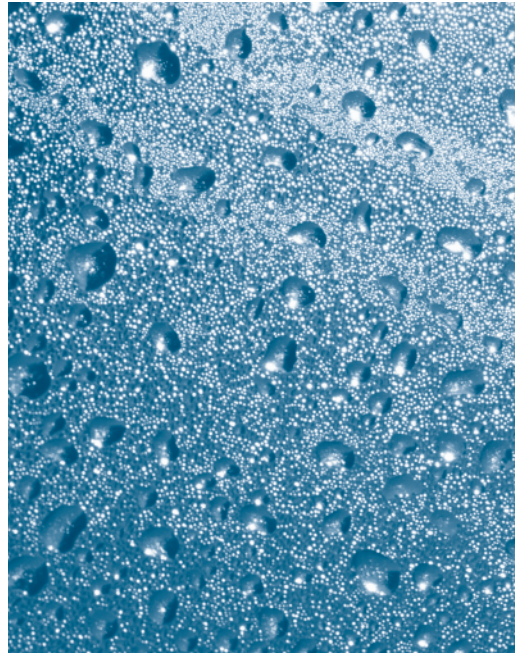
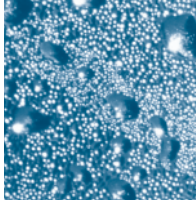


*Chapter 9*  
Developing a Site  
Stormwater Management Plan



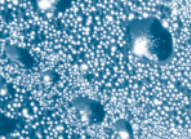


# Volume II: Design

## Chapter 9

### Developing a Site Stormwater Management Plan

|   |     |
|---|-----|
| 9.1 Plan Development .....                                  | 9-2 |
| 9.2 Plan Content.....                                       | 9-2 |
| 9.2.1 Applicant/Site Information .....                      | 9-3 |
| 9.2.2 Project Narrative.....                                | 9-3 |
| 9.2.3 Calculations.....                                     | 9-4 |
| 9.2.4 Design Drawings and Specifications.....               | 9-6 |
| 9.2.5 Construction Erosion and Sedimentation Controls ..... | 9-7 |
| 9.2.6 Supporting Documents and Studies.....                 | 9-7 |
| 9.2.7 Other Required Permits .....                          | 9-7 |
| 9.2.8 Operation and Maintenance .....                       | 9-7 |



While this Manual describes the selection and design of a wide range of stormwater treatment practices, it is important that the designer effectively communicates their rationale, design, and maintenance requirements to several audiences including the facility owner, regulatory reviewers, and maintenance personnel. This is critical so that all parties fully understand the need for and the future operation of the treatment practices, and so that the selection of the specified practice is appropriate.

A site stormwater management plan describes the potential water quality and quantity impacts associated with a development project both during and after construction. A stormwater management plan also identifies selected source controls and treatment practices to address those potential impacts, the engineering design of the treatment practices, and maintenance requirements for proper performance of the selected practices.

## 9.1 Plan Development

Stormwater management plans should be developed for all new and redevelopment projects, including phased developments, that meet any of the following criteria:

- *Any development resulting in the disturbance of greater than or equal to one acre of land*
- *Residential development consisting of 5 or more dwelling units*
- *Residential development consisting of fewer than 5 dwelling units involving construction of a new road or reconstruction of an existing road*
- *Residential development consisting of fewer than 5 dwelling units where imperviousness of the site after construction exceeds 30 percent*
- *Stormwater discharge to wetlands/watercourses*
- *New stormwater discharges located less than 500 feet from tidal wetlands*
- *Land uses or facilities with potential for higher pollutant loadings (see Chapter Seven)*
- *Industrial and commercial development projects which result in 10,000 sq. ft. or greater of impervious surface. (Industrial and commercial activities requiring authorization under the DEP General Permit for the Discharge of Stormwater Associated with Industrial Activity or General Permit for the Discharge of Stormwater Associated with Commercial Activity have specific Stormwater Management Plan requirements which focus on source controls and pollution prevention.)*
- *New highway, road, and street construction*
- *Modifications to existing storm drainage systems*

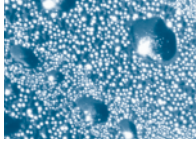
These types of projects are also subject to the hydrologic sizing criteria described in Chapter Seven of this Manual.

