Chapter 4: Unified Stormwater Sizing Criteria

Section 4.1 Introduction

This chapter presents a unified approach for sizing SMPs in the State of New York to meet pollutant removal goals, reduce channel erosion, prevent overbank flooding, and help control extreme floods. For a summary, please consult Table 4.1 below. The remaining sections describe the four sizing criteria in detail and present guidance on how to properly compute and apply the required storage volumes.

Table 4.1 New York Stormwater Sizing Criteria		
Water Quality (WQ _v)	90% Rule: $WQ_v = [(P)(R_v)(A)] /12$ Rv = 0.05+0.009(I) I = Impervious Cover (Percent) Minimum $Rv = 0.2$ P = 90% Rainfall Event Number (See Figure 4.1) A = site area in acres	
Channel Protection (Cp _v)	Default Criterion: Cpv = 24 hour extended detention of post-developed 1-year, 24-hour storm event. Option for Sites Larger than 50 Acres: Distributed Runoff Control - geomorphic assessment to determine the bankfull channel characteristics and thresholds for channel stability and bedload movement.	
Overbank Flood (Q _p)	Control the peak discharge from the 10-year storm to 10-year predevelopment rates.	
Extreme Storm (Q _f)	Control the peak discharge from the 100-year storm to 100-year predevelopment rates. Safely pass the 100-year storm event.	
<i>Note: The local review autho requirements in some instance:</i>	rity may waive channel protection, overbank flood, and extreme storm s. Guidance is provided in this chapter.	

Section 4.2 Water Quality Volume (WQ_v)

The Water Quality Volume (denoted as the WQ_v) is designed to improve water quality sizing to capture and treat 90% of the average annual stormwater runoff volume. The WQ_v is directly related to the amount of impervious cover created at a site. Contour lines of the 90% rainfall event are presented in Figure 4.1.

The following equation can be used to determine the water quality storage volume WQ_v (in acre-feet of storage):

$$WQ_v = \frac{(P) (R_v)(A)}{12}$$

where:

A minimum WQ_v of 0.2 inches per acre shall be met at residential sites that have less than 17% impervious cover.



Figure 4.1 90% Rainfall in New York State

It is assumed that by meeting the WQ_v requirements through employment of the practices presented in Table 5.1 a project will, by default, meet water quality objectives. In some jurisdictions, on-site load calculations are required to demonstrate removal of specific pollutants. As an aid to communities, Appendix A of this manual includes a discussion of a method for calculating pollutant export loads from development sites. This method, known as the "Simple Method," provides estimates for stormwater runoff pollutant loads for urban areas using a modest amount of information, including the subwatershed drainage area and impervious cover, stormwater runoff pollutant concentrations, and annual precipitation. Please consult Appendix A for a more detailed discussion of the Simple Method and its applications for water quality determinations. Please note that the Simple Method is intended as an analysis tool, and should not be used to guide the design of SMPs.

Basis Of Design for Water Quality

As a basis for design, the following assumptions may be made:

Measuring Impervious Cover: the measured area of a site plan that does not have permanent vegetative or permeable cover shall be considered total impervious cover. Impervious cover is defined as all impermeable surfaces and includes: paved and gravel road surfaces, paved and gravel parking lots, paved driveways, building structures, paved sidewalks, and miscellaneous impermeable structures such as patios, pools, and sheds. Porous or modular block pavement may be considered 50% impervious. Where site size makes direct measurement of impervious cover impractical, the land use/impervious cover relationships presented in Table 4.2 can be used to initially estimate impervious cover.

Table 4.2 Land Use and Impervious Cover (Source: Cappiella and Brown, 2001)		
Land Use Category	Mean Impervious Cover	
Agriculture	2	
Open Urban Land*	9	
2 Acre Lot Residential	11	
1 Acre Lot Residential	14	
1/2 Acre Lot Residential	21	

Table 4.2 Land Use and Impervious Cover (Source: Cappiella and Brown, 2001)		
Land Use Category	Mean Impervious Cover	
1/4Acre Lot Residential	28	
1/8 Acre Lot Residential	33	
Townhome Residential	41	
Multifamily Residential	44	
Institutional**	28-41%	
Light Industrial	48-59%	
Commercial	68-76%	
 * Open urban land includes developed park land, recreation areas, golf courses, and cemeteries. ** Institutional is defined as places of worship, schools, heapitale, government officer, and police and fire stations. 		

