Chapter 3: Stormwater Management Planning

This chapter presents a required planning process that must be followed when addressing stormwater management in new development and redevelopment projects. This process is intended to guide the designer through steps that maintain pre-construction (Note: For new development, the pre-construction terminology indicates pre-development or natural conditions) hydrologic conditions of the site by application of environmentally-sound development principles, such as Green Infrastructure, as well as treatment and control of runoff discharges from the site.

Section 3.1 Introduction

The increased emphasis on a holistic approach to resource protection, water quality treatment, flow volume control, maintenance cost reduction, and the dynamics of stormwater science has led to several changes in stormwater management. Carrying out stormwater management design standards for the past few years has provided the regulatory agencies, regulated entities, and design community with valuable experiences and a body of knowledge to enhance and improve urban runoff planning, methodologies, and techniques towards implementation of green infrastructure.

In the context of stormwater management, the term green infrastructure includes a wide array of practices at multiple scales to manage and treat stormwater, maintain and restore natural hydrology and ecological function by infiltration, evapotranspiration, capture and reuse of stormwater, and establishment of natural vegetative features. On a regional scale, green infrastructure is the preservation and restoration of natural landscape features, such as forests, floodplains and wetlands, coupled with policies such as infill and redevelopment that reduce overall imperviousness in a watershed or ecoregion. On the local scale green infrastructure consists of site- and neighborhood-specific practices and runoff reduction techniques. Such practices essentially result in runoff reduction and or establishment of habitat areas with significant utilization of soils, vegetation, and engineered media rather than traditional hardscape collection, conveyance and storage structures. Some examples include green roofs, trees and tree boxes, pervious pavement, rain gardens, vegetated swales, planters, reforestation, and protection and enhancement of riparian buffers and floodplains.

Planners and designers must address this approach in a five-step process that involves site planning and stormwater management practice (SMP) selection. The five steps include:

1. site planning to preserve natural features and reduce impervious cover,

2. calculation of the water quality volume for the site,

3. incorporation of runoff reduction techniques and standard SMPs with Runoff Reduction Volume (RRv) capacity,

4. use of standard SMPs, where applicable, to treat the portion of water quality volume not addressed by runoff reduction techniques and standard SMPs with RRv capacity, and

5. design of volume and peak rate control practices where required. The flow chart in Figure 3.1 summarizes the five step approach.

For detailed information on the State Pollutant Discharge Elimination System ("SPDES") General Permit for Stormwater Discharges from Construction Activity as well as environmental permits under the Uniform Procedures Act (UPA) consult DEC web site at http://www.dec.ny.gov/chemical/8468.html .

Section 3.2 Green Infrastructure for Stormwater Management

The green infrastructure approach for stormwater management reduces a site's impact on the aquatic ecosystem through the use of site planning techniques, runoff reduction techniques, and certain standard SMPs. The objective is to replicate pre-development hydrology by maintaining pre-construction infiltration, peak runoff flow, discharge volume, as well as minimizing concentrated flow by using runoff control techniques to provide treatment in a distributed manner before runoff reaches the collection system. This approach offers a distinct advantage over conventional "hard" stormwater infrastructure by reducing the production of runoff and the need for collection, storage, and treatment. When implemented throughout a development and watershed, green infrastructure can (Coffman, 2002 and USEPA, 2007):

- Reduce runoff volume, peak flow, and flow duration
- Slow down the flow to increase time of concentration and promote infiltration and evapotranspiration
- Improve groundwater recharge
- Protect downstream water resources, including wetlands

- Reduce downstream flooding and property damage
- Reduce incidence of combined sewer overflow (CSOs)
- Provide water quality improvements/reduced treatment costs
- Reduce thermal pollution
- Improve wildlife habitat

For the greatest level of success at reducing the negative effects of stormwater, this approach must be incorporated into an iterative site planning and design process. In the iterative site planning and design process, the designer tries various combinations of runoff reduction techniques (described in this section) and certain standard SMPs with RRv capacity (described in sections 3.3 and 3.6) to address stormwater runoff so that the RRv requirement is met. The design and layout of stormwater management features are conducted in unison with site planning and green infrastructure objectives. This approach has three primary components that mitigate the effects of stormwater runoff from development:

1. Avoiding the Impacts – *Avoid or minimize disturbance by preserving natural features and using conservation design techniques*
2. Reducing the Impacts – *Reducing the impacts of development by reducing impervious cover*
3. Managing the Impacts – *Manage the impacts by using natural features and runoff reduction practices to slow down the runoff, promote infiltration and evapo-transpirtation, and consequently minimizing the need for the structural "end-of-pipe" practices*

Runoff reduction techniques are highly effective when used to address stormwater runoff from smaller, more frequent storms. As precipitation size and intensity increase, pervious surfaces become less capable of infiltrating runoff and their peak flow reduction "benefits" diminish. Thus, runoff reduction is not generally applied to larger storms. Volume and peak rate control practices for meeting quantity control objectives must be documented in the Stormwater Pollution Prevention Plan (SWPPP).

A summary of the green infrastructure planning tools and runoff reduction techniques covered in this Manual can be found in Tables 3.1 and 3.2. The green infrastructure planning tools, presented in Table 3.1, are practices that indirectly result in runoff reduction. A water quality reduction is realized when calculating the percentage of impervious area in the water quality volume formula in Chapter 4. The runoff reduction techniques, presented in Table 3.2, are practices for which runoff reduction is quantified. Complete definition, design specification, and computation method are presented in Chapter 5 of this manual.

Exceptions to Meeting the Runoff Reduction Volume (RRv) Criteria:

- Although encouraged, meeting the RRv criteria is not required for redevelopment activities that meet the criteria in Chapter 9 of this manual.
- Meeting the RRv criteria is required for projects over karst geology. However, the use of large infiltration basins must be avoided. A geotechnical assessment is recommended for infiltration and recharge at small scales.
- For projects that meet the "hotspot" criteria in Chapter 4 of this manual, designers shall use non-infiltration type practices to meet the RRv criteria.

Table 3.1 Green Infrastructure Planning General Categories and Specific Practices

Group	Practice	Description
Preservation of Natural Resources	Preservation of Undisturbed Areas	Delineate and place into permanent conservation easement undisturbed forests, native vegetated areas, riparian corridors, wetlands, and natural terrain.
	Preservation of Buffers	Define, delineate and place in permanent conservation easement naturally vegetated buffers along perennial streams, rivers, shorelines and wetlands.
	Reduction of Clearing and Grading	Limit clearing and grading to the minimum amount needed for roads, driveways, foundations, utilities and stormwater management facilities.

	Locating Development in Less Sensitive Areas	Avoid sensitive resource areas such as floodplains, steep slopes, erodible soils, wetlands, mature forests and critical habitats by locating development to fit the terrain in areas that will create the least impact.
	Open Space Design	Use clustering, conservation design or open space design to reduce impervious cover, preserve more open space and protect water resources.
	Soil Restoration	Restore the original properties and porosity of the soil by deep till and amendment with compost to reduce the generation of runoff and enhance the runoff reduction performance of practices such as grass channels, filter strips, and tree clusters.
Reduction of Impervious Cover	Roadway Reduction	Minimize roadway widths and lengths to reduce site impervious area
	Sidewalk Reduction	Minimize sidewalk lengths and widths to reduce site impervious area
	Driveway Reduction	Minimize driveway lengths and widths to reduce site impervious area
	Cul-de-sac Reduction	Minimize the number of cul-de-sacs and incorporate landscaped areas to reduce their impervious cover.
	Building Footprint Reduction	Reduce the impervious footprint of residences and commercial buildings by using alternate or taller buildings while maintaining the same floor to area ratio.
	Parking Reduction	Reduce imperviousness on parking lots by eliminating unneeded spaces, providing compact car spaces and efficient parking lanes, minimizing stall dimensions, using porous pavement surfaces in overflow parking areas, and using multi-storied parking decks where appropriate.

