

Controlling Stormwater Pollution in NYC's Watershed

by Angus Eaton and James Tierney

Not long ago, my sister-in-law looked out her kitchen window and said: "They are beautiful every time I look at them." She was referring to her view of the Catskill Mountains. My brother and she had built their house to have the same view of the Catskills that my family enjoyed when I was growing up. We were not alone in our desire to enjoy the raw beauty of the Catskill Mountains, albeit from afar. Many people want to enjoy that beauty, but some from a much closer vantage point.

– Angus Eaton

Building to obtain that close vantage point raises concerns about the effects that development has on New York City's drinking water. Much of the Catskills, as well as large parts of Westchester and Putnam Counties, are in a watershed that feeds New York City drinking water reservoirs (the New York City watershed). Many people would never think that building in the watershed could result in degradations to water quality. But in the New York City watershed, it is precisely the cumulative effects of human activity that have led to water quality standard violations and the Clean Water Act program to address those violations.

Nutrient Loads from Development

Phosphorus loads from land areas can quadruple when that land area is converted from forested land to low to medium density residential housing without very careful controls to address increased pollutant loads. Phosphorus loads increase even more if the land area is converted to higher density uses. Those increases in loading can degrade waters to the point where they are not fit for fishing, swimming or human consumption. The adverse economic impacts of

polluted runoff are apparent to anyone involved in a vacation-tourist business that has been affected by such runoff. Those more deeply involved overseeing water quality know that New York's process for classifying the health of surface waters (generally streams, ponds, lakes, and estuaries) lists some waters as "impaired." Impaired waters are those waters that cannot be used as they are intended for drinking water, fishing and/or swimming. Of New York's waters listed as impaired, 27 percent of those impairments are attributed to polluted runoff. Many of these impairments are due to excess nutrients in the stormwater.

Those excess nutrients, like phosphorus and nitrogen, have long been known to cause algae blooms and aquatic weed growth in both fresh water and marine systems. Algae blooms, as they die and decay, reduce oxygen levels to the point where fish must move away or else suffocate. The infamous "dead zone" in the Gulf of Mexico is the most well known example of this phenomenon, which happens on a smaller scale in many other waters – such as the western portion of Long Island Sound in warm weather. High levels of phosphorus in lakes also can result in blooms of toxic cyanobacteria, more commonly referred to as "blue-green" algae.

Algae blooms not only harm swimming, fishing, boating and scenic views, but also degrade drinking water reservoirs and interfere with drinking water treatment. The organic sediment from dead algae can operate to transport pathogens and interfere with the effectiveness of drinking water disinfection. Low oxygen conditions often result in chemical processes that can cause the water to look bad, smell bad and taste bad at the tap. When organic material produced from decaying aquatic vegetation comes into contact with chlorine – a common disinfectant used in water treatment plants – they react to produce a class of chemicals known as "disinfection byproducts," such as trihalomethanes and haloacetic acids. These chemicals are regulated by the US Environmental Protection Agency (EPA), based on concerns that they may be carcinogenic and increase the rate of early-term miscarriage. Therefore, effective measures to control polluted runoff are a central element of any effective program to protect drinking water supplies.

Sediment loading from disturbed soils on construction sites is a significant problem as well. The EPA estimates that one unstabilized acre subject to construction activity loses 1,000 to 2,000 times the sediment during a rain event that an acre of forest or natural meadow would lose. Such eroded sediments often carry adsorbed contaminants and nutrients to the water. Eroded sediments can fill wetlands and silt in the rock cobble that serves as spawning beds for trout. Sediment operates to impair drinking water quality by assisting in the transport of pathogens and interfering with the effectiveness of disinfection.

Another important element of stormwater control is the attenuation of peak levels of runoff volume. An engineering rule of thumb is that one acre of impervious surface discharges about 15 times the water that a fully vegetated acre would discharge. New development can cause the peak level of flow through a stream to double, triple or more. At 62.4 pounds per cubic foot, the force of water can literally rip a stream apart. As the stream banks are destroyed, critical habitats are destroyed both at the point of bank destruction and downstream, where sediments and nutrients are deposited. Flooding also increases as unmitigated development affects an area.



