HOW SHOULD WE MANAGE STORMWATER IN DEVELOPED AREAS?

Imagine for a moment that you are camping in one of your favorite mountain campgrounds in your favorite spot overlooking a trout stream. It is a summer weekend in western Pennsylvania which means….yes, the rain is pouring down. But, it is 1:00 a.m. and you are nestled dry and warm in your sleeping bag listening to the rain patter on tree and leaf and ground, and loudly hit the asphalt road you drove in on. As you crawl out of your sleeping bag in the morning, the rain has stopped and you hope that the stream is not flooded and chocolate-milk-mud brown, the way the stream back at home always seems to be after rain. You are happy to find that, while the water is a little higher and faster and leaves and twigs are swirling in the eddies, the water and rocky stream bottom are still clear and clean.

Just what you expect of a stream flowing through a mountain campground, but should you also expect it in streams closer to home? Why does your "home" stream become a mud-colored, bank-scouring torrent after a storm? Why do mountain and headwater streams respond so differently to stormwater?

Of course, the farther downstream in the watershed you are, the larger the stream will be, the more water it will carry, and the more organic material from sources outside of the stream will be present. But, the major reasons the campground streams and those "close to home" look and behave differently following rainfall and storms are due to our activities and can be summed up in two words - LAND USE.

In the undeveloped watershed of our campground, it is likely that well over 90 percent of the watershed is covered in growing vegetation and undisturbed uncompacted soils covered by a protective layer of leaves and other plant material, and less than 5 percent is under impervious cover roads, the shower houses and campground office), and small areas of compacted soil (from car tires and heavily-used trails). In this type of natural environment, on average:

- 25 percent of the rainfall infiltrates through the soil to the groundwater (deep infiltration,
- 25 percent infiltrates into the upper soil layers (shallow infiltration) where it travels laterally through the soil at a slow rate toward the stream'
- 40 percent of the rainfall is taken up by plants and re-enters the atmosphere through evapotranspiration, and
- less than 10 percent of the rainfall becomes surface runoff to the stream, the rate of flow of which is slowed by ground vegetation and leaf litter.

Thus, in natural environments a miniscule volume (measured in gallons or cubic feet) of rainwater enters the stream as direct runoff AND it enters the stream at a slow rate (measured in cubic feet per second).

Now, let's compare this to one of our local streams back home in our developed environment where we live, work, shop, and play.

Imagine now that you are coming out of one of the stores at Donaldson's Crossroads, or Trinity Pointe, or Washington Crowne Center, or the Tanger Outlets (the list is endless and you get the idea). You want to get to your car, but it is raining again. As you wait for a little break in the storm, you might notice the water

surging out of the building downspouts and the raindrops splashing on the pavement. As you run to your car, you might get your shoes soaked in the rivulets of increasing width and depth that are rapidly flowing across the paved parking lot, perhaps carrying plastic bags and cigarette butts in their wake. What does this mean for our streams?

Table 1 shows the percentages of Evapotranspiration, Infiltration, and Surface Runoff as the percentage of impervious surface in a given area increases. You can see that there is an increase in the percentage of surface runoff when as little as 20 percent of the watershed is under impervious surfaces. By the time 75% to 100% impervious surface is reached (as it is in many of our developed commercial areas), the percentage of rainfall volume converted to surface runoff increases to 55% compared to 10% under natural ground cover, with infiltration and evapotranspiration reduced to 45 percent of the total compared to over 99 percent under natural conditions.