Table 3.2 Acceptable Runoff Reduction Techniques

Group	Practice	Description
Runoff Reduction Techniques	Conservation of natural areas	Retain the pre-development hydrologic and water quality characteristics of undisturbed natural areas, stream and wetland buffers by restoring and/or permanently conserving these areas on a site.
	Sheetflow to riparian buffers or filter strips	Undisturbed natural areas such as forested conservation areas and stream buffers or vegetated filter strips and riparian buffers can be used to treat and control stormwater runoff from some areas of a development project.
	Vegetated open swale	The natural drainage paths, or properly designed vegetated channels, can be used instead of constructing underground storm sewers or concrete open channels to increase time of concentration, reduce the peak discharge, and provide infiltration.
	Tree planting / tree box	Plant or conserve trees to reduce stormwater runoff, increase nutrient uptake, and provide bank stabilization. Trees can be used for applications such as landscaping, stormwater management practice areas, conservation areas and erosion and sediment control.
	Stream daylighting for redevelopment projects	Stream Daylight previously-culverted/piped streams to restore natural habitats, better attenuate runoff by increasing the storage size, promoting infiltration, and help reduce pollutant loads.
	Rain garden	Manage and treat small volumes of stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression.
	Green roof	Capture runoff by a layer of vegetation and soil installed on top of a conventional flat or sloped roof. The rooftop vegetation allows evaporation and evapotranspiration processes to reduce volume and discharge rate of runoff entering conveyance system.
	Stormwater planter	Small landscaped stormwater treatment devices that can be designed as infiltration or filtering practices. Stormwater planters use soil infiltration and biogeochemical processes to decrease stormwater quantity and improve water quality.
	Rain tank/Cistern	Capture and store stormwater runoff to be used for irrigation systems or filtered and reused for non-contact activities.
	Porous Pavement	Pervious types of pavements that provide an alternative to conventional paved surfaces, designed to infiltrate rainfall through the surface, thereby reducing stormwater runoff from a site and providing some pollutant uptake in the underlying soils.

Section 3.3 Standard Stormwater Management Practices for Treatment

This section presents a list of standard stormwater management practices (SMPs) that are acceptable for water quality treatment. The practices on this list were selected based on the following criteria:

1. Can capture and treat the full water quality volume (WQv)
2. Are capable of 80% TSS removal and 40% TP removal.
3. Have acceptable longevity in the field.
4. Have a pretreatment mechanism.

It also provides data justifying the use of these practices, and minimum criteria for the addition of new practices to the list.

Standard SMPs are structural practices that are acceptable for water quality treatment and meet the performance standards defined in Chapter 6 of this manual. These practices are designed to capture and treat the water quality volume (the portion infeasible to retain onsite using runoff reduction techniques) through one or more pollutant removal pathway(s) and their performances are documented by removal efficiency of specific pollutants. The standard SMPs are often sited as “end-of-the-pipe” treatment systems and designed to function as storage or flow-through systems.

3.3.1 Practice List

Practices on the following list will be presumed to meet water quality requirements set forth in this manual if designed in accordance with the sizing criteria presented in Chapter 4 and constructed in accordance with the performance criteria in Chapter 6. The practices must also be maintained properly in accordance with the prescribed maintenance criteria also presented in Chapter 6. Acceptable practices are divided into five broad groups, including:

I. **Stormwater Ponds** Practices that have either a permanent pool of water or a combination of permanent pool and extended detention capable of treating the WQ_v

II. **Stormwater Wetlands** Practices that include significant shallow marsh areas, and may also incorporate small permanent pools and extended detention storage to achieve the full WQ_v

III. **Infiltration Practices** Practices that capture and temporarily store the WQ_v before allowing it to infiltrate into the soil.

IV. **Filtering Practices** Practices that capture and temporarily store the WQ_v and pass it through a filter bed of sand, organic matter, soil, or other acceptable treatment media.

V. **Open Channel Practices** Practices explicitly designed to capture and treat the full WQ_v within dry or wet cells formed by check dams or other means.

