The Word of the Day – Imperviousness

by
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The dictionary definition of the word "Impervious" is simply, "Impossible to penetrate". That seems pretty clear but the implications of imperviousness are much more complex, especially when we are talking about the health of our creeks and waterways.

Imperviousness is a useful indicator of the impacts of land development on aquatic systems. It has been studied in many locations, under different conditions and with many different methods. The results all yield similar conclusions: Stream degradation begins to be evident at levels of imperviousness within a community of 10 – 20%. These are relatively low levels, especially when it is understood that impervious surfaces include not only roads, sidewalks and parking lots but the rooftops of buildings as well.

Let's examine some of the specifics associated with imperviousness.

Impervious surfaces are directly related to the amount of stormwater run-off that must be managed. Stormwater run-off is measured according to run-off coefficients that describe the percentage of rainfall that runs off of an acre of a particular type of surface. For instance, the run-off coefficient for one acre of natural meadow is 6% while the run-off coefficient for the same area of parking lot is 95%. That is a significant increase. If you were collecting run-off from these two surfaces, the run-off of a one-inch storm on a meadow would fill a 10 ft x 10 ft space to a depth of about two feet. The run-off from a parking lot in the same size storm would fill the 10 ft x 10 ft space to a depth of more than 30 feet.

Why is there such a dramatic increase? The characteristics of meadow plants and access to non-compacted soils allow the stormwater to infiltrate into the soil where it will either be used by the plants or move further down to the aquifers below. The parking lot is solid and does not allow any infiltration so all of the stormwater runs off. In addition, paved surfaces are generally graded to ensure that the water flows to the edges rather than puddling. Therefore, even water that could evaporate or be absorbed by landscape plantings generally ends up as run-off.

So what's the big deal about run-off? After all, doesn't the water belong in the streams & creeks anyway?

Let's start the answer to these questions by remembering that streams are mostly fed from the water that enters them from underground! In a natural setting the stormwater infiltrates into the ground and continues to be pulled down by gravity. The water is under a great deal of pressure and must keep moving, even underground. When its downward movement is blocked, it will seek other ways to escape the pressure. It may come back to the surface as a spring or it may enter streams and creeks from under the streambed. This is what keeps creeks flowing during dry spells and is critical to stream health. When all the stormwater is diverted directly into the streams, the water is immediately lost to the local ecosystem. As you may guess, there are numerous consequences to dealing with stormwater in this way.

The Perkiomen Valley receives about 45 inches of rain per year. In an undisturbed area, about 12 inches of rainfall will make it into the local aquifer. Nearly 25 inches of rainfall is absorbed by vegetation and returned to the atmosphere as water vapor. In an area that is heavily developed, with nearly all impervious surfaces, 43 inches of rain will become run-off, leaving only 2 inches to support the plants, the aquifer, creeks and human water supplies.

Stream Shapes

Streams, creeks and rivers are constantly changing their shape. The Grand Canyon is one of the most extreme examples of the power of water - over lots of time. When imperviousness increases, the amount and velocity of stormwater can increase dramatically. More water moving at a greater speed can severely damage fragile streambanks. Streams are widened and downcut triggering additional streambank erosion and habitat degradation. Research models developed in the Pacific Northwest indicate that streambank stability will start to be impacted at the relatively low rate of 10% imperviousness. Imperviousness in excess of this threshold increases the number of times the streams are full and overfull, resulting in unstable and eroding stream channels. So the changes in stream shape that would ordinarily take hundreds or thousands of years occur within a few seasons.

In addition, streambank erosion increases the amount of sediments that are washing into the stream, even after small rainstorms. The increase in sedimentation in highly urbanized creeks directly impacts the spawning abilities of fish and other organisms that require a gravelly substrate.

Water Quality

One of the benefits of allowing stormwater to infiltrate through the soil is that the soils actually filter out many of the impurities that fall with the rain. In contrast, when the rain falls on impervious surfaces, it loosens and picks up pollutants, carrying them along through the stormwater management systems, directly to local streams. Imperviousness therefore, not only interrupts the natural filtering process of the soil but it greatly adds to the load of pollutants that end up in the stream.