Table 1. Stormwater paths with increasing percentage impervious cover in watershed

Impervious Surface	EVAPOTRANSPIRATION	INFILTRATION		RUNOFF
(%)	(%)	SHALLOW	DEEP	(%)
Natural Ground Cover	40	25	25	10
10 – 20 percent	38	21	21	20
35 – 50 percent	35	20	15	30
75 – 100 percent	30	10	5	55

U.S. EPA Green Infrastructure Website Series, Site Planning and Design Considerations, May 12, 2009 http://www.epa.gov/npdes/outreach.cfm?program_id0&otype=1

Not only does the VOLUME of runoff increase with the increase in developed areas, but so does the RATE at which it discharges to the stream because there is often nothing to slow the flow of stormwater off of impervious surfaces. And, not only does the VOLUME and RATE of runoff increase, but the POLLUTANT load increases. Oil and grease, antifreeze, and heavy metals, fertilizers and pesticides, and plastic and other litter are swept toward the streams with no ground vegetation or leaf litter to filter them out as in a natural environment. Unlike natural ground cover, there is no vegetation and leaf litter to filter out pollutants before they reach the streams.

The increased surface runoff volume, rate, and pollutant loads result in severe physical degradation of streams including bank erosion, sedimentation, channel downcutting and loss of connection with the floodplain, water quality degradation, destruction of aquatic habitat, loss of aquatic species, loss of aesthetics and recreational opportunities, and downstream flooding.

So, how can we manage stormwater to help protect and restore our streams so that they are closer to what they were before development, and function more like the streams that we enjoy on our camping trips?

STORMWATER MANAGEMENT FROM 1987 TO 2009

In the upper Chartiers Creek watershed, stormwater systems are separate from the sanitary sewer system and discharge stormwater to the streams. The stormwater might directly enter the storm sewer system which discharges to the stream, or it first might be directed into detention basins or underground tanks before entering the storm sewer system. But, either way, it all ends up in a stream.

Federal and state laws and regulations to manage stormwater on construction sites are designed with the goal of minimizing erosion and sedimentation and associated nonpoint source pollution. Post-construction stormwater management traditionally focused on managing the rate at which the stormwater entered the stream to avoid or minimize downstream flooding. In an effort to control flooding, for many years state and federal regulations have required developers to incorporate methods that would maintain the stormwater runoff rate from the developed site to the same or less than the rate from pre-development conditions. Traditional rate control methods include aboveground detention ponds and below-ground tanks. These methods controlled rate, but volume control and pollutant removal were secondary concerns. Vegetated detention basins resulted in some pollutant removal if the basins were well-maintained, but did not address the increased volume of stormwater runoff.

Many people are familiar with the heavily developed, commercial stretch of Route 19 in Peters Township between McMurray Road and Waterdam Road. Businesses include strip malls with anchoring stores Giant Eagle and K-Mart, smaller strip malls, drug stores, restaurants, professional/medical office buildings, hardware stores, and real estate offices (to name a few). Stormwater management methods on existing developed sites include direct discharge, underground tanks, oversized storm sewer pipes, and detention ponds, and all have one thing in common. They all discharge into the storm sewer system that discharges to Canonsburg Lake. Unlike in other areas where development drains to streams, Peters Township does not require rate control for stormwater runoff in the Canonsburg Lake stormwater management area because the lake acts as a de facto giant detention pond due to the dam.

Donaldson's Crossroads Shopping Center (DCSC) which was built before stormwater management regulations were developed, discharges directly into the storm sewer system, without rate, volume, or water quality controls. Some variation of underground tank systems are installed in the McDowell Shops site (K-Mart), the McMurray Shops (Capstone Grille, etc.), Waterdam Plaza (professional buildings, Dairy Queen, etc.), and Lakeside Plaza (Starbucks, Supercuts, etc). These tanks capture water and depending on the design, may or may not exert any control over rate. Waterdam Commons (Grande Restaurant, Ace Hardware, etc.) utilizes a vegetated detention pond, which controls rate and provides some pollutant removal.

NEW AND INNOVATIVE STORMWATER MANAGEMENT

The Pennsylvania Department of Environmental Protection (PADEP) stormwater regulations and Erosion and Sediment Control Best Management Practice Manual were revised last year to manage all three parts of stormwater management – RATE, VOLUME, and WATER QUALITY. Many new methods and proprietary products have been developed that reduce volume and control rate to pre-construction levels or lower and treat water quality. Examples of products and designs that encourage infiltration, evapotranspiration, and water quality improvements include underground infiltration tanks, rain gardens, constructed wetlands, bioswales (bioretention), porous pavement and permeable pavers (infiltration),

water quality inserts in catch basins, and “green roofs”.