Within each of these broad categories, select practices are presumed to meet the established water quality goals (see Table 3.3). Guidance on the performance criteria for each practice type and matrices for selecting practices are provided in Chapters 6 and 7.

Table 3.3 Stormwater Management Practices Acceptable for Water Quality		
Group	**Practice**	**Description**
Pond	Micropool Extended Detention Pond (P-1)	Pond that treats the majority of the water quality volume through extended detention, and incorporates a micropool at the outlet of the pond to prevent sediment resuspension.
	Wet Pond (P-2)	Pond that provides storage for the entire water quality volume in the permanent pool.
	Wet Extended Detention Pond (P-3)	Pond that treats a portion of the water quality volume by detaining storm flows above a permanent pool for a specified minimum detention time.
	Multiple Pond System (P-4)	A group of ponds that collectively treat the water quality volume.
	Pocket Pond (P-5)	A stormwater wetland design adapted for the treatment of runoff from small drainage areas that has little or no baseflow available to maintain water elevations and relies on ground water to maintain a permanent pool.
Wetland	Shallow Wetland (W-1)	A wetland that provides water quality treatment entirely in a wet shallow marsh.
	Extended Detention Wetland (W-2)	A wetland system that provides some fraction of the water quality volume by detaining storm flows above the marsh surface.
	Pond/ Wetland System (W-3)	A wetland system that provides a portion of the water quality volume in the permanent pool of a wet pond that precedes the marsh for a specified minimum detention time.
	Pocket Wetland (W-4)	A shallow wetland design adapted for the treatment of runoff from small drainage areas that has variable water levels and relies on groundwater for its permanent pool.
Infiltration	Infiltration Trench (I-1)	An infiltration practice that stores the water quality volume in the void spaces of a gravel trench before it is infiltrated into the ground.
	Infiltration Basin (I-2)	An infiltration practice that stores the water quality volume in a shallow depression, before it is infiltrated it into the ground.
	Dry Well (I-3)	An infiltration practice similar in design to the infiltration trench, and best suited for treatment of rooftop runoff.
Filtering Practices	Surface Sand Filter (F-1)	A filtering practice that treats stormwater by settling out larger particles in a sediment chamber, and then filtering stormwater through a sand matrix.
	Underground Sand Filter (F-2)	A filtering practice that treats stormwater as it flows through underground settling and filtering chambers.
	Perimeter Sand Filter (F-3)	A filter that incorporates a sediment chamber and filer bed as parallel vaults adjacent to a parking lot.
	Organic Filter (F-4)	A filtering practice that uses an organic medium such as compost in the filter, in the place of sand.
	Bioretention (F-5)	A shallow depression that treats stormwater as it flows through a soil matrix, and is returned to the storm drain system.
Open Channels	Dry Swale (O-1)	An open drainage channel or depression explicitly designed to detain and promote the filtration of stormwater runoff into the soil media.
	Wet Swale (O-2)	An open drainage channel or depression designed to retain water or intercept groundwater for water quality treatment.

3.3.2 Criteria for Practice Addition

The stormwater field is always evolving, and new technologies constantly emerge. The New York State Department of Environmental Conservation supports the development of innovative practices, provided the green infrastructure requirements are met, and allows the use of manufactured systems where specific site conditions demand. However, the Department currently does not have a stormwater management practice verification process in place. Instead, the Department relies on the verification and certification process, being implemented by other regulatory agencies with technical standards similar to those of New York State, to identify the alternative practices that are acceptable for installation in New York State**.**

The goals for performance of practices remain consistent with the performance criteria as stated in Section 3.3 of this Manual. A list of acceptable sources of verification for new stormwater management practices is provided on the Department's website. All proposed alternative stormwater management practices in new construction are considered to be in deviation from State Standards. Such practices must provide a full description to justify the reason(s) for deviation as well as detailed justification on how the proposed practice is equivalent to the standards defined in this Design Manual. In order to be in compliance with the technical standards, projects must meet both required performance and sizing criteria. All proposed alternative practices must at minimum meet the sizing criteria as defined in Chapter 4 of this Design Manual. The equivalency of the performance of the proposed new technologies to the performance criteria required by the State of New York must be verified and certified by one of the sources accepted by the Department and documented in the SWPPP. All design and plan review professionals must adhere to the design parameters that constitute the removal efficiency equivalent to the Department's performance criteria (80% TSS removal and 40% phosphorus removal).

