Considering Stormwater Management

IN SITE PLAN REVIEW

by Chester L. Arnold, Jr.

Volunteers serving on planning, zoning and related commissions (such as wetland or conservation commissions) routinely review site plans to determine compliance of proposed development with land use regulations. A major consideration of this site plan review should be the proposed development's impact on water resources, particularly from polluted stormwater runoff, or "nonpoint source pollution."

Traditionally, stormwater management has emphasized water quantity, with little concern for water quality. To address both of these factors in a comprehensive manner, each site plan should contain a stormwater management plan that details the impact of proposed land use on water quantity and quality, both on-site and within the watershed. While the detailed engineering is best left to trained professionals, land use commissioners can review plans for compliance with general planning guidelines.

The Need for Stormwater Management in a Watershed Framework

When water falls to earth as rain or snow most of it seeps into the ground. However, if the ground is saturated, frozen, or covered with impervious surfaces, excess precipitation flows over the land. Stormwater management is the process of controlling and cleansing excess runoff so it does not harm natural resources or human health.

A major focus of stormwater management should be prevention of nonpoint source water pollution.  *Nonpoint Pollution.* It is more cost-effective to prevent flooding and water pollution than to correct problems after damage has occurred.

Potential Impact of Development on Water Resources

Development may disturb land and create impervious surfaces such as roads, rooftops, and compacted soil that in turn drastically change natural drainage patterns. During construction, existing grades and vegetation can be damaged, resulting in soil erosion. Runoff from

Nonpoint Pollution

The term nonpoint pollution is used to distinguish this type of pollution from point source pollution, which comes from specific sources such as sewage treatment plants or industrial facilities. Scientific evidence shows that although huge strides have been made in cleaning up major point sources, our precious water resources are still threatened by the effects of polluted runoff. In fact, the Environmental Protection Agency (EPA) has estimated that this type of pollution is now the single largest cause of the deterioration of our nation's water quality.

Polluted runoff is the cumulative result of our everyday personal actions and our local land use policies. Here's a brief rundown on the causes and effects of the major types of pollutants carried by runoff.

Pathogens: Pathogens are disease-causing microorganisms, such as bacteria and viruses, that comes from the fecal waste of humans and animals. Exposure to pathogens, either from direct contact with water or through ingestion of contaminated shellfish can cause a number of health problems. Because of this, bathing beaches and shellfish beds are closed to the public when testing reveals significant pathogen levels. Pathogens wash off the land from farm animal and pet waste, and can also enter our waterways from improperly functioning septic tanks, leaky sewer lines, and boat sanitary disposal systems.

Nutrients: Nutrients are compounds that stimulate plant growth, like nitrogen and phosphorous. Under normal conditions, nutrients are beneficial and necessary, but in high concentrations, they can become an environmental threat. Nitrogen contamination of drinking water can cause health problems, including "blue baby" syndrome. Over fertilization of ponds, bays, and lakes by nutrients can lead to massive algal blooms, the decay of which can create odors and rob the waters of life-sustaining dissolved oxygen. Nutrients in polluted runoff can come from agricultural fertilizers, septic systems, home lawn care products, and yard and animal wastes.

Sediment: Sand, dirt, and gravel eroded by runoff usually ends up in stream beds, ponds, or shallow coastal areas, where they can alter stream flow and decrease the availability of healthy aquatic habitat. Poorly protected construction sites, agricultural fields, roadways, and suburban gardens can be major sources of sediment.

Toxic Contaminants: Toxic contaminants are substances that can harm the health of aquatic life and/or human beings. Toxins are created by a wide variety of human practices and products, and include heavy metals, pesticides, and organic compounds like PCBs. Many toxins are very resistant to breakdown and tend to be passed through the food chain to be concentrated in top predators. Oil, grease, and gasoline from roadways, and chemicals used in homes, gardens, yards, and on farm crops, are major sources of toxic contaminants.