- *Aquatic Resources*: More stringent local regulations may be in place or may be required to protect drinking water reservoirs, lakes, or other sensitive aquatic resources. Consult the local authority to determine the full requirements for these resources.
- *SMP Treatment*: The final WQ_v shall be treated by an acceptable practice from the list presented in this manual. Please consult Chapter 5 for a list of acceptable practices.
- Determining Peak Discharge for WQ_v Storm: When designing flow splitters for off-line practices, consult the small storm hydrology method provided in Appendix B.
- Extended Detention for Water Quality Volume: The water quality requirement can be met by
 providing 24 hours of the WQ_v (provided a micropool is specified) extended detention. A local
 jurisdiction may reduce this requirement to as little as 12 hours in trout waters to prevent stream
 warming.
- *Off-site Areas:* Provide treatment for off-site areas in their current condition. If water quality treatment is provided off-line, the practice must only treat on-site runoff.

Section 4.3 Stream Channel Protection Volume Requirements (Cp_v)

Stream Channel Protection Volume Requirements (Cp_v) are designed to protect stream channels from erosion. In New York State this goal is accomplished by providing 24-hour extended detention of the one-year, 24-hour storm event. Trout waters may be exempted from the 24-hour ED requirement, with only 12 hours of extended detention required to meet this criterion.

For developments greater than 50 acres, with impervious cover greater than 25%, it is recommended that a detailed geomorphic assessment be performed to determine the appropriate level of control. Appendix J provides guidance on how to conduct this assessment.

The Cp_v requirement does not apply in certain conditions, including the following:

- Recharge of the entire Cp_v volume is achieved at a site.
- The site discharges directly tidal waters or fourth order (fourth downstream) or larger streams. Within New York State, streams are classified using the following:

New York State Codes Rules and Regulations (NYCRR) Volumes B-F, Parts 800-941 West Publishing, Eagan, MN

• A downstream analysis reveals that channel protection is not required (see section 4.7).

Detention ponds or underground vaults are methods to meet the Cp_v requirement (and subsequent Q_{p10} and Q_f criteria). Schematics of typical designs are shown in Figures 4.2. and 4.3. Note that, although these practices meet water quantity goals, they are unacceptable for water quality because of poor pollutant removal, and need to be coupled with a practice listed in Table 5.1. The Cp_v requirement may also be provided above the water quality (WQ_v) storage in a wet pond or stormwater wetland.

Basis for Determining Channel Protection Storage Volume

The following represent the minimum basis for design:

- TR-55 and TR-20 (or approved equivalent) shall be used to determine peak discharge rates.
- Rainfall depths for the one-year, 24 hour storm event are provided in Figure 4.4.
- Off-site areas should be modeled as "present condition" for the one-year, 24 hour storm event.
- The length of overland flow used in time of concentration (t_c) calculations is limited to no more than 100 feet for post development conditions.
- Cp_v is not required at sites where the resulting diameter of the ED orifice is too small to prevent clogging. (A minimum 3" orifice with a trash rack or 1" if the orifice is protected by a standpipe

having slots with an area less than the internal orifice are recommended to prevent clogging. See Figure 3 in Appendix K for design details).

- Extended detention storage provided for the channel protection (Cp_v-ED) does not meet the WQ_v requirement. Both water quality and channel protection storage may be provided in the same SMP, however.
- The CP_v detention time for the one-year storm is defined as the time difference between the center of mass of the inflow hydrograph (entering the SMP) and the center of mass of the outflow hydrograph (leaving the SMP). See Appendix B for a methodology for detaining this storm event.



Figure 4.2 Example of a Conventional Stormwater Detention Pond

PLAN VIEW



A typical detention facility provides channel protection control (Cp_v) and overbank control (Q_p) but no water quality control (WQ_v) . If this practice is used, WQv must be provided in a separate facility listed in Table 5.1.