Specific requirements for redevelopment applications are addressed in Chapter 9 of this Design Manual.

Section 3.4 Quantity Controls

Quantity control practices are systems which are primarily designed for channel protection, safe conveyance of the flow, and flood control. Most quantity control facilities are structural systems that provide detention and control discharge rate. Some examples of quantity control practices include detention ponds, underground storage vaults (chambers, large diameter pipe), and blue roofs. Infiltration practices can also be used as an accepted control for up to the 10-year storm, provided the infiltration rate is greater than 5.0 in/hr. In addition, extended detention storage may be provided above the water quality volume in an infiltration basin with a proper outlet design. This allows a designer to meet all the quantity control sizing criteria in Chapter 4 (Cpv, Qp, Qf).

Flood controls are primarily managed through detention structures. Examples of quantity control facilities are presented in Table 3.4.

Table 3.4 Stormwater Management Practices for Stormwater Quantity Control

Group	Practice	Description
Above ground systems	Dry Detention	Dry detention basins and dry extended detention basins are surface facilities intended to provide for the temporary storage of stormwater runoff to reduce downstream water quantity impacts.
	Blue Roofs	Blue roofs (rooftop detention systems) are constructed by installing slotted flow restriction devices known as collars or restrictors around the roof drains of flat, structurally sound, waterproof roofs. By this mechanism, stormwater is detained on the roof and the peak rate of discharge is reduced.
Underground systems	Underground Storage Vaults (chambers, pipes)	An underground storage system is a subsurface stormwater system suitable for sites within high-density urban areas. Such systems are designed as an arched structure, a vault or large diameter pipe and function in both permeable and non-permeable soils for subsurface detention of stormwater runoff or infiltration. Chambers, vaults or pipes can decrease the peak flow when used with a controlled flow orifice at the outlet.
Infiltration Systems	Infiltration Basin	Practices that capture and temporarily store runoff before allowing it to either infiltrate into the soil (Infiltration rate > 5 in/hr) or be released by a controlled outlet. (*See EPA Class V injection well language in Chapter 4)

This Design Manual does not provide design specifications for the quantity control practices. However, example technical drawings and examples of outlet structure sizing (orifices and weir), and determination of detention time are presented in Chapters 4 and 8 of this Design manual.

Section 3.5 Maintenance Requirements

The responsibility for implementation of long term operation and maintenance of a post-construction stormwater management practice shall be vested with a responsible party by means of a legally binding and enforceable mechanism such as a maintenance agreement, deed covenant or other legal measure. This mechanism shall protect the practice from neglect, adverse alteration and/or unauthorized removal. The mechanism and Operation and Maintenance (O&M) plan must be included in the SWPPP.

At a minimum, the O&M plan must address each of the following:

1. An owner of a post-construction stormwater management practice, including the runoff reduction practices and SMPs included in this Design Manual, shall erect or post, in the immediate vicinity of the stormwater management practice, a conspicuous and legible sign of not less than 18 inches by 24 inches (or 10"X12" for footprints smaller than 400 sf) bearing the following information:

2. **Stormwater Management Practice -** *(name of the practice)*

3. Project Identification - (SPDES Construction Permit #, other)

4. Must Be Maintained In Accordance With O&M Plan

5. **DO NOT REMOVE OR ALTER**

6. Example:

7. **Stormwater Management Practice** – Rain Garden

8. Project Identification - SPDES NYR10K123

9. Must Be Maintained In Accordance With O&M Plan

10. **DO NOT REMOVE OR ALTER**

11. Identification of the entity that will be responsible for long term operation and maintenance of the stormwater management practices.

