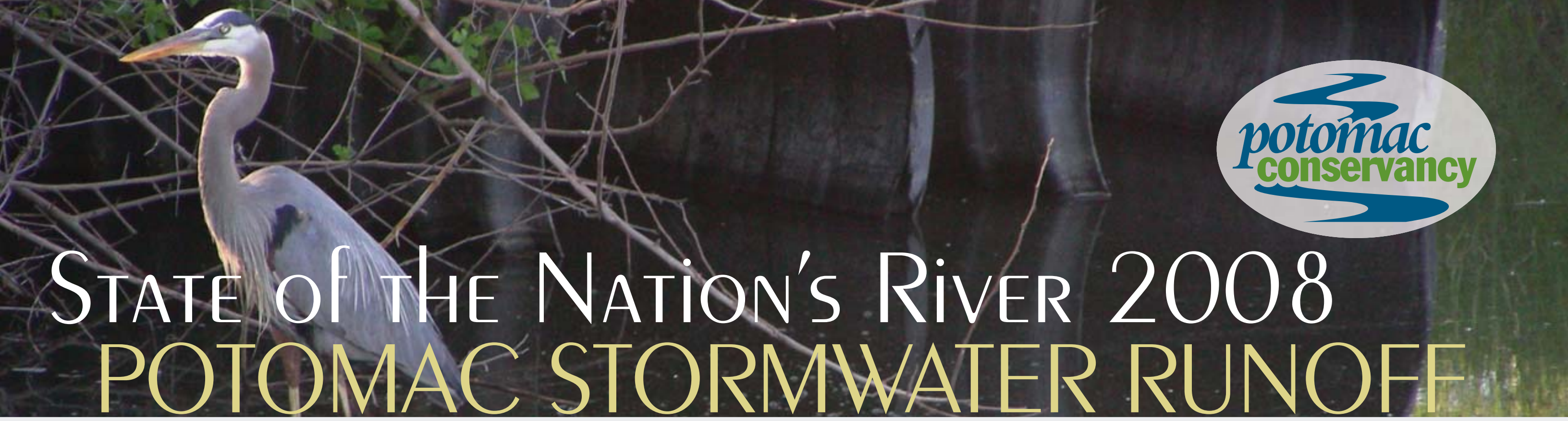


State of the Nation's River 2008
POTOMAC STORMWATER RUNOFF

Potomac River Watershed Is a "Hard" Place to Live

Runoff from development is the fastest growing source of pollution in the Potomac River watershed. Our continued love affair with asphalt, concrete, and turf grass has created a "hard" urban landscape that cannot effectively absorb rainfall. What network meteorologists call rainstorms and what water managers call wet weather events wreak havoc on local waterways. Regardless of the name, the sudden influx of hot, dirty, and disease-laden runoff creates an aquatic version of "scorched earth."

Polluted stormwater runoff was cited in the Conservancy's 2007 *State of the Nation's River* report as one of the key issues troubling the Potomac River watershed. This year's report shows the consequences of allowing runoff to flow unchecked—and often untreated—into our local rivers and streams.

A survey commissioned by Potomac Conservancy shows that more than two thirds of DC metro area residents feel that stormwater runoff is an important issue for Potomac River water quality, and were concerned that untreated sewage went into our rivers and streams during heavy rainfalls. The respondents, however, were at a loss to recommend constructive solutions.

The Conservancy advocates workable solutions to the runoff problem. Indeed, these "low impact development" solutions are already being implemented, but only on a very limited scale. What is needed is more awareness of the problem, and government action to make low impact development the rule rather than the exception.