## 9.2 Plan Content

A stormwater management plan should include source controls for potential sources of stormwater runoff pollution and treatment controls for stormwater discharges. In addition, any supporting documentation, including calculations, engineering details, or reports, should be provided to illustrate the proposed development's compliance with applicable federal, state, and local regulations, and the design guidelines of this Manual. Professionals (engineers, surveyors, landscape architects, etc.) must affix their seal and dated signature to all plans and documents prepared by them or under their direct supervision.

The major elements of a stormwater management plan include:

- *Applicant/Site Information*
- *Project Narrative*
- *Calculations*



- *Design Drawings and Specifications*
- *Construction Erosion and Sedimentation Controls*
- *Supporting Documents and Studies*
- *Other Required Permits*
- *Operation and Maintenance*

Each of these elements is described further in the following sections. **Appendix D** contains a checklist that can be used in preparing or reviewing a site stormwater management plan.

### 9.2.1 Applicant/Site Information

The stormwater management plan should include the following information to clearly identify the applicant and site of the proposed activity:

- *Applicant name, legal address, and telephone/fax numbers*
- *Common address and legal description of the proposed site*
- *Site location or locus map*

### 9.2.2 Project Narrative

Projects that require a stormwater management plan must include documentation that adequately describes the proposed improvements or alterations to the site. In particular, it is necessary to describe any alterations to surface waters, including wetlands and waterways, removal of vegetation, and earth moving operations. The project scope and objective must identify, in summary, the potential water quality impacts to receiving waters during construction and the post-construction water quality and quantity impacts that may occur as a result of the intended use(s) of the property.

In describing the project, alternative designs or construction methods should be evaluated to address the goal of impact minimization through the use of site design practices such as providing “green” parking areas, and preserving natural buffers or open spaces. The purpose of evaluating project alternatives is to achieve a final design that allows an appropriate, legal use of the property while minimizing impacts to surface water quality caused by stormwater runoff.

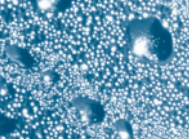
The project narrative should consist of:

**Project Description and Purpose:** Provide a general description of the project in adequate detail such that reviewers will have a sense of the proposed project and potential impacts. This section should describe existing and proposed conditions, including:

- *Natural and manmade features at the site including, at a minimum, wetlands, water-courses, floodplains, and development (roads, buildings, and other structures)*
- *Site topography, drainage patterns, flow paths, and ground cover*
- *Impervious area and runoff coefficient*
- *Site soils as defined by USDA soil surveys including soil names, map unit, erodibility, permeability, depth, texture, and soil structure*
- *Stormwater discharges, including the quality of any existing or proposed stormwater discharges from the site and known sources of pollutants and sediment loadings*
- *Critical areas, buffers, and setbacks established by the local, state, and federal regulatory authorities*
- *Water quality classification of on-site and adjacent water bodies and identification of any on-site or adjacent water bodies included on the Connecticut 303(d) list of impaired waters*

**Potential Stormwater Impacts:** Describe the project’s potential for stormwater impacts affecting water quality, peak flow, and groundwater recharge. The elements that should be included in this section are:

- *Description of all potential pollution sources such as erosive soils, steep slopes, vehicle fueling, vehicle washing, etc.*
- *Identification of the types of anticipated stormwater pollutants and the relative or calculated load of each pollutant*
- *A summary of calculated pre- and post-development peak flows*
- *A summary of calculated pre- and post-development groundwater recharge*



**Critical On-site Resources:** Describe and identify the locations of on-site resources that could potentially be impacted by stormwater runoff. These resources may include:

- *Wells*
- *Aquifers*
- *Wetlands*
- *Streams*
- *Ponds*
- *Public drinking water supplies*

**Critical Off-site Resources:** Describe and identify the locations of off-site resources (typically downstream of the site) that could potentially be impacted by stormwater runoff. These resources may include:

- *Neighboring land uses*
- *Wells*
- *Aquifers*
- *Wetlands*
- *Streams*
- *Ponds*
- *Public drinking water supplies*

**Proposed Stormwater Management Practices:** Describe the proposed stormwater management practices and why they were selected for the project. Stormwater management practices that should be described in this section are:

- *Source controls and pollution prevention*
- *Alternative site planning and design*
- *Stormwater treatment practices*
- *Flood control and peak runoff attenuation management practices*

**Site Plan:** Include a site plan showing, at a minimum, the following existing and proposed features:

- *Topography, drainage patterns, drainage boundaries, and flow paths*
- *Locations of stormwater discharges*
- *Perennial and intermittent streams*

- *Soil types*
- *Proposed borehole investigations*
- *Vegetation and proposed limits of clearing and disturbance*
- *Resource protection areas such as wetlands, lakes, ponds, and other setbacks (stream buffers, drinking water well setbacks, septic setbacks, etc.)*
- *Roads, buildings, and other structures*
- *Utilities and easements*
- *Temporary and permanent conveyance systems (grass channels, swales, ditches, storm drains, etc.) including grades, dimensions, and direction of flow*
- *Location of floodplain and floodway limits and relationship of site to upstream and downstream properties and drainage systems*
- *Location, size, maintenance access, and limits of disturbance of proposed structural stormwater management practices (treatment practices, flood control facilities, stormwater diversion structures, etc.)*
- *Final landscaping plans for structural stormwater management practices and site revegetation*
- *Locations of source controls*

**Construction Schedule:** Describe the anticipated construction schedule, including the construction sequence and any proposed phasing of the project.

### 9.2.3 Calculations

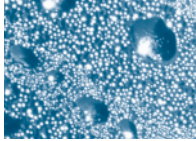
The stormwater management plan should include calculations to demonstrate that the proposed project satisfies the stormwater management objectives and treatment practice sizing criteria described in Chapter Seven of this Manual.

#### **Pollutant Reduction**

**Water Quality Volume (WQV):** Calculate the design water quality volume (WQV) to be treated by the proposed stormwater treatment practices using the procedures described in Chapter Seven. Design calculations should demonstrate that the proposed stormwater treatment practices meet the required WQV, detention time, and other practice-specific design criteria as described in this Manual.

**Water Quality Flow (WQF):** Calculate the design water quality flow (WQF), which is the peak flow rate associated with the WQV. The WQF is used to size flow rate-based treatment practices (i.e., manufactured





treatment systems such as catch basin inserts, media filters, and hydrodynamic structures), grass drainage channels, and flow diversion structures for off-line treatment practices. The WQF should be calculated using the procedures described in **Appendix B**. The peak flow rates associated with larger design storms should also be evaluated to ensure that stormwater treatment practices could safely convey large storm events while providing the minimum rates of pollutant removal established in this Manual.

**Pollutant Loads:** At the discretion of the review authority, estimate pollutant loads found in pre- and post-development runoff. One method to determine stormwater pollutant loads for urbanized areas is the Simple Method developed by Schueler (Metropolitan Washington Council of Governments, 1987). This method can be used to estimate stormwater pollutant loads for different land uses, but does not provide an estimate of the base flow pollutant load. However, the Simple Method may be used to calculate the pollutant load associated with storm events.

### **Groundwater Recharge**

**Groundwater Recharge Volume (GRV):** Calculate the required groundwater recharge volume to maintain pre-development annual groundwater recharge on the site after the site is developed. The GRV should be calculated using the procedures described in Chapter Seven. The GRV calculation should include the average annual groundwater recharge (i.e., stormwater infiltration) provided by the proposed stormwater management practices.

### **Runoff Capture**

**Runoff Capture Volume (RCV):** For new stormwater discharges located less than 500 feet from brackish and tidal wetlands, which are not fresh-tidal wetlands, calculate the volume of runoff generated by the first inch of rainfall. The design calculations should demonstrate how the proposed stormwater management system would retain or infiltrate this runoff capture volume (RCV). The RCV should be calculated based on the procedures described in Chapter Seven.

### **Peak Flow Control (Stormwater Quantity)**

For new development projects, calculations should be provided to demonstrate that post-development peak flows do not exceed pre-development peak flows for a range of design storms. For redevelopment projects, the bank condition and sensitivity of receiving waters may justify a reduction in peak flows and runoff volume from the site. Achieving a reduction in runoff from a redevelopment project may often be feasible with proper planning and implementation of detention or infiltration practices.