Figure 4.3 Example of Stormwater Detention Provided by an Underground Pipe System

PLAN VIEW



An underground pipe system or vaults may be used to provide Cpv, Qp and Qf controls but not WQv.



Figure 4.4 One-Year Design Storm

Section 4.4 Overbank Flood Control Criteria (Q_p)

The primary purpose of the overbank flood control sizing criterion is to prevent an increase in the frequency and magnitude of out-of-bank flooding generated by urban development (i.e., flow events that exceed the bankfull capacity of the channel, and therefore must spill over into the floodplain).

Overbank control requires storage to attenuate the post development 10-year, 24-hour peak discharge rate (Q_p) to predevelopment rates.

The overbank flood control requirement (Q_p) does not apply in certain conditions, including:

- The site discharges directly tidal waters or fourth order (fourth downstream) or larger streams. Within New York State, streams are classified using the following: New York State Codes Rules and Regulations (NYCRR) Volumes B-F, Parts 800-941 West Publishing, Eagan, MN
- A downstream analysis reveals that overbank control is not needed (see section 4.7).

Basis for Design of Overbank Flood Control

When addressing the overbank flooding design criteria, the following represent the minimum basis for design:

- TR-55 and TR-20 (or approved equivalent) will be used to determine peak discharge rates.
- When the predevelopment land use is agriculture, the curve number for the pre-developed condition shall be derived from the recommended five-year crop rotation for a region, from the local Soil Conservation Service, or from the historical five-year crop rotation for the site, whichever results in a lower curve number value.
- Off-site areas should be modeled as "present condition" for the 10-year storm event.
- Figure 4.5 indicates the depth of rainfall (24 hour) associated with the 10-year storm event throughout the State of New York.
- The length of overland flow used in t_c calculations is limited to no more than 150 feet for predevelopment conditions and 100 feet for post development conditions. On areas of extremely flat terrain (<1% average slope), this maximum distance is extended to 250 feet for predevelopment conditions and 150 feet for postdevelopment conditions.



Figure 4.5 10-

10-Year Design Storm

Section 4.5 Extreme Flood Control Criteria (Q_f)

The intent of the extreme flood criteria is to (a) prevent the increased risk of flood damage from large storm events, (b) maintain the boundaries of the predevelopment 100-year floodplain, and (c) protect the physical integrity of stormwater management practices

100 Year Control requires storage to attenuate the post development 100-year, 24-hour peak discharge rate (Q_f) to predevelopment rates.

The 100-year storm control requirement can be waived if:

- The site discharges directly tidal waters or fourth order (fourth downstream) or larger streams. Within New York State, streams are classified using the following: New York State Codes Rules and Regulations (NYCRR) Volumes B-F, Parts 800-941 West Publishing, Eagan, MN
- Development is prohibited within the ultimate 100-year floodplain
- A downstream analysis reveals that 100-year control is not needed (see section 4.7)

Detention structures must provide safe overflow of the 100-year flood, as discussed in the New York State Department of Environmental Conservation publication: "Guidelines for the Design of Dams," available from the Bureau of Flood Protection at 518-402-8151.

Basis for Design for Extreme Flood Criteria

- Consult with the appropriate review authority *including the local municipality's flood protection permit administrator*, to determine the analysis required for the Q_f storm.
- The same hydrologic and hydraulic methods used for overbank flood control shall be used to analyze Q_f.
- Figure 4.6 indicates the depth of rainfall (24 hour) associated with the 100-year storm event throughout New York State.
- When determining the storage required to reduce 100-year flood peaks, model off-site areas under current conditions.
- When determining storage required to safely pass the 100-year flood, model off-site areas under ultimate conditions.