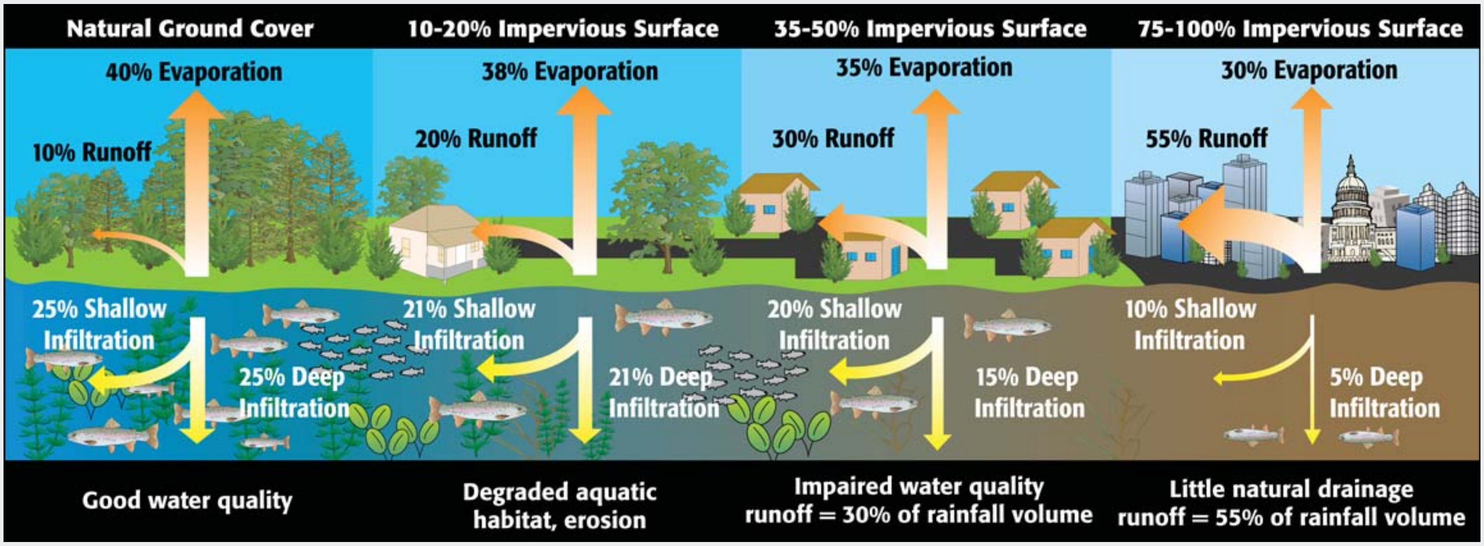
Stormwater Runoff Treats Our Streams Like Sewers

Runoff from rainfall is not a manmade creation. Rainfall is a critical and beneficial part of the natural (hydrologic) cycle that replenishes groundwater and nurtures plant and animal life. In a balanced system, the land holds rainwater and allows it to slowly filter into streams, rivers, and lakes. Even in a natural system some rainfall runs off the land, but this is a slow and controlled process in which only a small percentage of precipitation becomes runoff.

Unfortunately, increased land development in recent decades has thrown a wrench in the earth's natural filtering mechanisms. Traditional development sets up a concrete-lined system of tributaries that bypasses the earth's natural systems and dumps directly into rivers and streams. Stormwater superhighways like roads and gutters provide straight, impermeable paths for water to travel, picking up speed, volume, pollution, and pathogens along the way. During rainfalls, stormwater outfalls release millions of gallons of stormwater laden with trash, oil, pesticides, chemicals, nutrients, and other pollutants.

The result? Waterways that function more as sewers than as natural streams. For example, fecal coliform, a bacteria found in excrement and that causes serious gastrointestinal ailments, is found in much higher levels in streams near where stormdrains empty. *In fact, stormwater pollution is a primary reason that the District of Columbia has banned swimming in all its rivers and streams, including the Potomac.*

Figure 1. Effects of Diminishing Natural Ground Cover on Water Quality



Source: EPA. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

As impermeable surfaces increase, natural ground cover and surfaces decrease, which causes more runoff and degraded stream health. Scientists estimate that when it rains, a natural surface absorbs about 90% of the precipitation; the remaining 10% is converted into runoff. However, when a surface contains 75-100% impervious cover about 55% of precipitation is converted into runoff.