These methods are being used by developers to help meet new requirements under Pennsylvania General Permit (PAG-02) and Individual NPDES Permit for stormwater activities associated with construction activities. An Individual Permit is required when the construction will be occurring in a PADEP designated Special Protection Watershed, such as Little Chartiers Creek, which has been designated by the PADEP as a High Quality Water from its source to the Canonsburg Lake Dam. Thus, any new projects in the Route 19 corridor described above would require an Individual Permit.

A requirement for both the PAG-02 and Individual permit is a post construction stormwater management (PCSM) plan. The goals of the Post Construction Stormwater Management Plan (PCSM) Plan include the elimination or minimization of point source discharges to surface waters, preservation of the integrity of the stream channel, and protection of the physical, biological, and chemical properties of the receiving water. In addition, an Individual Permit requires an anti-degradation analysis to minimize the potential for pollutants to receiving waters so that existing or designated surface water uses are protected.

None of the stormwater management methods in the existing developments would meet the requirements of the new PAG-02 or the Individual Permit. However, at least two sites in the Donaldson’s Crossroads area have incorporated new and innovative stormwater management methods – the Changing Seasons Learning Center and Lakeview Square.

Changing Seasons Learning Center - Carol Teodori was in the vanguard in 2002 when she asked Evolve, Inc. to design the landscape and stormwater management of Changing Seasons Learning Center, several years before “Low-Impact-Design” and “green” buildings entered the mainstream. Changing Seasons Learning Center is located on one acre of land adjacent to the Heritage Meadows residential development behind Donaldson’s Crossroads Shopping Center. In addition to rain that falls on the one acre site, runoff is received from the upslope Heritage Meadows development. The stormwater management features employ infiltration, underground storage, bioretention, and above ground storage in a landscaped pond. The parking areas were constructed with a cellular confinement system in the upper lot and plastic porous paving system in the lower lot, both having a gravel base layer and pea gravel to allow infiltration. Any water that exceeds infiltration capacity in the lower parking lot would drain into an underdrain pipe and flow downhill to enter the municipal stormwater system along McMurray Road. Any water that exceeds infiltration capacity in the upper parking lot enters an underdrain pipe which discharges to a decorative stone waterfall, and then is piped to the pond. Runoff from the roof enters underground cisterns. The cisterns drain to a landscaped wetland they call the “Marsh”. The Marsh overflows to the pond. The pond is designed to send any overflow to the municipal storm sewer. The construction was completed in 2003. Ms. Teodori said they have monitored the outflow pipes to the storm sewer, and have never seen any water leaving the site, even during and after the hurricane remnant storms in 2004.

Front View of Changing Signs Learning Center Building

Lake View Square - Currently under construction, Lake View Square will be completed in January of 2010. This project required an individual permit and corresponding post-construction stormwater management plan, which complies with all stormwater management criteria set forth by the Pennsylvania Department of Environmental Protection (PA DEP) and Peters Township. International design firm Burt Hill provided sustainable architecture, landscape architecture, and civil engineering solutions for design of the development, which meets the prescribed requirements and focuses on volume reduction and water quality improvement / anti-degradation.

