spray pesticides on a windy day.
- Mix, load, and dispose of pesticides properly. Mix or load at the application site or on an impervious pad.
- Use backflow prevention devices.
- Calibrate application equipment regularly.
- Properly triple rinse or pressure rinse empty containers.
- Clean up spills promptly, no matter how small.
- Store potential water pollutants away from water sources such as wells, ponds, and streams.