Strange Brew: Stormwater and Sewage Increase Stream Bacteria Levels

What we call stormwater is not just runoff from our roofs and pavements. One particularly ominous addition to the stormwater mixture is the overflow from combined stormwater sewer systems. Although the antiquated combined sewer system helps prevent the backup of sewage waste into homes and streets, it places the overflow into neighboring waterways. By combining stormwater (80-85%) with raw sewage (15-20%), combined sewers can emit dangerous pathogens, chemicals, nutrients, and other pollutants into the watershed. In Georgetown, in the District of Columbia, an overflow can occur when as little as one-tenth of an inch of rainfall is added to the Potomac River. The overflow event can last for more than 4 hours. *Along the Anacostia shoreline, 17 discharge locations result in 2 to 3 billion gallons of sewage overflow into the river each year.*

With population and development on the rise, the volume of sewage and stormwater is also increasing. *According to the Environmental Protection Agency (EPA), discharges from both separate and combined stormwater sewers are the leading cause of impairment and pollution for the Potomac. About 70% of the impairment and pollution of the Potomac River in Washington, DC, is caused by overflow from these combined sewer outlets.*

Our Hardened Landscape Cannot Absorb Pollutants

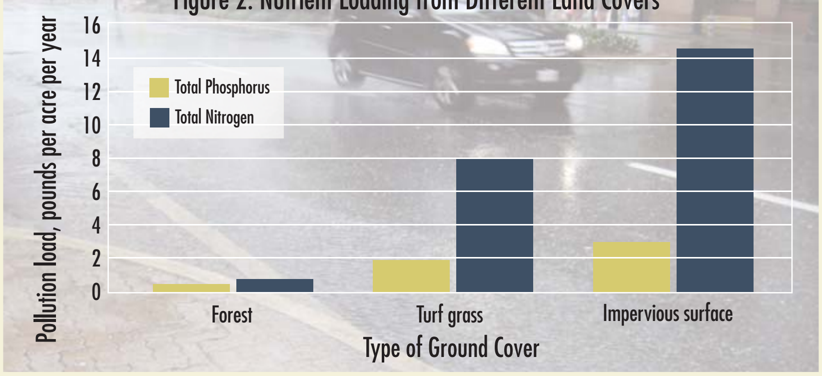
The true culprits of the stormwater runoff problem are the hardened surfaces—known as impervious surfaces—that cannot effectively absorb or infiltrate rainfall. As development in the Potomac River watershed increases each year, so does the amount of impervious cover. In fact, the paving of our land often outpaces the rate of development by a factor of 5.

As impermeable surfaces increase, forest cover decreases. Over a 30-year period, the tree canopy in the District of Columbia has declined by 16% and the stormwater runoff has increased by 34%. This rapid loss of natural cover can be found throughout the watershed. *Between 1986 and 1999, Maryland averaged more than 6,000 acres of forest loss per year. This loss is significant because forests are capable of capturing up to 6 times more rain than grass alone and 20 times more rain than impervious surfaces, such as parking lots.*

Negative effects to water quality and to fish and other aquatic species have been documented in the Bay with as little as 10% development. *In urban areas like the many metropolitan centers in the Potomac watershed, impervious ground cover can make up 45% (or more!) of land cover.*

Can runoff really wreak this much havoc? It can and does. *As impervious cover and the related stormwater volumes increase, studies show a correlated decline in water quality. Health risks related to stormwater range from boosted bacterial concentrations to unsafe quantities of toxins to fish kills from darkened, oxygen-depleted water.*

Figure 2. Nutrient Loading from Different Land Covers



Source: Schueler, T. Controlling Urban Runoff: a Practical Manual for Planning and Designing Urban Best Management Practices. Metropolitan Washington Council of Governments, Washington, DC, 1987.