Debris: Trash is without a doubt the simplest type of pollution to understand. It interferes with enjoyment of our water resources and, in the case of plastic and styrofoam, can be a health threat to aquatic organisms. Typically this debris starts as street litter that is carried by runoff into our waterways.

these areas can pollute streams. Development, through increases in impervious surfaces and installation of storm sewers, speeds movement of concentrated pollutants off-site and interferes with water infiltration to the ground. *Impervious Surfaces.*

Traditional Approaches to Stormwater Management

Most communities attempt to manage stormwater by emphasizing water quantity rather than water quality. The goal has been to drain water from developed sites as rapidly as possible through the use of gutters, downspouts, pipes, curbs, catch basins, and culverts.

Some communities require developers to install detention ponds to temporarily store a portion of the excess runoff, then gradually release it after the peak natural runoff has occurred. Many hydrologists are concerned that mandating detention ponds on each site, while controlling runoff in the immediate vicinity, may work to collectively increase peak flows in the watershed, resulting in downstream flooding. Experts caution about reliance on one management practice to solve all drainage issues.

The Importance of Watershed Management Plans

Stormwater management begins with an understanding that every piece of land is part of a watershed. A watershed is defined as an area in which all drainage flows to a common outlet. Comprehensive land use planning and sound site design are necessary for effective stormwater management. Water resource experts strongly recommend that towns develop watershed management plans, so that management practices on individual sites can be coordinated as to location, size, and function.

Comprehensive watershed management plans include data from field inspections and inventories of existing drainage structures, mapping of watercourses, analysis of runoff rates and allowable capacities, and identification of existing and potential problem areas.

In addition to hydraulic and quantity impact analysis, watershed management plans should also address water quality issues. Things to be identified in the plan should include: priority water resources to be protected; known sources of contamination and existing pollutant levels; particular contaminants of concern; water quality goals; and overall watershed-level protection measures (such as use of buffer zones along waterways).

Within the context of a watershed plan, stormwater management should combine efforts to minimize impervious surfaces with efforts to maximize infiltration of clean runoff into the ground.

The Contents of a Stormwater Management Plan

Developers are generally required to submit site plans to help local officials determine whether proposed development complies with municipal land use regulations. Each site plan should contain a stormwater management plan addressing the impact the proposed land use will have both on water quantity and quality.

Site-level stormwater management plans are typically composed of maps and a narrative. The maps and associated construction drawings show existing site features and proposed alterations, highlighting the location and type of proposed stormwater management system. The narrative consists of: a written statement explaining the natural and proposed drainage system; a detailed description of projected runoff quantity and quality; and an explanation of why certain management practices were chosen for pollution control. Highlighted should be a detailed description of the relationship of the proposed development to drainage and runoff within the entire watershed (with reference to a watershed management plan should one exist). Provisions for site safety and maintenance of approved management measures should also be included.

Principles to Strive for in Stormwater Management

Stormwater management should include measures to control and convey runoff flow, and to collect and cleanse runoff on-site. These principles might be summarized as "The Four C's" of stormwater management: control, conveyance, collection, and cleansing. Measures do not fall neatly into one category in most cases; for instance, measures that control runoff, such as swales, may convey and clean runoff as well. These four principles, however, can provide a helpful framework for looking at stormwater plans.

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Impervious Surfaces

When development occurs, the resultant alteration to the land can lead to dramatic changes to the *hydrology*, or the way water is transported and stored. Impervious man-made surfaces (asphalt, concrete, rooftops) and compacted earth associated with development create a barrier to the percolation of rainfall into the soil, increasing surface runoff and decreasing groundwater infiltration. This disruption of the natural water cycle leads to a number of changes, including:

- increased volume and velocity of runoff;
- increased frequency and severity of flooding;
- peak (storm) flows many times greater than in natural basins;
- loss of natural runoff storage capacity in vegetation, wetland and soil;
- reduced groundwater recharge; and
- decreased base flow, the groundwater contribution to stream flow. (This can result in streams becoming intermittent or dry, and also affects water temperature.)

Stormwater runoff and paved surfaces are words that almost always seem to go together.