A number of methods and models are available to calculate peak stormwater discharge rates, and the designer must determine the most appropriate method for the project. The following information must be submitted with all stormwater management plans:

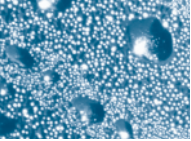
### **Hydrologic and Hydraulic Design Calculations:**

Calculate the pre-development and post-development peak runoff rates, volumes, and velocities at the site limits. The calculations shall be based on the following 24-hour duration design storm events to satisfy the sizing criteria described in Chapter Seven:

- *Stream Channel Protection: 2-year frequency ("over-control" of 2-year storm)*
- *Conveyance Protection: 10-year frequency*
- *Peak Runoff Attenuation: 10-year, 25-year, and 100-year frequency (and other design storms required by the local review authority)*
- *Emergency Outlet Sizing: safely pass the 100-year frequency or larger storm*

Provide the following information for each of the above design storms for pre-development and post-development conditions:

- *Description of the design storm frequency, intensity, and duration*
- *Watershed map with locations of design points and watershed area (acres) for runoff calculations*
- *Time of concentration (and associated flow paths)*
- *Imperviousness of the entire site and each watershed area*
- *NRCS runoff curve numbers or volumetric runoff coefficients*
- *Peak runoff rates, volumes, and velocities for each watershed area*
- *Hydrograph routing calculations*
- *Culvert capacities*
- *Infiltration rates, where applicable*
- *Dam breach analysis, where applicable*
- *Documentation of sources for all computation methods and field test results*



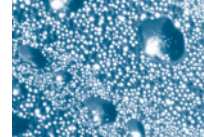
**Downstream Analysis:** Improperly placed or sized detention may adversely affect downstream areas by delaying the timing of the peak flows from the site. Delayed peaks can coincide with the upstream peak flow that naturally occurs later as the discharge travels from the upper portions of the watershed. If the site is in the middle to lower third of a watershed and detention is proposed, provide calculations of existing and proposed discharges at any critical downstream points using hydrograph analysis. Critical downstream points may be currently flooded properties or roadways, for example. Routing calculations should proceed downstream to a confluence point where the site drainage area represents 10 percent of the total drainage area (i.e., the “10 percent rule”). The downstream analysis should be performed using the methods described in Chapter Seven.

**Drainage Systems and Structures:** Provide design calculations for existing and proposed drainage systems and structures at the site. Based on the design storm for those structures, a hydrograph analysis should be used to analyze the storage and discharge for detention structures. Drainage system components should be designed according to the standards outlined in this Manual, as well as other applicable local standards or requirements.

## 9.2.4 Design Drawings and Specifications

Design drawings and specifications must be prepared by a professional engineer licensed to practice in the State of Connecticut. The format of site plans and drawings should conform to the following:

- *Drawings should be no larger than 24" x 36" and no smaller than 8-1/2" x 11".*
- *Plans and documents should not be pieced together or submitted with handwritten markings. Blue line prints or photocopies of original plans are acceptable.*
- *A scale should be used that adequately presents the detail of the proposed improvements for the project. A maximum scale of 1" = 40' is recommended, however larger scales up to 1" = 100' may be used to represent overall site development plans or for conceptual plans. Profiles and cross-sections should be prepared at a maximum scale of 1" = 4' vertical and 1"=40' horizontal.*
- *Design details including cross-sections, elevation views, and profiles as necessary to allow the proper depiction of the proposed controls for review and permitting and ultimately to allow the proper construction of these controls.*
- *Specifications, which clearly indicate the materials of construction, the specific stormwater control product designations (if applicable), the methods of installation, and reference to applicable material and construction standards.*
- *Plans should contain a title block that includes the project title, location, owner, assessor's map and parcel number of the subject site(s), name of preparer, sheet number, date (with revision date, if applicable), and drawing scale.*
- *Legend defining all symbols depicted on the plans.*
- *A cover sheet with a sheet index for plan sets greater than two sheets. Multiple sheets should contain either match lines or provide an overlap of 1" with information on adjoining plan sheets.*
- *North arrow.*
- *Property boundary of the entire subject property and depicting the parcels, or portions thereof, of abutting land and roadways within one hundred feet of the property boundary.*
- *Locus map of the site prepared at a scale of 1" = 1,000' with a north arrow. The map should adequately show the subject site relative to major roads and natural features, if any.*
- *The seal of a licensed professional should be affixed to all original design plans, calculations, and reports prepared by them or under their direct supervision.*