Arsenic, Bacteria, Chemicals: The ABCs of What's in our Stormwater

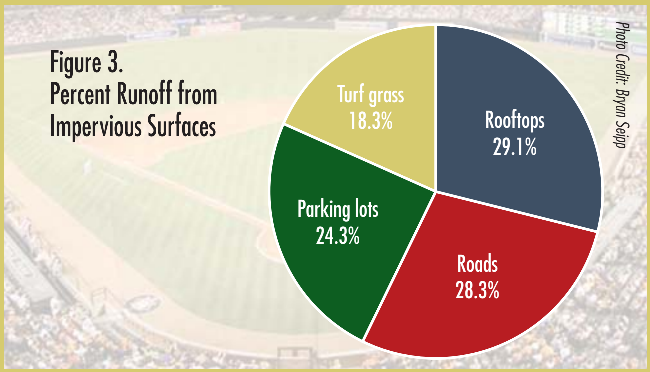
Stormwater has the ability to carry with it a multitude of pathogens and pollutants that can be harmful to humans. In the United States, the majority of the cases of waterborne illnesses—those caused by *Cryptosporidium*, *Giardia*, *Shigellosis*, and *Escherichia coli*—are associated with heavy rain storms. All these waterborne pathogens can cause gastrointestinal illnesses and hospitalization. Pesticides were detected in 95% of urban streams and fish tissue in Maryland, which resulted in a public health advisory against eating bottom-dwelling fish in the District of Columbia. There is also a ban against swimming in the Potomac and Anacostia Rivers and Rock Creek.

In addition to pesticides and pathogens, stormwater also includes toxic mineral and chemicals such as arsenic, and other chemicals that may cause cancer, lymphoma, and neurological damage. A list of substances found in stormwater is available at www.potomac.org.

Grass Isn't Always Greener

There are three types of impervious cover. Two are obvious: rooftops and transport-related surfaces such as roads, sidewalks, and parking lots. The third type is known as impaired urban soil, or turf grass, which includes suburban mainstays such as lawns, golf courses, and baseball diamonds. When new homes are built, several feet of topsoil are often removed when development sites are graded. This naturally porous soil is then replaced with lesser grade soils and covered with sod. *Areas with soils that infiltrate water well should be identified and preserved during construction, and used to help control post-construction runoff.*

Figure 3. Percent Runoff from Impervious Surfaces



Source: Adapted from Tilley, JS, Slonecker, ET. Quantifying the Components of Impervious Surfaces: Open-File Report 2006-1008, U.S. Geological Survey, 2006.

Learning the Hard Way: Current Development Practices are Unsustainable

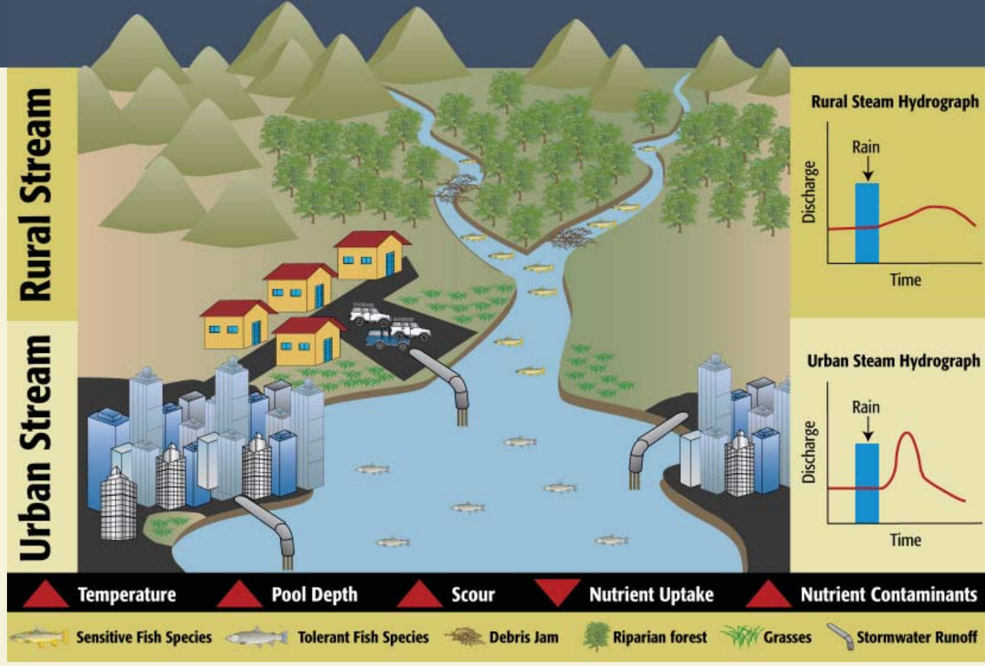
The Chesapeake Bay Program estimates that while the population of Bay watershed grew at a rate of 8% during the 1990s, the amount of paved surfaces increased by 41% during the same period. This 5x multiplier points to overbuilding, inefficient land development, and a host of other problems with the way we are building and preserving our remaining open spaces.