Photo by Sean Eaton

The awesome beauty of the Catskill Mountains, such as this vista from Chatham, NY, draws people to live in the region.



Photo by Diana Abramshe, NYCDEP

Turbid discharge coming out of the Village of Tannersville stormwater drainage system



Photo by Diana Abramshe of NYCDEP

The mixing of the turbid discharge from Tannersville Junior/Senior High School and the Sawmill Creek

Stormwater Controls Statewide

Congress initiated the current national program to address polluted stormwater runoff in its 1987 amendments to the Clean Water Act – where it created a two-phase program to address stormwater discharges. Under an agreement with the EPA, New York is primarily responsible for implementing the program within the state. Given the sheer number of dischargers, New York decided to develop “general permits” to control stormwater discharges within the framework of the State Pollutant Discharge Elimination System (SPDES) program.

A general permit is one permit, with associated conditions and requirements, which is issued for use by many similar activities or facilities. A general permit contains standardized requirements that apply to all of the facilities it encompasses. The general permit undergoes a public review process in the same manner as an individual permit. However, once the general permit is issued, operators and owners that comply with the permit requirements are authorized to discharge by submission of a “Notice of Intent” to obtain coverage under the general permit. Filing of the Notice of Intent obligates the party to comply with all requirements of the general permit. In contrast to the individual permit process, there is not a separate

public review process for each facility that is covered. Stormwater general permits are SPDES permits and are fully enforceable in the same manner as any SPDES permit.

In 1993, the New York State Department of Environmental Conservation issued the “phase one” stormwater permits in accordance with EPA regulations and New York State law. This first phase involved a general permit for industrial stormwater and another for large construction sites (that disturb five or more acres), as well as individual permits for New York City’s separate storm sewer systems. Consistent with EPA regulations, the NYSDEC issued the “Phase II” stormwater general permits in 2003. Under these general permits, permit coverage was required for construction sites down to one acre and smaller “municipal separate storm sewer systems” (MS4s).

There are now over 6,500 construction sites and approximately 500 MS4s authorized to discharge under the SPDES general permit. Although the pace of authorizations has slowed significantly in recent months, for most of the last five years, approximately 150 new construction sites were being authorized under these general permits each month.

The 2003 construction stormwater general permit required each construction site to develop and implement a stormwater pollution prevention plan consistent with the New York State Standards for Erosion and Sediment Control to control soil loss during construction. Many construction sites must also comply with the New York State Stormwater Management Design Manual (the Design Manual) to address on-going post-construction stormwater discharges, treating stormwater to improve water quality and detaining stormwater to address flow variations. Individuals or entities engaging in regulated construction activities must retain a qualified professional to develop a “storm water pollution prevention plan” that complies with standards, and then implement the plan. The importance of these state technical standards in stormwater management cannot be over emphasized. The standards provide explicit direction on stormwater management practices to designers. The standards apply to all development and redevelopment projects and can be used as the basis for “retrofitting” controls onto older development sites. How the standards are written and implemented play a key role in determining whether stormwater management will protect water quality, what types of practices will be encouraged or discouraged, whether stormwater infrastructure will be cost effective, and whether installed practices will be inexpensive or expensive to maintain.

Municipalities operating separate storm sewer systems (MS4s) located in “urbanized” areas and selected designated sensitive watersheds were required to gain coverage under the Small MS4 General Permit. In very general terms, these regulated MS4s were required to develop a stormwater management program that would:

1. Implement educational efforts to raise public awareness on stormwater issues
2. Detect and eliminate “illicit discharges” (i.e., discharges of untreated sewage)
3. Control runoff from new development and redevelopment
4. Minimize pollution from municipally owned properties and stormwater infrastructure.