The design of Lake View Square incorporates water quality inserts in all stormwater inlets, as well as a proprietary underground infiltration facility (Rain Tank®). Once it is fully constructed, the system will direct stormwater runoff to the inlets. Each insert has a series of graduated stainless steel screens to capture various sized particles and debris while allowing water to efficiently pass through the system. Each catch basin insert is equipped with polycarbonate storm booms to further confine oil, grease, and other such unwanted water pollutants. After filtering occurs at the inlet, the stormwater continues to drain through to the infiltration facility. The inflow to the infiltration facility has a sump, or standing pool of water, that then settles out any particles not previously captured at the inlets. Once through the sump, the stormwater finally enters the infiltration facility, where it begins to infiltrate the ground. The facility, made of 85% recycled polypropylene, infiltrates the increase in volume as determined by analyzing pre- and post-

development runoff based on the “two-year storm” as prescribed by the PA DEP. Once infiltrated, the runoff is further cleansed by natural processes, and eventually migrates into nearby Canonsburg Lake.

Lakeview Square Rain Tank - During Construction

Just think what a difference it will make to our streams all across Pennsylvania as these types of volume reduction and water quality stormwater management techniques become the norm instead of the exception for new development.

Of course, we still will have hundreds of acres of impervious surface in existing developments that will continue to contribute to stormwater impacts to our streams. Although retrofits of these sites to meet volume reduction and water quality goals are not required by the PADEP, the owners should be encouraged by local municipalities and the public to renovate their sites to incorporate some of these methods. Underground tanks may be cost-prohibitive to install on an existing site, but other methods such as rain gardens, curb cuts, green roofs, permeable pavers/porous pavement, and restoration of natural stream buffers might be possible. The ChCWA encourages developers and site owners to use the best available technologies and innovative ideas to reduce the volume and rate of stormwater and improve water quality so that our streams are protected against further degradation and eventually restored to healthy, functioning ecosystems.

Many activities in addition to development lead to degradation of our streams (e.g. poorly managed

agricultural sites, abandoned mine drainage, existing mining operations and natural gas drilling), but unmanaged stormwater is certainly one of the major causes of stream degradation that we can control.

WHAT CAN YOU DO?

If you are a developer developing a new site or altering an existing site:

- meet the minimum requirements of the new laws,
- consider the lifetime cost of improvements not just traditional costs,
- incorporate as many features of best management practices for stormwater management whether required or not.

If you are an elected municipal official:

- be active in the preparation of the Washington County Stormwater Management Plan,
- ask the municipal engineer and planning commission to make recommendations on what changes need to be made to the subdivision and land development ordinance and stormwater management ordinance to incorporate new stormwater management laws and to encourage or reward use of best management practices for stormwater management and
- follow-up by adopting an updated subdivision and land development ordinance and stormwater management ordinance consistent with the County Stormwater Management Ordinance.

If you are a resident or landowner:

- attend Planning Commission meetings to find out about new proposed developments, and encourage the use of volume reduction and pollution minimization methods.
- the next time you see a site under development, take the time to ask your municipal planning commission or the developer what stormwater management methods are being used and if the PCSM Plan is available. The owner or operator of the facility with a stormwater discharges covered by the PAG-02 or Individual Permit is required to make PCSM Plans available to the public upon request, and the PCSM Plan must be made available at the site of the construction activity at all times.
- Thank elected officials, planning commission members and developers who are doing a good job of incorporating best stormwater management practices in local ordinances and developments.

ADDITIONAL RESOURCES

There is an abundance of information available on Best Management Practices, new and innovative methods and products, “green” development and retrofits, low-impact design, and models for cost/benefit analysis. The following references are good starting points for those who want to learn more.

U.S. EPA's National Pollutant Discharge Elimination System (NPDES) website www.epa.gov/npdes

Center for Watershed Protection http://www.cwp.org

Pennsylvania Department of Environmental Protection www.depweb.state.us.pa

ACF Environmental http://www.acf.com

NPDES Training Courses and
Workshops http://cfpub2.epa.gov/npdes/outreach.cfm?program_id=0&otype=1

USEPA NPDES Stormwater Program homepage http://cfpub2.epa.gov/npdes/home.cfm?program_id=6

PA Erosion and Sediment Control Program Best Management Practice Manual and the PAG-02 and Individual Permit application http://www.elibrary.dep.state.pa.us/dsweb/Homepage