According to a 1994 study, more than a quarter of the Potomac River watershed has already been "hardened: that is, paved, roofed or turfed over." Natural plantings, topsoil, and elevations are bulldozed clear and flat in most construction projects, replanted later with small trees and sod.

Figure 4. Symptoms of a Sick Stream: Urban Stream Syndrome

The degradation of streams draining developed land is known as "urban stream syndrome." The streams consistently feature the combined effects of increased percentages of impervious surfaces and more runoff from those surfaces into piped stormwater drainage systems. Symptoms of urban stream syndrome include increased flash floods; elevated concentrations of nutrients and contaminants; altered stream morphology, including incised channels that cuts off vegetation from its water source and increased sedimentation from eroded streambanks; and reduced diversity, with an influx of more tolerant species to counter the loss of more sensitive species. Aquatic habitat is affected. The trend arrows indicate the negative changes in urban stream characteristics, including increased temperature, pool depth, scour, and contamination by nutrients such as phosphorous and nitrogen, and a decrease in uptake of those same nutrients. As seen in the hydrographs at far right, urban streams tend to be more "flashy," that is, more frequent, larger flows than their rural counterparts.

Source: This figure is adapted with permission from Cushman, SF. Fish Movement, Habitat Selection, and Stream Habitat Complexity in Small Urban Streams. Ph.D. Dissertation, University of Maryland, College Park, MD, 2006. Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.



Anatomy of a Storm: Fast Flowing Water Scours and Degrades Streams

Heavy rainfall enters stormdrains and races through pipes to stream outfalls, where the water tears into the stream, leaving in its wake carved out streambanks, piles of soil, and deposits of litter. Innovations such as gutters, sidewalks, and curbs have increased the volume, velocity, and temperature of water as it is transported downstream from the urban landscape.

Volume

In our urban areas, large quantities of stormwater pour off impervious surfaces and rush into surrounding bodies of water. Increased stormwater volume can destabilize streams by creating wider channels through erosion. When this occurs, pool habitats are lost, streamside vegetation is destroyed, and woody debris becomes less common, all of which removes the living space for aquatic species that reside in these calmer, deeper waters. Stormwater volume increase causes stream scour events that alter the shape and depth of the stream. *Research shows that a reduction in stormwater volume also reduces the amount of polluting nutrients flowing into streams.*

The figure below shows streamflow data collected by the US Geological Survey, which reflects peak flow for all storms over the duration of their 2000 study. Accotink Creek is characterized by heavy development, while Aquia Creek is located in a largely wooded and undeveloped area. As shown, peak flow is nearly ten times higher for Accotink Creek than Aquia Creek. *The increase in peak flow can augment sediment load and add to the acceleration of erosion*.