12. Identification of the mechanism(s) that will be used to ensure long term operation and maintenance of the stormwater management practices (Deed covenant, easements/rights-of-way, executed maintenance agreement, etc.). Include a copy of such mechanism.

13. A copy of the schematics of the practice, with the measurements of design specifications clearly defined.

14. A list of maintenance requirements (already defined in this Design Manual and the additional site specific requirements), proper frequency, and a maintenance log for tracking and observation.

Section 3.6 The Six Step Process for Stormwater Site Planning and Practice Selection

Stormwater management using green infrastructure is summarized in the five step process described below (See Figure 3.1 also). Designers are required to adhere to the five step process when developing a SWPPP. This includes providing information in the SWPPP which documents compliance with the required process.

Step 1: Site Planning

In Step 1, the designer uses practices identified in Table 3.1 to protect natural resources and utilize the hydrology of the site before laying out the proposed development. The Preservation of Natural Resources practices (see Table 3.1) include protecting natural areas, avoiding sensitive areas and minimizing grading and soil disturbance. The designer then considers practices to reduce impervious cover when laying out the initial site design. The Reduction of Impervious Cover practices (see Table 3.1) include conservation design and reducing impervious cover in roads, driveways and parking lots.

The SWPPP must include an evaluation of all the green infrastructure planning measures as they apply to the site. This evaluation process requires the following measures:

- Developing a map that identifies natural resource areas and drainage patterns; including but not limited to:
    - Wetlands (jurisdictional, wetland of special concern)
    - Waterways (major, perennial, intermittent, springs)
    - Buffers (stream, wetland, forest, etc.)
    - Floodplains
    - Forest, vegetative cover
    - Critical areas
    - Topography (contour lines, existing flow paths, steep slopes, etc.)
    - Soil (hydrologic soil groups, highly erodible soils, etc.)
    - Bedrock, significant geology features
- Devising the strategies for protection and enhancement of natural resources

  - Prior to site layout, preserve natural features (site fingerprinting)
  - Utilize natural features to preserve the natural hydrology
  - Maintain natural drainage design points
  - Maximize retention of forest cover and undisturbed soils
  - Avoid erodible soils on steep slopes and limit mass grading

- Reducing the impacts of development by reducing impervious surfaces
- Demonstrating that all reasonable opportunities for preserving natural conditions of the site are employed to minimize the runoff and maintain the pre-construction hydrology

During the planning step, the designer should check with the municipality to determine if there are local laws and ordinances that regulate wetlands, stream buffers, forest or habitat protection, erosion control or grading. If present, the local regulations will determine minimum areas of protection that the designer can then expand upon to maximize runoff reduction objectives. The designer should also consult the municipality for laws relating to conservation or cluster design, roads, driveways and parking lots to determine the level of flexibility in reducing impervious surfaces.

This component of the plan must also be clearly addressed in the Erosion and Sediment Control (ESC) Plan (Development of ESC plan is provided in the New York Standards and Specifications for Erosion and Sediment Control). Description and minimum requirements for meeting site planning principles are presented in Chapter 5 of this Manual.

Step 2: Determine Water Quality Treatment Volume (WQv)

In Step 2, the designer calculates the required WQv for the site using the criteria in Chapter 4. Once the preliminary site layout is prepared, impervious areas are defined, and sub-catchments are delineated, the designer should calculate the water quality volume. This initial calculation of WQv may have to be revised after runoff reduction techniques are applied.

Step 3: Apply Runoff Reduction Techniques and Standard SMPs with RRv Capacity (e.g. infiltration practices, bioretention and open channel practices) to Reduce Total WQv

In Step 3, the designer experiments with combinations of runoff reduction techniques and standard SMPs with RRv capacity on the site. In each case, the designer estimates the spatial area to be treated by each runoff reduction technique, potentially reducing the required WQv by incorporating runoff reduction techniques or standard SMPs with RRv capacity within each drainage area on the site.

