3.04
Post Construction Stormwater Management

Background

Introducing impervious surfaces to a landscape can substantially impact receiving streams and water bodies by increasing both stormwater runoff and its associated pollutants. It has been estimated that a site with 35-50% imperviousness has three times the runoff compared to a more natural groundcover. By limiting the ability of the soil to infiltrate, an increase in impervious surfaces leads to reduced groundwater recharge as well as increased stormwater runoff volume, peak rate and duration of flow, all of which tends to increase the potential for flooding. In addition, data indicates a direct relationship between the amount of imperviousness in a given watershed and the degree of degradation. A recent report to Congress by the National Academies of Science places additional emphasis on the habitat impacts from urban stormwater runoff. Highly impervious watersheds tend to be flashier and exhibit lower base flows. The frequency of out-of-bank occurrences also increases, leading to increased bank erosion and sediment deposition. All these factors stress aquatic organisms, potentially shifting the aquatic ecosystem to favor less desirable species.

Sediment has been determined to be the most significant pollutant of concern associated with stormwater runoff. Suspended sediment particles cause turbidity problems in the water treatment process and act as an environmental stressor on aquatic life. In addition, as soil particles wash off the land through the erosion process, their chemically active nature makes them particularly conducive to transporting adsorbed nutrients, metals, toxics, and other contaminants into the receiving waters. Typical loadings for total suspended solids from urban land uses range from less than 100 lb/ac/yr for low density residential development to over 500 lb/ac/yr for urban highways. In addition to these land-based sources, urban stream channel erosion can lead to sediment loads that are an order of magnitude greater in the receiving waters themselves depending on the effective imperviousness of the watershed.

Nitrogen is a nutrient associated with the soluble component of stormwater runoff. Although necessary for plant growth, excess nitrogen in water becomes a pollutant by stimulating the growth of algae and other less desirable plants. Nitrogen enrichment is typically more problematic in estuarine ecosystems. Major sources associated with urban stormwater runoff include fertilizers and atmospheric deposition. Typical loadings for total nitrogen from urban land uses range from 10 to 15 lbs/ac/yr. Phosphorus is a nutrient more associated with the particulate component of stormwater runoff, since it readily adsorbs to sediment. Also necessary for plant growth, excess phosphorous becomes a pollutant typically more problematic in freshwater ecosystems. The major source of phosphorus associated with urban runoff is fertilizer. Some soluble phosphorus can be traced to septic systems; however, the use of low phosphorus detergents has significantly reduced this source. Typical loadings for total phosphorus from urban land uses range from 0.75 to 1.25 lbs/ac/yr. Other pollutants in urban stormwater runoff include bacteria, trace metals and hydrocarbon derivatives.

The traditional approach to stormwater management was one of quantity control to prevent flooding. Later, greater emphasis was placed on managing stormwater runoff from a water quality perspective. A wide selection of best management practices (BMPs), including manmade ponds, filtration systems, and infiltration structures have been successfully used to manage stormwater runoff. Until recently, however, such BMPs have largely sought to control the particulate pollutants found in surface runoff, such as sediment and those pollutants which tend to adsorb to sediment, such as phosphorus. Soluble pollutants, such as nitrogen, can be found in both surface runoff and subsurface flow. BMPs that have a vegetative component designed for nutrient uptake and/or an anaerobic component to induce denitrification, such as constructed wetlands, biofiltration systems, and bioretention structures, can reduce these pollutants. Current urban BMP designs remove 10 to 50 percent of total nitrogen, and 45 to 75 percent of total phosphorous. With the recent recognition of the habitat impacts associated with urban stormwater runoff, stream stability issues must also be addressed. The traditional approach of "collect and convey" using a single BMP is no longer seen as adequate to manage the complex problems associated with urban stormwater runoff. Contemporary designs aim to reduce runoff volume utilizing distributed techniques and "treatment trains" tailored to the problems associated with a specific site. The post-construction stormwater management component adheres to this philosophy.