Stormwater Controls in NYC’s Watershed

The Clean Water Act process for eliminating impairments starts with identification of the impairment, then calculation of what loads would not cause impairments (Total Maximum Daily Loads or TMDLs), and then actions to meet the TMDLs. The TMDL for the

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New York City watershed that lies east of the Hudson showed that large reductions (6700 kg/year) in phosphorus loads from stormwater, as well as less defined nonpoint sources, is necessary to meet the TMDL.

For stormwater, the action required by the TMDL was implementation of more rigorous stormwater controls than those that apply in the rest of the state. So, when the Phase II permits were issued in 2003, the NYSDEC, by designation in accordance with federal rule, required all municipalities in the New York City East of Hudson (NYC EOH) watershed to be permitted as regulated MS4s.

The 2003 general permit for construction stormwater also includes an enhanced requirement for the NYC EOH watershed. Single-family residential developments that disturb between one and five acres in the watershed were required to install post-construction controls. In contrast, in most other areas of the state, such developments were not required to install post-construction controls.

On April 16, 2008, the NYSDEC renewed the stormwater general permits for construction activities and small MS4s. Those renewals included, in addition to the enhanced controls included in the 2003 permits, more enhanced requirements for “Watershed Improvement Strategy” areas that have been degraded by stormwater pollution. The enhanced controls for the NYC EOH watershed include requirements for enhanced phosphorus removal standards for new construction, retrofits of older construction with stormwater management practices, prevention of septic system failures and remediation of failed septic systems, the regulation of smaller construction sites, leaf management, enhanced storm sewer system mapping and maintenance, fertilizer controls and improved public education. In addition, the April 2008 permit for construction activities may not be used to authorize development on steep slopes.

The MS4s in the East of Hudson watershed are required by the MS4 permit to begin implementing the enhanced controls over the three years following permit issuance. The NYSDEC expects the enhanced permit requirements to result in decreases in phosphorus loading to the watershed and that some of that load reduction will be predictable using appropriate mathematical models. Under the permit, East of Hudson MS4s are responsible for preparing such mathematical models of their phosphorus loading to the watershed by 2013, and assuring decreases in the phosphorus loads that can be modeled. The NYSDEC provided a summary of available models with the permit responsiveness summary for the April 2008 MS4 permit renewal. In addition, the EPA is developing better models for stormwater loads that should be considered for the loading assessments due in 2013.

The decreased loads should, over time, result in measurable decreases in phosphorus concentrations in the reservoirs. The NYSDEC expects that the New York City Department of Environmental Protection (DEP) will continue to measure concentrations of phosphorus in the receiving waters in the New York City watershed. The success of the enhanced requirements will be judged, at least in part, by whether the concentrations of phosphorus decline with time. The concentration information, as well as the loading assessments provided by the MS4 pollutant modeling, will guide future permit requirements.

New Phosphorus Removal Standards

In addressing the pollution associated with stormwater runoff in general and stormwater runoff in the New York City watershed in particular, one must face the uncomfortable truism of past stormwater experiences – development has almost always resulted in



Photo by Pat Ferracane, NYSDEC

NYSDOT enhanced stormwater practice constructed at Exit 3, Routes 684/22

increases of pollutant loading from the developed areas over the loads that existed pre-development. The NYSDEC’s standard that controls post-construction discharges statewide, the Design Manual, does much to slow the rate of growth of pollutant loads from new development, but is not intended to prevent or minimize pollutant loading increases. In April 2008, to minimize and in many cases prevent phosphorus-loading increases, the NYSDEC upgraded the Design Manual to address pollutant-specific watershed concerns. The latest additions to the Design Manual are the enhanced phosphorus removal standards that apply in the NYC EOH watershed, as well as some other phosphorus-limited watersheds. The enhanced standards require larger practices, qualitative improvements to practices, use of newer precipitation data that reflect the increased storm intensity associated with climate change, and feasible reductions in the volume of stormwater discharged.