Stream Health

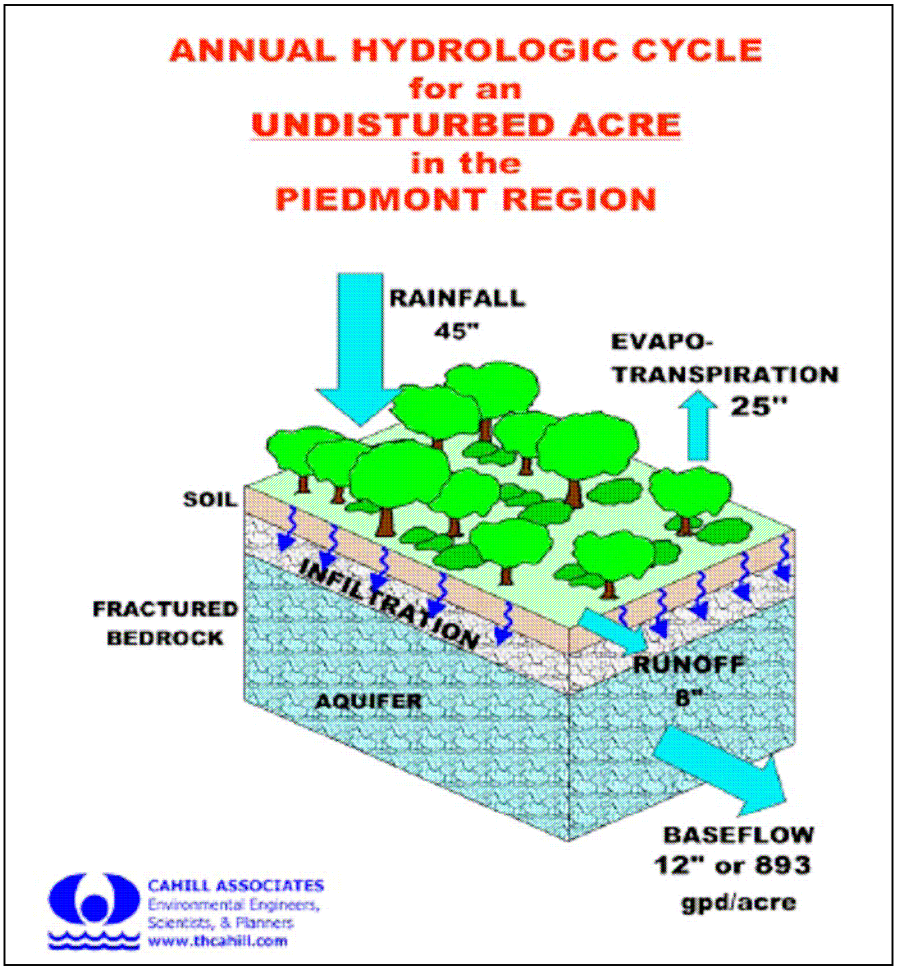
There are a number of variables that impact the health of a stream. One is water temperature. Cold water fisheries have monthly temperature limits to protect native fish populations. Above these temperatures, the waterway may not be able to support native trout and other temperature sensitive species. Trout, in particular, have stringent temperature requirements and are seldom found in watersheds with more than 15% imperviousness. Impervious surfaces impact stream temperatures in two ways. Impervious surfaces can increase local air & ground temperatures to 10 to 12 degrees higher than surrounding fields and forests. This increase in ambient air temperature also increases local water temperatures. In addition, all the rain that falls on paved surfaces is warmed as it runs over those surfaces and remains warmer once it reaches the stream. Research indicates that artificial ponds and lack of streamside trees also affect water temperature but the amount of impervious surfaces is the primary contributor to warmer waters.

Biological diversity within the stream is a leading indicator of water quality. The *benthic macroinvertebrates* or streambed insects form the base of the aquatic food chain and are a useful environmental indicator. Once again, imperviousness of 10% to 15% seems to be the threshold at which sensitive organisms are replaced by those that are more pollution-tolerant. Recent studies by the Stroud Water Research Center within the Perkiomen Creek basin bear out these relationships. Generally in areas with less total development, more of the sensitive aquatic insects are in residence while in more developed areas only the pollution tolerant insects can be found. Once again, imperviousness at 10% to 15% of the total land area appears to trigger the decline.

So what are we to do to protect not only our own sources of drinking water but also the streams and all the life they support?