- *Survey plans should be prepared according to the Minimum Standards for Surveys and Maps in Connecticut with the class of survey represented on the plan, and must be stamped by a professional land surveyor. The survey plan should depict topography at contour intervals of two feet, the referenced or assumed elevation datum, two (2) benchmarks on the site within one hundred feet of the proposed construction, the outside limits of disturbances, and any plan references.*

### **9.2.5 Construction Erosion and Sedimentation Controls**

The proposed Erosion and Sedimentation Control Plan should, at a minimum, demonstrate the methods and designs to be utilized during construction and stabilization of the site following completion of construction activity. All proposed erosion and sediment control measures must comply with the *Connecticut Guidelines for Soil Erosion and Sediment Control, DEP Bulletin 34* (Connecticut Council on Soil and Water Conservation and the Connecticut Department of Environmental Protection, 2002). Erosion and sediment control measures must be included on the plans with sufficient detail to facilitate review of the design by regulatory officials, and proper construction of the measures.

### **9.2.6 Supporting Documents and Studies**

Information used in the design of construction and post-construction stormwater controls for the overall site development must be included (or referenced, if appropriate) with reports, plans, or calculations to support the designer's results and conclusion. Pertinent information may include:

- *Soil maps, borings/test pits*
- *Infiltration test results*
- *Groundwater impacts for proposed infiltration structures*
- *Reports on wetlands and other surface waters (including available information such as Maximum Contaminant Levels [MCLs], Total Maximum Daily Loads [TMDLs], 303(d) or 305(b) impaired waters listings, etc.)*
- *Water quality impacts to receiving waters*
- *Impacts on biological populations/ecological communities including fish, wildlife (vertebrates and invertebrates), and vegetation*
- *Flood study/calculations*

### **9.2.7 Other Required Permits**

Approval of a stormwater management plan does not relieve a property owner of the need to obtain other permits or approvals from federal, state, and local regulatory agencies. Stormwater regulatory programs in the state of Connecticut are summarized in Chapter One of this Manual. The stormwater management plan should include evidence of acquisition of all applicable federal, state, and local permits or approvals such as copies of DEP permit registration certificates, local approval letters, etc.

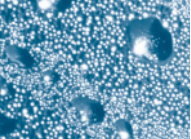
Where appropriate, a grading or building permit should not be issued for any parcel or lot unless a stormwater management plan has been approved or waived. If requirements of federal, state, and local officials vary, the most stringent requirements should be followed.

### **9.2.8 Operation and Maintenance**

Stormwater management plans should describe the procedures, including routine and non-routine maintenance, that are necessary to maintain treatment practices, including vegetation, in good and effective operating conditions. Chapter Eleven of this Manual contains operation and maintenance guidelines and recommendations for individual stormwater treatment practices. Operation and maintenance elements that should be included in the stormwater management plan include:

- *Detailed inspection and maintenance requirements/tasks*
- *Inspection and maintenance schedules*
- *Parties legally responsible for maintenance (name, address, and telephone number)*
- *Provisions for financing of operation and maintenance activities*
- *As-built plans of completed structures*
- *Letter of compliance from the designer*
- *Post-construction documentation to demonstrate compliance with maintenance activities*





## References

Connecticut Council on Soil and Water Conservation and the Connecticut Department of Environmental Protection. 2002. *2002 Connecticut Guidelines for Soil Erosion and Sediment Control, DEP Bulletin 34*.

Connecticut Department of Environmental Protection (DEP). 1995. *General Permit for Stormwater Associated with Commercial Activities*.

Connecticut Department of Environmental Protection (DEP). 1997. *General Permit for Stormwater Associated with Industrial Activities*.

Connecticut Department of Environmental Protection (DEP). 2000. *General Permit for the Discharge of Stormwater and Dewatering Wastewaters Associated with Construction Activities*. Issuance date October 1, 1997, modified December 20, 2000.

Schueler, T.R. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments. Washington, D.C.