General Requirements

All post construction stormwater management BMPs shall be designed and constructed in accordance with the standards and specifications developed or endorsed by the Department. These include, but are not limited to:

A. Natural Resource Conservation Service (NRCS) National Engineering Handbook

B. Water Environment Federation (WEF) Manual of Practice FD-20, "Design and Construction of Urban Stormwater Management Systems"

C. Federal Highway Administration (FHWA) Hydraulic Design Series No. 5, "Hydraulic Design of Highway Culverts"

D. Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 22, "Urban Drainage Design Manual"

E. U.S. Army Corps of Engineers (USACE) Engineer Manual 1110-2-2300, "Earth and Rock-Fill Dams – General Design and Construction Considerations"

F. Delaware Dept. of Transportation (DelDOT) Road Design Manual

G. Delaware DNREC Standards & Specifications for Post Construction Stormwater Management BMPs

H. Delaware DNREC Erosion & Sediment Control Handbook

I. NRCS Small Pond Code 378 for Delaware

All hydrologic computations shall be in accordance with Natural Resource Conservation Service (NRCS) methodologies. In addition, the Delmarva Unit Hydrograph shall be used for all projects south of the Chesapeake and Delaware (C&D) canal. Computations for estimating annual runoff shall be based on the methodologies from the Source Loading and Management Model (WinSLAMM). Hydrologic references include, but are not limited to:

A. Natural Resource Conservation Service (NRCS) National Engineering Handbook, Part 630, "Hydrology"

B. Natural Resource Conservation Service (NRCS) Technical Release 55 (TR-55)

C. Delaware DNREC Runoff Reduction Guidance Document (see 3.04.2)

D. WinSLAMM User's Guide

All water surface profile computations shall be in accordance with U.S. Army Corps of Engineers (USACE) methodologies. References include, but are not limited to:

A. U.S. Army Corps of Engineers (USACE) Engineer Manual 1110-2-1416, "River Hydraulics"

B. U.S. Army Corps of Engineers (USACE) HEC-RAS, River Analysis System Hydraulic Reference Manual

Any hydrologic or hydraulic software program proposed for performing computations to comply with the Delaware Sediment & Stormwater Regulations must be endorsed by the Department. The USACE HEC-HMS and HEC-RAS software programs shall be used as the standards to resolve conflicting computational results between different software programs.

Pre-engineered and/or proprietary devices proposed for compliance with the Delaware Sediment & Stormwater Regulations must meet the Standards & Specifications for Post Construction Stormwater Management BMPs contained in 3.06.2.15.

A soils investigation report shall be provided for any post construction stormwater management BMP that relies on full or partial infiltration. Procedures for conducting the infiltration testing shall be in accordance with Department guidance (see 3.06.2.A-1).

Compliance Criteria for Regulatory Storm Events

(see Stormwater Management Compliance Flowchart, 3.04.1)

Resource Protection Event

A. The design parameter for the Resource Protection Event shall be the annualized runoff volume produced by a storm having a 99% probability of occurring annually (i.e., the 1-YR event) based on post-developed conditions.

B. The Resource Protection Event volume (RPv) shall be determined in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2).

C. Compliance with the Resource Protection Event may be accomplished by:

   i. Reducing the RPv in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2). For new development, the RPv shall be reduced to an equivalent 0% effective imperviousness. For redevelopment, the RPv shall be reduced to an equivalent 70% of the existing effective imperviousness. The RPv shall be further reduced to an equivalent wooded condition for any existing meadow or wooded areas within the limit of disturbance based on the 2007 Delaware Land Use/Land Cover data; or

   ii. In cases in which only partial reduction can be achieved, releasing the residual RPv at a rate not to exceed the equivalent 24-hr extended detention of the full RPv and providing an offset in accordance with Department guidance (see Article 2.04); or

   ~~iii. A “de minimis” discharge rate determined on a case-by-case basis; or~~

   ~~iv.~~iii. Limiting the reconstruction of existing paved areas, re-grading and replacement of existing turfgrass areas, rebuilding or repairing of structures damaged by fire, flood, wind, or other natural disaster and where the disturbed area will return to the original hydrologic condition and land cover at the conclusion of the project.

D. If compliance cannot be achieved in accordance with Section C above after employing all runoff reduction practices to the Maximum Extent Practicable (MEP), an offset shall be provided in accordance with the guidelines included in Article 2.04.