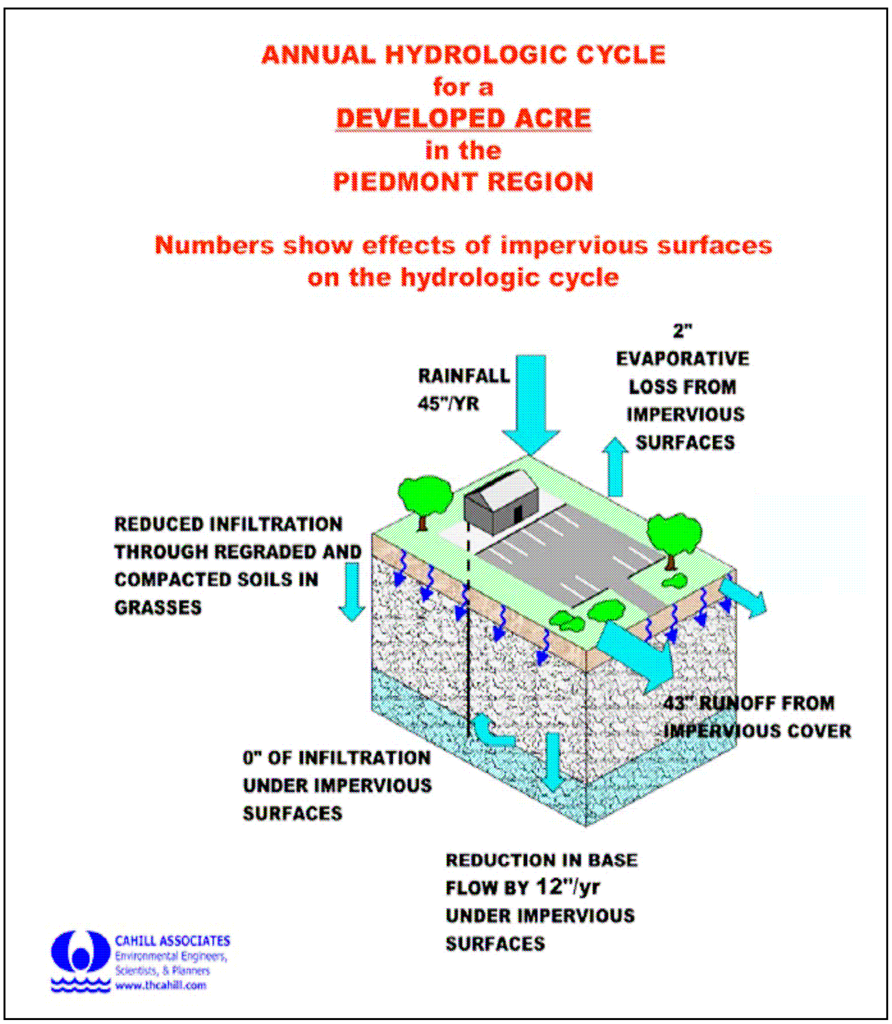
Communities can take a great number of actions to help protect their water resources. Individual property owners can do some things while others require the commitment of the whole community. Included here are ten items that are easy to do and are vital to protecting water resources in every community.

The proceeding information was summarized from the *Fall 1994 edition of Watershed Protection Techniques, Volume 1, Number 3*.



On an undisturbed acre in the Perkiomen Valley, more than half of the annual rainfall is taken up by trees and plants. About ¼ of rainfall infiltrates to the aquifers that feel local wells.

- 95% of rainfall occurs in storms of < 3" /day
- Trees & natural vegetation consume large amounts of rainwater & retain rainwater on leaves & bark allowing it to slowly drop to the ground or evaporate.
- 10,000 trees retain about 10 million gallons of rainwater/ year. (Center for Urban Forest Research, Univ. of California, Davis, Calif.)



Construction of impervious surfaces without concern for preserving natural areas can have significant impacts on local water supplies.

- Land development increases impervious surfaces therefore stormwater runoff also increases.
- As runoff increases, the amount of water that soaks into the soil decreases. Groundwater recharge, evapo-transpiration, and stream baseflow all decrease.
- Modern construction methods compact soils resulting in more runoff from lawns than from undisturbed natural areas.
- After development, stormwater runoff occurs during small rainfall events that previously did not generate runoff. The frequency of runoff events increases.