Runoff Reduction techniques are grouped into two categories:

- Practices resulting in a reduction of contributing area
  - Examples: preservation/restoration of conservation areas, vegetated channel, etc.
- Practices resulting in a reduction of contributing volume
  - Example: green roofs, stormwater planters, and rain gardens

The standard SMPs with RRv capacity are listed in Table 3.5. A designer can apply the following percentages of WQv (provided by the standard SMP) towards meeting the RRv sizing criteria, provided the design of the practice complies with the "Required Elements" in Chapter 6:

Table 3.5 Runoff Reduction Capacity for Standard SMPs

SMP	RRv Capacity (% of WQv provided by practice)
Infiltration Practices (by source control)	100%
Bioretention Practice	100% in HSG A and B (without underdrain)
	40% HSG C and D (with underdrain)
Dry Swale (Open Channel Practice)	40% in HSG A and B
	20% in HSG C and D

If the standard SMPs with RRv capacity listed above are going to be used to address the RRv criteria, the practices must be designed to capture runoff near the source. The practices must be localized systems that are installed throughout the site at each runoff source, thereby minimizing the use of traditional "end-of-pipe" treatment systems.

By applying a combination of runoff reduction techniques and standard SMPs with RRv capacity, the designer must reduce 100% of the WQv calculated in Step 2. If the RRv calculated in this step is greater than or equal to the WQv calculated in Step 2, the designer has met the RRv requirement and may proceed to Step 6. Unless it can be demonstrated that site limitations exist to provide relief from reducing 100% of the WQv, designers must return to Step 1 to see if an alternative site plan or combination of the runoff reduction techniques and standard SMPs with RRv capacity can be applied to achieve compliance with the RRv sizing criteria. Acceptable site limitations include conditions that prevent the use of an infiltration technique and or infiltration of the total WQv. Typical site limitations include: seasonal high groundwater, shallow depth to bedrock, and soils with an infiltration rate less than 0.5 inches/hour. For construction activities that cannot reduce the total WQv, the designer shall identify the specific site limitations in the SWPPP

In the event that a designer cannot reduce 100% of the WQv due to site limitations, they shall direct runoff from all newly constructed impervious areas to a RR technique or standard SMP with RRv capacity unless infeasible. For each area where runoff from newly constructed impervious area is not directed towards a RR technique or standard SMP with RRv capacity, the designer must provide justification in the SWPPP as to why each of the aforementioned practices are infeasible. If a demonstration of infeasibility cannot be made, then the designer must return to Step 1 to see if an alternative site plan or combination of the runoff reduction techniques and standard SMPs with RRv capacity can be applied to achieve compliance with the RRv sizing criteria. .

Note: The design specifications and runoff reduction credit for the runoff reduction techniques and standards SMPs with RRv capacity are provided in Chapters 5 and 6 of this Manual, respectively.

Step 4: Determine the minimum RRv required

In Step 4, the designer determines the minimum RRv required for the construction activity as calculated using the criteria in Section 4.3 of this Design Manual and compares this to the runoff reduction achieved from impervious surfaces (determined in Step 3). In no case shall the runoff reduction achieved from the newly constructed impervious areas be less than the Minimum RRv.

Step 5: Apply Standard Stormwater Management Practices to Address Remaining Water Quality Volume

In Step 5, the designer uses standard SMPs (see Table 3.3) such as filtering practices, ponds, or stormwater wetlands to to treat the remaining water quality volume that cannot be reduced by applying the runoff reduction techniques and standard SMPs with RRv capacity. The designer must verify that the RRv requirement has been met; otherwise the plan does not comply with the required sizing criteria in Chapter 4.

Step 6: Apply Volume and Peak Rate Control Practices if Still Needed to Meet Requirements

The channel protection volume, overbank flood control, and extreme flood control must be met for the plan to be completed. In Step 6, the designer may use practices such as infiltration basins, dry detention basins, and blue roofs to meet water quantity requirements.

Figure 3.1: Stormwater Site Planning and Practice Selection Flow Chart