Conveyance Event

A. The primary design parameter for the Conveyance Event shall be the additional runoff volume (above the RPv) produced by a storm having a 10% probability of occurring annually (i.e., the 10-YR event) based on post-developed conditions. The peak discharge may be considered a secondary design parameter under certain circumstances.

B. The Conveyance Event volume (Cv) shall be determined using the NRCS runoff equation. Peak discharge for the Conveyance Event shall be based on the NRCS Type II, 24-HR design storm.

C. Compliance with the Conveyance Event may be accomplished by:

i. Discharging into either a closed drainage system or open channel having adequate capacity for the Conveyance Event to tidal waters under non-erosive conditions; or

ii. Reducing the entire Cv in accordance with Department guidance (see Runoff Reduction Guidance 3.04.2).; or

iii. For projects that qualify by receiving all “Minor” ratings on the Stormwater Assessment Report (SAR) and opt for the Unit Discharge approach, releasing the Cv at a rate not to exceed the weighted average based on the following pre-developed land use as determined from the 2007 Delaware Land Use/Land Cover data:

a. Non-woodland/Non-meadow: 0.75 cfs/ac

b. Woodland/meadow: 0.375 cfs/ac

c. Woodland (Hydrologic Soil Group A): 0 cfs/ac; or

iv. For projects that are required or opt for the performance-based approach, complying with Department guidance (see 3.02.2.3); or

v. A “de minimis” discharge rate determined on a case-by-case basis.

Flooding Event

A. The primary design parameter for the Flooding Event shall be the additional runoff volume (above the Cv) produced by a storm having a 1% probability of occurring annually (i.e., the 100-YR event) based on post-developed conditions. The peak discharge may be considered a secondary design parameter under certain circumstances.

B. The Flooding Event volume (Fv) shall be determined using the NRCS runoff equation. Peak discharge for the Flooding Event shall be based on the NRCS Type II, 24-HR design storm.

C. Compliance with the Flooding Event may be accomplished by:

   i. Discharging into either a closed drainage system or open channel having adequate capacity for the Conveyance Event to tidal waters under non-erosive conditions; or

   ii. For projects that qualify and opt for the Unit Discharge approach, releasing the Cv at a rate not to exceed the weighted average based on the following pre-developed land use as determined from the 2007 Delaware Land Use/Land Cover data:

      a. Non-woodland/Non-meadow: 2.25 cfs/ac

      b. Woodland/meadow: 1.25 cfs/ac

      c. Woodland (Hydrologic Soil Group A): 0.25 cfs/ac; or

   iii. For projects that are required or opt for the performance-based approach, complying with Department guidance (see 3.02.2.3.)

Alternative Criteria

A. In cases where a watershed master plan has been developed and endorsed by the Department, the management criteria defined by that master plan shall take precedence over the criteria in Compliance Criteria for Regulatory Storm Events above.

B. In cases where a receiving waterbody has been identified as impaired, or designated with a specific pollutant reduction target necessary to meet State or Federal water quality regulations, additional stormwater treatment practices or alternative criteria may be required in accordance with Department guidance. Examples include, but are not limited to, a Total Maximum Daily Load (TMDL) requirement for nutrients and/or sediment which would require specific pollutant reductions for compliance.

C. In cases where a specific pollutant source or “hot spot” has been identified, additional stormwater treatment practices or alternative criteria may be required in accordance with Department guidance. An example of this would be specific permits required under the National Pollutant Discharge Elimination System when discharges are a combination of stormwater and industrial or domestic wastewater or which must comply with Parts 122, 123, and 124 of Title 40 of the Code of Federal Regulations.

   i. When a land disturbing activity that falls under the applicability of these Regulations occurs on a site with an existing NPDES stormwater discharge permit, the Department shall determine if:

      a. The post-construction discharge is covered under the existing Federal NPDES permit; or

      b. The post-construction discharge will be covered under a revision to the existing Federal NPDES permit; or

      c. The post-construction discharge must comply with the requirements for the Resource Protection Event (RPv) in accordance with the Compliance Criteria for Regulatory Storm Events above.

   ii. Projects that must meet the requirements of this section for water quality purposes must nonetheless meet the quantity management requirements for the Conveyance Event (Cv) and Flooding Event (Fv) in accordance with the Compliance Criteria for Regulatory Storm Events above.