THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

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Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210

Stormwater and Your Community

What is Stormwater Runoff?

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, precipitation flows over the land, creating stormwater runoff. It occurs everywhere and includes flows from storm drains and natural drainage courses serving industrial, commercial, residential, undeveloped, recreational, and agricultural lands. It can cause flooding, erosion, and pollution problems (Rouge River, 1995).

What is Stormwater Management?

Stormwater management is the process of controlling and processing runoff so it does not harm the environment or human health. Fundamental goals of stormwater management are to mimic the way runoff left the site before development and to prevent water pollution (ODNR, 1996).

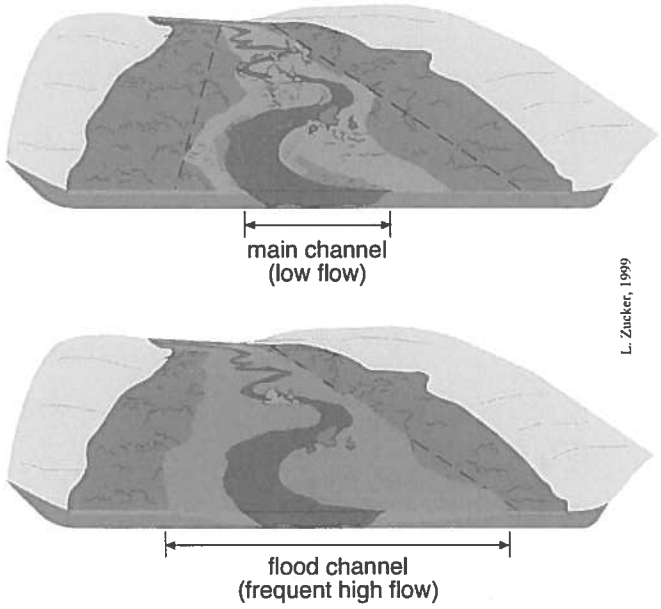
Hydrologic Differences Between Soil and Impervious Cover

Under natural conditions soil and vegetation absorb rain and make it part of the living ecosystem. Water is suspended by organic matter and soil pores, so it's available to plant roots. Microorganisms break down pollutants and convert them into nutrients for the living system. Soil storage turns intermittent pulses of rainfall into a perennial supply of moisture. Since most rainstorms are not large enough to fully saturate the soil, only a small percentage of annual rainwater flows over the surface as runoff. What does become runoff travels slowly, allowing time for suspended particles to settle out. Water percolating deep into soil becomes a stable supply of groundwater, and runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays (Ferguson, 1998).

In contrast, the impervious surfaces associated with urbanization prevent water from infiltrating into the soil. Small rainstorms generate stormwater runoff, which collects urban pollutants and concentrates them into narrow channels or pipes. This rapid concentration of water flow affects the hydrologic cycle in four ways: it increases flood potential, decreases the stability of channels, increases the concentration of pollutants, and reduces ground water levels. (Richman, 1999). The underlying cause of these problems is the loss of the water-retaining function of soil in the urban landscape. Water that may have lingered for a few hours, days, or weeks now flows rapidly across the land surface and arrives at the stream channel in short concentrated bursts (Booth, 1999).

Who Manages Stormwater?

A municipal separate storm sewer system (also known as an MS4) is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains); (USEPA, 1999). This system can be owned or operated by a public entity such as a city, state, town, county, district, or association. This includes special districts under State law such as sewer districts, flood control districts, or drainage districts. It is not a part of a combined sewer and not a publicly



Floodplain areas store water: Development in the floodplain and rigid channel controls are practices that often cause more damaging flood losses. Floodplains are natural detention areas for storm water.

owned treatment work (e.g., a municipal wastewater treatment plant). Storm water management is funded in some municipalities with storm water utility fees.

Stormwater Pollutants

Stormwater runoff has two major adverse impacts. One is related to quantity. Uncontrolled stormwater runoff entering sewers, lakes, rivers, and streams may cause flooding. Second, stormwater runoff often carries pollutants that may severely impact water quality. These discharges can result in fish kills, the destruction of spawning habitats, loss in aesthetic value, and contamination of drinking water supplies and recreational waterways that can threaten public health (USEPA, 1999).