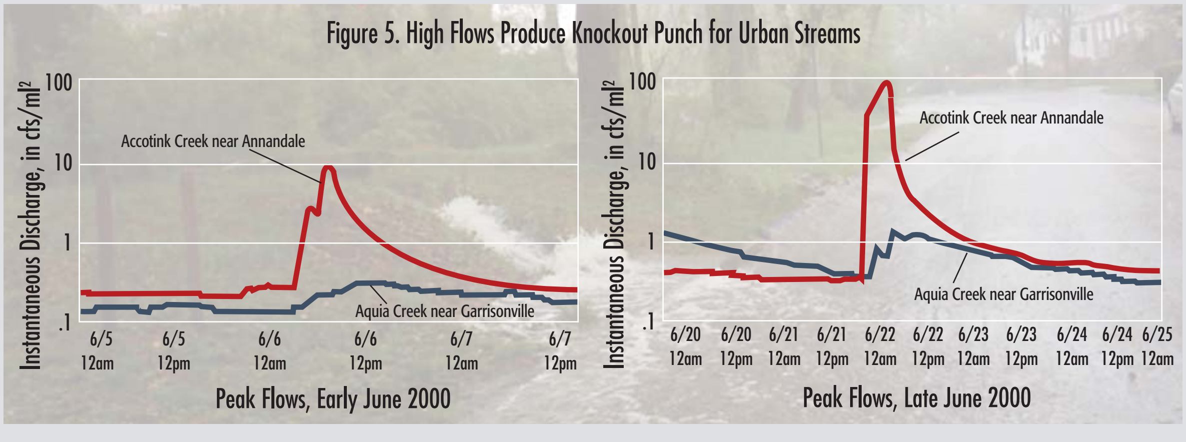
Velocity

The increased velocity of stormwater can also cause an increase in channel width, which can lead to a loss of the natural features of a stream, such as riffles and pools. The high-speed waters wash away critical vegetation and spawning habitat, and sediment and chemical contaminants enter the stream. Sediment is a major pollutant in the Potomac River watershed. It also a significant source of sediment, which is a major pollutant in the Potomac River watershed. The erosion caused by fast-moving stormwater deepens, or incises, stream channels and the water table drops below the level of roots and vegetation. This disconnect from roots to water causes a hydrological drought that stresses streamside trees and plants.

Temperature

Pavements and parking lots conduct and retain more heat than natural surfaces. After a rainfall, heated water runs off these surfaces into stream waters, creating a temperature increase, which is harmful to aquatic life. Urban streams have been known to have a higher summertime temperature—10-15 degrees Celsius higher—due to the water washing over the heated surfaces. The "heat island effect" is an increase in ambient temperature, especially in urban areas with high amount of paved and other impervious surfaces. Streams that have increased in temperature 10-12 degrees have less streamside shade vegetation, which alters the surrounding ecosystem. *Stream temperature has been known to increase by .25 degrees Celsius with every 1% of imperviousness.*

Figure 5. High Flows Produce Knockout Punch for Urban Streams



Urban development causes increased flow that scours streambeds and blows out streambanks. This graph shows the spike in water flow in a developed, urban stream (Accotink Creek, near Annandale, Virginia; in red) when compared to the effect of the same storm on a stream in a relatively undeveloped area (Aquia Creek, near Garrisonville, Virginia; in blue).

Source: Miller, CV, et al. Water Quality in the Upper Anacostia River, Maryland: Continuous and Discrete Monitoring with Simulations to Estimate Concentrations and Yields, 2003-05. US Geological Survey, 2007.

Weak Rules Fail to Prevent Stormwater Pollution

The Clean Water Act was not originally interpreted as regulating stormwater runoff, and its structure is not well-suited to addressing pollution like stormwater that comes from many diverse points (rather than out of a factory pipe). However, in 1987 Congress recognized the growing threat urban runoff presented to our nation's water quality, and added a new section to the Clean Water Act that requires urbanized areas to get a federal permit to discharge stormwater. These permits, issued by the state on behalf of EPA, are known as MS4 (municipal separated storm sewer system) permits. Today most urban stormwater runoff is regulated under the Clean Water Act, and urban areas are required to follow the rules set in their MS4 permits to reduce stormwater pollution.