Figure 4.6 100-

100-Year Design Storm

Section 4.6 Conveyance Criteria

In addition to the stormwater treatment volumes described above, the manual also provides guidance on safe and non-erosive conveyance to, from, and through SMPs. Typically, the targeted storm frequencies for conveyance are the two-year and ten-year events. The two-year event is used to ensure non-erosive flows through roadside swales, overflow channels, pond pilot channels, and over berms within practices. Figure 4.7 presents rainfall depths for the two-year, 24-hour storm event throughout New York State. The 10-year storm is typically used as a target sizing for outfalls, and as a safe conveyance criterion for open channel practices and overflow channels. Note that some agencies or municipalities may use a different design storm for this purpose.

Section 4.7 Downstream Analysis

A community may waive the channel protection, overbank, and extreme flood requirements based on the results of a downstream analysis. In addition, such an analysis is recommended for larger sites (i.e., greater than 50 acres) to size facilities in the context of a larger watershed. The analysis will help ensure that storage provided at a site is appropriate to when combined with upstream and downstream flows. For example, detention at a site may in some instances exacerbate flooding problems within a watershed. This section provides brief guidance for conducting this analysis, including the area of stream to be evaluated and minimum elements to be included in the analysis.

Downstream analysis can be conducted using the 10% rule. That is, the analysis should extend downstream to the point where the site represents 10% of the total drainage area. For example, the analysis point for a 10-acre site would be analyzed to the nearest downstream point with a drainage area of 100 acres.

The analysis should include the following:

- Computation of flows and velocities for channel protection, overbank, and flood control storms at 200-foot intervals, at the point where the 10% rule is met, and at all confluences along the downstream channel with first order or higher streams.
- Hydrologic and hydraulic effects of all culverts and/or obstructions within the downstream channel.
- An assessment of water surface elevations to determine if an increase in water surface elevations will impact existing buildings and other structures.

The design, or waiver, at a site level can be approved if the following criteria are met:

- Flow rates and velocities increase by less than 5% of the pre-developed condition for all flow conditions analyzed.
- No downstream structures or buildings are impacted.
- The site as designed is not expected to exacerbate downstream channel erosion.



Figure 4.7. Two-Year Design Storm

Section 4.8 Stormwater Hotspots

A stormwater hotspot is defined as a land use or activity that generates higher concentrations of hydrocarbons, trace metals or toxicants than are found in typical stormwater runoff, based on monitoring studies. If a site is designated as a hotspot, it has important implications for how stormwater is managed. First and foremost, stormwater runoff from hotspots cannot be allowed to infiltrate into groundwater, where it may contaminate water supplies. Second, a greater level of stormwater treatment is needed at hotspot sites to prevent pollutant washoff after construction. This treatment plan typically involves preparing and implementing *a stormwater pollution prevention plan* that involves a series of operational practices at the site that reduce the generation of pollutants from a site or prevent contact of rainfall with the pollutants. Table 4.3 provides a list of designated hotspots for the State of New York

Under EPA's stormwater NPDES program, some industrial sites are required to prepare and implement a stormwater pollution prevention plan. A list of industrial categories that are subject to the pollution prevention requirement can be found in the State of New York SPDES. In addition, New York's requirements for preparing and implementing a stormwater pollution prevention plan are described in the SPDES general discharge permit. The stormwater pollution prevention plan requirement applies to both existing and new industrial sites.

Table 4.3 Classification of Stormwater Hotspots

The following land uses and activities are deemed stormwater hotspots:

- Vehicle salvage yards and recycling facilities #
- Vehicle fueling stations
- Vehicle service and maintenance facilities
- Vehicle and equipment cleaning facilities #
- Fleet storage areas (bus, truck, etc.) #
- Industrial sites (based on SIC codes outlined in the SPDES)
- Marinas (service and maintenance) #
- Outdoor liquid container storage
- Outdoor loading/unloading facilities
- Public works storage areas
- Facilities that generate or store hazardous materials #
- Commercial container nursery
- Other land uses and activities as designated by an appropriate review authority

indicates that the land use or activity is required to prepare a stormwater pollution prevention plan under the SPDES stormwater program. The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Non-industrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an Integrated Pest Management (IPM) Plan).

While large highways (average daily traffic volume (ADT) greater than 30,000) are not designated as a stormwater hotspot, it is important to ensure that highway stormwater management plans adequately protect groundwater.