In urbanized areas, a number of surfaces collect pollutants from a variety of sources including air deposition and car exhaust which settle on surfaces such as city streets, driveways, parking lots, and lawns. These pollutants remain until a storm washes them into a nearby storm drain. Automobiles are one of the leading sources of pollution in urban areas. Streets are also major pollution generators because of the large area they cover and the number of cars that use them. Typical pollutants from developed areas include bacteria, pesticides, fertilizers, oils, salt, litter, and sediment. Runoff from some non-vegetated areas, such as construction sites, can carry high sediment loads (Ferguson, 1998).

Traditional Approaches to Stormwater Management

Traditionally, most communities have managed for stormwater 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 to eliminate on-site flooding and standing water. Some communities require developers to install detention ponds to temporarily store a portion of the excess runoff, then gradually release it after the peak runoff has occurred. Some 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 (University of Connecticut, 1995).

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 all the land for which all drainage flows to a common outlet. Comprehensive land use planning and sound site design are essential tools for effective stormwater management. Water resource experts also strongly recommend that communities develop watershed management plans so that management practices can be coordinated by location, size, and function. Comprehensive watershed management plans can 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 impacts, watershed management plans should also address water quality issues. Things to include in the plan are: 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 the use of buffer zones along waterways).

Stormwater management should combine efforts to minimize impervious surfaces with efforts to maximize infiltration of precipitation into the ground. However, there are some areas where infiltration should be avoided, for example: areas with steep unstable slopes; impermeable soils; areas close to water supply wells; areas close to septic systems; areas close to sensitive structural foundations; and contaminated sites that would leach with added flow. Untreated stormwater should not be allowed to discharge directly into surface or subsurface waters.

Site-specific runoff control measures should be based on their location within the watershed. Effective stormwater management will strive to maintain the natural patterns of runoff within the watershed and minimize the extent to which storm drains and constructed ditches replace natural drainage ways. For example, runoff from the lower portions of the watershed should be allowed to pass downstream without delay (as long as the downstream floodway is capable of handling these flows), while runoff from the central and headwater sections of the watershed should be slowed or held back using natural features such as wetlands and floodplains to minimize peak flow rates.

Principles to Strive for in Stormwater Management

These principles might be summarized as "The Four Cs" of stormwater management: control, collection, conveyance, and cleansing. Measures do not fall neatly into one category in most cases. For instance, measures that control runoff, such as grassed swales may convey and clean runoff as well.

These four principles provide a helpful framework for looking at stormwater plans:

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 proper containment measures, spill prevention and cleanup, waste reduction, public education, illicit connection control, and reduced use of fertilizers and pesticides.

Runoff control measures focus on minimizing runoff from new developments, and siting infrastructure to discourage development in environmentally sensitive areas. These controls are cost-effective if implemented in the site-planning phase of

new development projects. Examples of these controls at the municipal planning level include zoning ordinances, subdivision regulations, buffers, and setback requirements. Runoff control measures also include techniques for slowing down runoff. These measures include limiting impervious surfaces, directing flow over grass swales or other vegetated areas, storing runoff in ponds, and installing infiltration systems. An important consideration with these systems is to determine if they will function and who will manage them when installed. All collection systems require regular monitoring and maintenance to ensure their continued effectiveness.

Collection. Capture and storage of runoff for more timely release is a vital component of most stormwater management systems. Retention basins are areas designed to hold the stormwater permanently until it infiltrates into the ground. Detention basins are meant to slow and hold stormwater before releasing it. When runoff is collected in vegetated storage areas such as retention and detention basins, adverse impacts on water resources can be greatly reduced. For sites where total capture is infeasible, studies suggest that collecting the "first flush," the (first 0.5 to 1.2 inches of rainfall) can capture a high percentage of contaminants.

Conveyance. Conveyance systems are used to drain and direct the flow of runoff generated on a site. This is often done with catch basins feeding into 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.

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 sediment basins and porous pavement, but also include natural systems like stream buffers and vegetated filter strips. Depending on their design, many collection systems like ponds and constructed wetlands also serve to clean water. Infiltration of stormwater into the ground, which allows pollutants to be filtered by natural biological and chemical processes in the soil, should be encouraged whenever soil type and groundwater systems can support it.