Larger practices are required by increasing the sizing criteria for water quality practices from the 90th percentile storm (approximately a one-inch storm, depending upon the area of the state) to the one-year storm (approximately a two and one-half inch storm). In the NYC EOH watershed, design of engineered stormwater treatment ponds, wetlands, filters, swales and infiltration practices must be based on the larger one-year storm.

The EPA has come to emphasize the importance of addressing the volume of the stormwater discharges as well as the concentration of stormwater discharges. That is because the total loading is dependent upon both the concentration as well as the total volume of the discharge. To reduce stormwater volumes, the enhanced standard requires stormwater management practice designers to consider and, where feasible, implement better site design (also known as low impact development or green infrastructure) principles in design of stormwater management practices. Better site design emphasizes practices that keep the stormwater on the site, generally through infiltration and, to a lesser extent, evapo-transpiration. Implementation of these standards helps maintain the natural hydrologic cycle, reduces development in natural areas, and minimizes pollutant loading.

Stormwater Retrofits to Reduce Existing Phosphorus Loads

As noted, MS4s in the NYC EOH watershed are required to implement a stormwater retrofit program to address polluted runoff from the built environment. The permit requires the development of approvable plans and schedules for retrofits, but does not include

specific numeric reduction targets. To provide MS4s with guidance on what would be considered approvable, in January 2009 the NYSDEC published a TMDL implementation plan that allocates needed numeric load reduction requirements to MS4s in the watershed based on the amount of high density development under each MS4's control.

Retrofits are an effective method for reducing pollutant loadings from existing development, but such programs also present significant cost challenges. The NYSDEC is working with other regulatory agencies, municipal governments, and stakeholders to evaluate options for a retrofit program starting with the NYC EOH watershed.

Remediation and Prevention of Septic System Failures

As effective as stormwater retrofits are expected to be in reducing pollutant discharges, they can be expensive and may not by themselves reduce pollutant loads enough to meet water quality standards. It is necessary to consider other alternatives to reducing pollutant loads as well.

One such way of reducing pollutant loads is to eliminate untreated and illegal discharges to the system. Such discharges can constitute a significant load to receiving waters. Contributions of phosphorus from failing septic systems can reasonably be estimated to be a kilogram per year per failing system. One way to find such illicit sources is to monitor dry weather discharges for constituents that should not be in stormwater and, when such constituents are found, tracking those constituents up pipe to the source. This can be a challenging process, especially if the source is intermittent. Another way to find illicit discharges is to focus on likely sources that are tributary to the storm sewer system.

In an area where significant portions of the populace are served by septic systems or, as professionals in the field call them, onsite wastewater treatment systems, targeting their failure is cost effective. At one time or another, the aphorisms come back as the best approach to problems. In the case of onsite systems, the old adages – “a stitch in time saves nine,” or “an ounce of prevention is worth a pound of cure,” – apply. As cost effective as it is to target failing onsite systems, it is many times more cost effective to prevent such failures. The MS4 permit requires MS4s in the NYC EOH watershed to develop a program and the legal authority to assure that onsite system failures are prevented and remediated. The program requires that onsite systems be inspected, maintained and, where necessary, rehabilitated every three years.

The program does not require that the MS4s themselves do the inspections – qualified third parties can also perform inspections. New York has an onsite training network that teaches practitioners in the field (e.g., septage haulers) how to inspect onsite systems. The EPA's guidance on onsite systems suggests five different management models, ranging from voluntary homeowner inspections (which would not meet the MS4 permit requirements), to onsite system management districts (which would exceed the permit requirements).