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1. Control. Control measures can be broken down into two categories: source control and runoff control. Source control measures focus on pollution prevention. Their objective is to avoid or limit the generation of pollutants. Typical source control measures include erosion control, street and parking lot sweeping, hazardous waste collection, and reduced usage of fertilizers and pesticides.

Runoff control measures focus on slowing down runoff, in order to reduce the likelihood of erosion, downstream flooding, and pollutant transport. These measures include limiting impervious surfaces, directing flow over grass swales or other vegetated areas, storing runoff in ponds, and installing infiltration systems.

2. Conveyance. Conveyance systems are used to drain and direct the flow of runoff generated on a site. This is often done with tile pipes feeding into catch basins and storm sewers. More natural systems using vegetated depressions and swales, which look and function much like the natural drainage system, should be used whenever possible. Existing systems can be adapted to reduce runoff; for example, perforated pipes can be used to promote infiltration. Particular attention should be given to system outlets, which commonly become restricted or blocked if poorly designed.

3. Collection. Capture and storage of runoff for more timely release is a vital component of most stormwater management systems. When runoff is collected in a vegetated storage area like a retention or detention pond, the site's adverse impacts on water resources can be greatly reduced. For sites where total capture is infeasible, studies suggest that collecting the "first flush" of one-half to one inch of rainfall can capture a high percentage of contaminants. All collection systems require regular monitoring and maintenance to ensure their continued effectiveness.

4. Cleansing. Control, conveyance, and collection of runoff mean little without provisions for cleansing. Cleansing is commonly accomplished through techniques that promote filtration and settling of pollutants, and their natural processing by vegetation and soil. Filtering devices include engineered structures like catch basins, sediment basins, and porous pavement, but also include more natural systems like stream buffers and vegetated filter strips.

Depending on their design, many collection systems like ponds and wetlands also serve to cleanse water. Infiltration of stormwater into the ground, which allows pollutants to be cleansed by natural biological and chemical processes in the soil and helps to recharge groundwater, should be encouraged wherever soil type and groundwater systems can support it.

Planning Guidelines For Stormwater Management

Site-by-site evaluation of stormwater plans can be greatly improved and facilitated by having a set of guidelines clearly stating the key management principles that the commission wants each applicant to address in a site plan. *Stormwater Guidelines.* As part of site plan review, commissioners should require assurances that any stormwater management plan complies with these general guidelines. The detailed engineering formulas and designs used to attain compliance with the guidelines are best handled by referring engineers and developers to commonly accepted manuals. Review of engineering design should be left to trained staff or consultants experienced in the field of water resources. ◆

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About NEMO: Based at the University of Connecticut, NEMO (Nonpoint Education for Municipal Officers) is the nerve center for the National NEMO Network, a group of 33 affiliated projects in 30 states and territories that are sharing educational techniques and tools. Detailed information about NEMO and the National Network is at: <http://nemo.uconn.edu>. Chester Arnold's article is excerpted from "fact sheets" on water pollution and runoff he has written for the NEMO Project, which can be downloaded from the NEMO web site.

Volunteers on a NEMO committee in Old Saybrook, Connecticut.

Stormwater Guidelines:

1. Consider the total environmental impact of the proposed system.
2. Consider water quality as well as water quantity.
3. Be consistent with the locally adopted comprehensive plan, and any existing watershed management plan.
4. Coordinate with erosion control measures and aquifer protection.
5. Minimize disturbance of natural grades and vegetation, and utilize existing topography for natural drainage systems.
6. Preserve natural vegetated buffers along water resources and wetlands.
7. Minimize impervious surfaces and maximize infiltration of cleansed runoff to appropriate soils.
8. Direct runoff to minimize off-site volume.
9. Reduce peak flow to minimize the likelihood of soil erosion, stream channel instability, flooding, and habitat destruction.
10. Use wetlands and water bodies to receive or treat runoff only when it is assured that these natural systems will not be overloaded or degraded.
11. Provide a maintenance schedule for management practices, including designation of maintenance responsibilities.