So why does stormwater pollution continue to grow, while other federally-regulated pollution—like that from factories and sewage treatment plants—shrinks? *Simply stated, the stormwater permits issued by EPA and the states fail to impose meaningful limits on stormwater pollution.*

While most industrial and other "point source" polluters are faced with strict limits on the amount of pollution they can release, permits for urban stormwater only require pollution reduction "to the maximum extent practicable." Historically, that has meant that the regulated jurisdiction develops its own stormwater management plan, implements certain best management practices, and monitors its own progress. Such planning, best management practices, and self-monitoring are used in lieu of specific pollution reduction requirements. In short, stormwater permit compliance generally requires some minimum actions but no measurable, enforceable, or even independently verified results. As a consequence, local governments can be in full compliance with their stormwater permit even while stormwater pollution continues to grow unabated.

Practical Natural Solutions: Low Impact Development

Traditional stormwater management focuses almost entirely on capturing and piping stormwater off-site as quickly as possible. This creates the "fast, hot, and dirty" stormwater runoff that is the fastest-growing source of pollution in the Potomac. In contrast, low impact development seeks to mimic the water-absorbing capabilities of a natural, undeveloped site even after that site is developed. It aims to prevent stormwater pollution by reducing or eliminating the overall amount of stormwater runoff entering our streams, and if runoff does reach the streams, to ensure that it enters slowly and is cleansed of most or all its pollutants beforehand.

Low impact development begins with conserving the natural runoff-absorbing assets of a site. Site design techniques include directing development away from sensitive environmental areas, preserving native vegetation and soils, maintaining existing drainage courses, and minimizing the extent of impervious areas. Stormwater that cannot be prevented is treated on-site, using natural filtration systems that capture, treat, and slow the release of stormwater. Common methods include rain gardens, green roofs, and porous pavements.

Low impact development median absorbs stormwater runoff from Adelphi Road in Prince George's County, Maryland.

Photo Credit: NOAA

Next Steps: Creating Runoff Accountability for a Runaway Problem

As we noted last year, the Potomac watershed is expected to add more than 1 million people to its population over the next 20 years. We are already building roads, parking lots, and rooftops at an incredible rate, and the needs of our growing population mean the pressure to pave the Potomac will only increase. So how do we keep the future from looking like the past, when pavement grew five times as fast as our population and water quality declined in virtually every urban and suburban stream in the watershed?

We need to grow smarter, minimizing impervious surfaces. We also need to ensure that when we do grow and build, development treads lightly on the land and water.

To make meaningful progress in reducing stormwater pollution in the Potomac, we must:

- Enforce the Clean Water Act by issuing MS4 and other stormwater permits that are enforceable, with numeric pollution limits that have a reasonable expiration date, and are linked to, and hopefully exceed, federal water quality standards.
- Issue regulations that limit stormwater runoff from new development sites to pre-development levels to protect water supplies and maintain a healthy ecosystem.
- Make low impact development standard practice for all development (streets, houses, commercial buildings, schools, etc.).
- Ensure local governments have the technical capacity they need to accurately review and assess stormwater plans, and to ensure runoff limits are meaningfully implemented and enforced as development occurs.

Effective stormwater solutions have been in limited use for at least a decade, but we have failed to implement them on a widespread basis. Changing this pattern of inaction will require government to create strong rules limiting polluted stormwater runoff. It will also require public support, to give our county and state leaders the political will necessary to make and enforce those rules.

Acknowledgements

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Since 1993, Potomac Conservancy has protected the health, beauty, and enjoyment of the Potomac and its tributaries.

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