Stormwater Management in Ohio

Standard practices for stormwater management for Ohio can be found in *Rainwater and Land Development: Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection* (ODNR, 1996). This publication offers a source of general standards that can be implemented as land is being developed. In Ohio, municipalities, townships, and counties all have authority to regulate stormwater. Ohio EPA administers the state regulations requiring stormwater permits for construction sites and the Phase 1 and Phase II stormwater regulations. The Phase I regulations cover municipal separate storm sewer systems serving a population of 100,000 or greater. Phase II regulations will cover small municipal separate storm sewer systems in urbanized areas not covered under Phase 1 regulations. (For more information see USEPA Storm Water Phase II Proposed Rule Factsheets.) Both sets of regulations require owners and operators of municipal separate storm water systems in urbanized areas and construction sites to implement programs and practices to control polluted stormwater runoff.

Ohio statutes generally delegate land use planning to citizen planning commissions. They are charged with the formation of comprehensive plans, review of subdivisions, recommendations on zoning changes, and review of long-range capital improvement projects. Members of these commissions are appointed by elected officials. The Ohio Revised Code and some municipality charters place one or more elected officials on the city or village planning commission (Meck and Pearlman, 1999).

Summary Planning Guidelines for Stormwater Management

Members of planning and zoning commissions routinely review site plans for new construction to determine compliance of a proposed development with land use regulations. A major consideration of the site plan review should be the proposed development's impact on water resources, particularly from stormwater runoff.

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 developers to address in the site plan. As part of the site plan review, commissioners may want to 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 designs should be left to trained staff or consultants experienced in the field of water resources. Below is a suggested list of guidelines for applicants to address when designing a stormwater management plan. Commissions should consider using these when reviewing submitted plans. Municipalities might also consider including these guidelines in their subdivision and zoning regulations, and referencing them in watershed management plans.

Recommendations for Stormwater Systems that Protect Water Quality:

1. Consider the total environmental impact of the proposed system.
2. Consider water quality as well as water quantity.
3. Minimize the amount of impervious area to be created.
4. Be consistent with the local Comprehensive Land Use

Plan and any existing watershed management plan.

5. Coordinate stormwater management practices with erosion control measures and aquifer protection.

6. Minimize disturbance of natural grades and vegetation, and utilize existing topography for natural drainage systems if adequate.

7. Preserve natural vegetated buffers along water bodies and wetlands.

8. Maximize infiltration of cleansed runoff to appropriate soils.

9. Reduce peak flow to minimize 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.

World Wide Web Resources

Stormwater Phase II Proposed Rule Fact Sheet Series. Contact the U.S. EPA Water Resource Center at 202-260-7786 or at: waterpubs@epa.gov or www.epa.gov/owm/sw/phase2/index.htm

A Guide to Developing Local Watershed Action Plans in Ohio. Contact the Ohio EPA Division of Surface Water at 614-644-2856 or Internet: http://chagrin.epa.state.oh.us/watershed/index.html

References

Booth, Derek B. 1999. "Field Evaluation of Permeable Pavement Systems for Improved Stormwater Management." *Journal of the American Planning Association*. Vol. 65, No. 3. Summer.

Ferguson, B. 1999. *Introduction to Stormwater*. John Wiley & Sons. Canada.

Ohio Department of Natural Resources. 1996. *Rainwater and Land Development: Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection.*

Meck Stuart, & Pearlman, Kenneth. 1999 Edition. *Ohio Planning and Zoning Law*. West Group, Cleveland Ohio.

Richman, Tom. 1999. *Vegetated Swales*. Latis. American Society of Landscape Architects, Washington, DC.

Rouge River National Wet Weather Demonstration Project Number 1. 1995. *Demo Bulletin Stormwater Management.*

University of Connecticut Cooperative Extension Service. 1995. *Reviewing Site Plans for Stormwater Management.* NEMO project Fact Sheet 7.

USEPA, 1999. Stormwater Phase II Proposed Rule Fact Sheet Series. http://www.epa.gov/owm/sw/palse 2/index.htm

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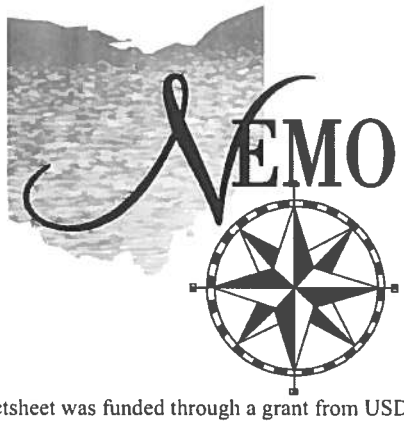

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