Erosion and Sediment Control on Small Sites

Land areas that have been disturbed for development can lose large quantities of soil when compared to land areas that are stabilized. This eroded soil is carried by runoff into receiving waters and causes the familiar turbid conditions and sedimentation. In additions, because phosphorus is contained in the soil matrix,

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eroded soil that runoff carries into receiving waters will also include the phosphorus that is contained in the soil matrix. The cumulative effect of that eroded phosphorus contributes to the water quality standard violations in the NYC EOH watershed. Both the General Permit for Construction Activities and the General Permit for MS4s address this source of phosphorus by requiring sites down to 5,000-square-foot disturbance in the NYC EOH watershed to be permitted under the construction permit and, beginning in January 2010, for MS4s to regulate those sites as well.

To provide for appropriate oversight of small construction activities, the NYSDEC has signed a cooperative agreement with NYCDEP that will, among other things, provide for coordinated inspections of smaller construction sites in the watershed.

Leaf Management

Decaying leaves are ubiquitous in forested areas and forested land areas are considered one of the least significant land areas in terms of contribution of phosphorus surface waters. So, it is logical to conclude that leaf management should be neglected as a source of phosphorus. Yet studies have shown decaying leaves can be as much as 50 percent of the phosphorus load from developed areas – possibly because of the connection that impervious surfaces and stormwater conveyance systems create between areas where leaves are decaying and surface waters.

To address these loads from decaying leaves, the MS4 permit requires MS4s in the NYC EOH watershed to remove leaves adjacent to impervious areas before they decay to the point they are contributing phosphorus to surface waters.



Photo by Patrick Ferracane, NYSDEC

Effects of erosion during severe storm

System Mapping

Practitioners who have been called upon to track illicit discharges emphasize the value of having good sewer system maps to facilitate such track-downs. In addition, system maps are useful if not indispensable in determining the most effective areas to retrofit. Because of the value of such system maps, MS4s in the NYC EOH watershed are required to have their systems mapped by March of 2013, with reasonable annual progress toward that deadline.

Limit Development on Steep Slopes

Stormwater management becomes more complex as slopes increase in the landscape. Steep slopes are more prone to severe erosion when soils are exposed during construction. It is often impractical to provide post construction controls on hilly sites. Rainfall mobilizes soil particles and accelerates sheet erosion. The



Photos by Christina Falk, NYSDEC

View of greening of Trout Creek as it enters Cannonsville Reservoir

risk is maximized when, as frequently occurs during construction, the top layer of soil is stripped. This is particularly true when soils are more erodible, and slopes are extended beyond moderate percentage and length.

To protect not just the New York City watershed but also other sensitive drinking watersheds, the General Permit for stormwater discharges from construction activities limits the disturbance of one or more acres of land on steep slopes (over 25 percent) in areas tributary to sensitive water bodies (classified as AA or higher).

Inter-Municipal Agreements

Throughout the state, localities are collaborating to implement stormwater management programs. There are two very active coalitions that are operating in Putnam and Westchester counties. Implementation of any of the enhanced requirements for stormwater controls will be more effective and cost less utilizing the shared services of coalitions. The NYSDEC continues to be committed to facilitating and enhancing such collaboration in the NYC EOH watershed.

Stormwater Permit Review

The level of interest demonstrated by the comments submitted during public review of the draft renewals indicated that there is a need to carefully consider further refinements to these permits with interested parties. To facilitate this review, the permits were renewed for a two-year period – instead of the normal five-year term. The DEC scheduled 12 informal monthly review meetings, giving parties who commented on the permits renewed this past April an opportunity to provide input on an identified set of issues prior to the next formal publication and public review. As of the end of March, eight of the monthly meetings have been held on better site design; low impact development and green infrastructure; inter-municipal cooperation; stormwater retrofit programs for impaired waters; public participation in the development of stormwater pollution prevention plans; numeric effluent limits; MS4 funding options; steep slopes/high erosion risk areas; and riparian buffers. In the upcoming months, the stormwater permit review meetings will focus on drafts of the permits for renewal in April 2010.

Almost certainly there will be some changes in the renewed construction and MS4 permits that effect stormwater controls in the New York City watershed. Those changes will build on the enhancements set forth in the April 2008 permit renewals that hold so much promise for water quality improvements.

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