ANATOMY OF A RUNOFF EVENT

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How Water Runs Off a Field

When rain or snowmelt water accumulates on a field faster than it can flow into the soil, or *infiltrate*, it will begin to fill up all the depressions in the soil surface. If there is enough water that all the indentations fill up and spill over, runoff will begin. Initially, runoff can flow down hill as very thin sheets of water. It does not have to travel very far, sometimes just a few feet, before it starts to form very small but visible channels, called rills. As the water continues to flow down slope with more water flowing into them, the channels become bigger until they flow into gullies or intermittent streams.

What Determines How Much Water Runs Off

The rate and length of time that water is applied to a field as rainfall or snowmelt has an obvious effect on the amount of runoff resulting from a particular storm or snowmelt event. Soil and field conditions also affect runoff volumes – often a storm that produces a large amount of runoff on one field will not produce any runoff at all from adjacent fields. Many factors affect runoff volumes, including:

- Soil texture – heavier soils generally have lower infiltration rates than sandier ones
- Slope and landscape configuration – runoff flows and forms channels more quickly on steeper slopes
- Soil structure – compacted soils have few pore spaces for water to enter
- Soil moisture – if soil pores are already partially filled with water, infiltration is slowed
- Frozen soil – the presence of ice in soil pores can block infiltration
- Plants – stems and leaves near the soil surface trap runoff or slow it down, reducing the formation of channels and allowing for more infiltration
- Residue – crop residue left on the surface also traps and slows runoff
- Surface depressions – the higher the volume of depressions, such as tillage furrows, the more water will be stored there before running off. Direction of the depressions on a slope is very important – furrows on the contour will capture and hold runoff, while furrows running up-and-down slope can act as flow channels.

The last three items above vary with crops and tillage, while soil moisture and freezing are a function of weather and the season. To show how these factors can interact to cause differences in runoff amounts, we can compare the runoff generated on three fields during spring and winter events at the UW-Platteville's Pioneer Farm. (Note: These fields have similar soils and topography, but are not exactly the same, and we know that some of the variability in runoff volumes shown below has to do with the shape of the slopes rather than crops and tillage.)

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Example 1: Total runoff inches generated by a series of rainstorms, June 12 – June 16, 2004.

Field A. Alfalfa/brome – 0.07

Field B. First year corn for grain following fall-killed alfalfa (low residue, smooth field, crop not up yet) – 0.6

Field C. Second year corn for grain, fall-chisel plowed – 0.11

Example 2: Total runoff inches generated by snowmelt and rain on snow, Feb. 12- Feb. 16, 2005.

Field A. Alfalfa/brome – 1.0

Field B. Corn for grain, following fall chisel-plowing on contour, some winter-applied manure- 0.6

Field C. Corn field, following fall chisel-plowing on contour – 0.8

The alfalfa/brome field had much less runoff than the first year corn field in June when the corn crop had just emerged, but more in the winter. Depressions remaining after fall tillage stored some snowmelt runoff in the corn fields.

How Manure Runs Off a Field

Manure constituents like nitrogen, phosphorus, and organic carbon can be lost from fields by dissolving into runoff or as manure particles carried by flowing water. A critical factor in how much of a manure application's nutrients are removed in runoff is the amount of time between the application and the runoff event. It is likely that any water running off of a field within several days of a manure application is going to be very dark and have a high concentration of phosphorus, nitrogen and manure particulates. As a general rule, the longer the time between the application and runoff, the more the manure becomes part of the soil and less susceptible it is to loss. Another critical factor in determining losses is the total volume of runoff. The effect on water quality of nearby surface water is determined by both the nutrient concentrations and quantity of manure-carrying runoff water.

Runoff amounts from fields with manure are affected by the same factors as fields without manure. A manure application can be thought of as a mixture of residue (dry matter) and water. The more liquid the manure is, the more it adds to surface soil moisture. On the other hand, dry matter added as manure can act like residue in slowing and trapping runoff.

Runoff events that have occurred soon after manure application on monitored fields provide examples of how much manure can be lost from the field in runoff. At the Arlington Research Station, 8500 gallons per acre dairy manure were applied to a field in continuous corn silage on 10/29/03. Rainfall started on 11/1/03 before a planned chisel plowing to incorporate the manure could take place and continued off-and-on for several days. Approximately 3% of the applied manure ran off during this period. Another example is a no-till corn field which received 6000 gallons per acre liquid dairy manure in early October of this year. Within three hours of application there was an unexpected storm with 0.55 inches rainfall. About 4% of the applied manure ran off. Manure on snow is at risk of loss in snowmelt, particularly if it is applied within a short time period before the thaw. At the Pioneer Farm, about 3% of the solid beef manure applied in early February ran off during the first series of snowmelt events after application to a fall-chiseled corn field (Field B in Example 2 above). While 3 or 4% may seem like a relatively small proportionate loss, it can have a substantial impact on water quality if the runoff reaches a stream without substantial dilution. An adjacent stream turned black immediately following the October event described above.