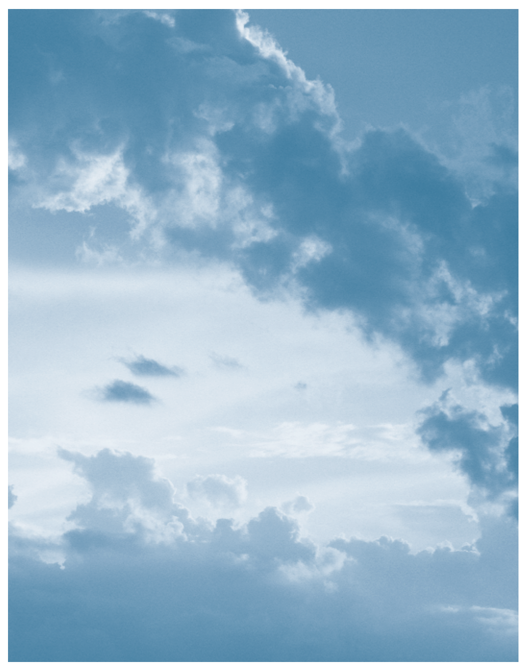
Chapter 3

Preventing and Mitigating Stormwater Impacts



Volume 1: Background

Chapter 3

Preventing and Mitigating Stormwater Impacts

3.1 Introduction

Stormwater management involves the selective use of various management measures to cost-effectively address the adverse water quality and quantity impacts of urban stormwater runoff described in Chapter Two. **Table 3-1** lists the major elements and associated objectives of a comprehensive stormwater management strategy.

Effective site planning and design is the most critical and potentially beneficial element of a successful stormwater management program since it addresses the root causes of both stormwater quality and quantity problems early in the development process. Source controls and pollution prevention, as well as construction erosion and sedimentation controls, are also key elements for preventing or mitigating stormwater quality problems. These preventive measures can reduce the size and scope of stormwater treatment and flood control facilities. However, it is also recognized that stormwater treatment and flood control measures are often effective and necessary to achieve water quality and quantity control objectives. **Figure 3-1** shows the relationship and recommended hierarchy of these stormwater management elements.

Table 3-1 Elements of a Comprehensive Stormwater Management Strategy

Element	Addresses Water Quality or Quantity?
Effective site planning and design	Quality and quantity
Source control practices and pollution prevention	Quality
Construction erosion and sedimentation controls	Quality
Stormwater treatment practices	Quality (primary), quantity (secondary)
Drainage design and flood control	Quantity (primary), quality (secondary)

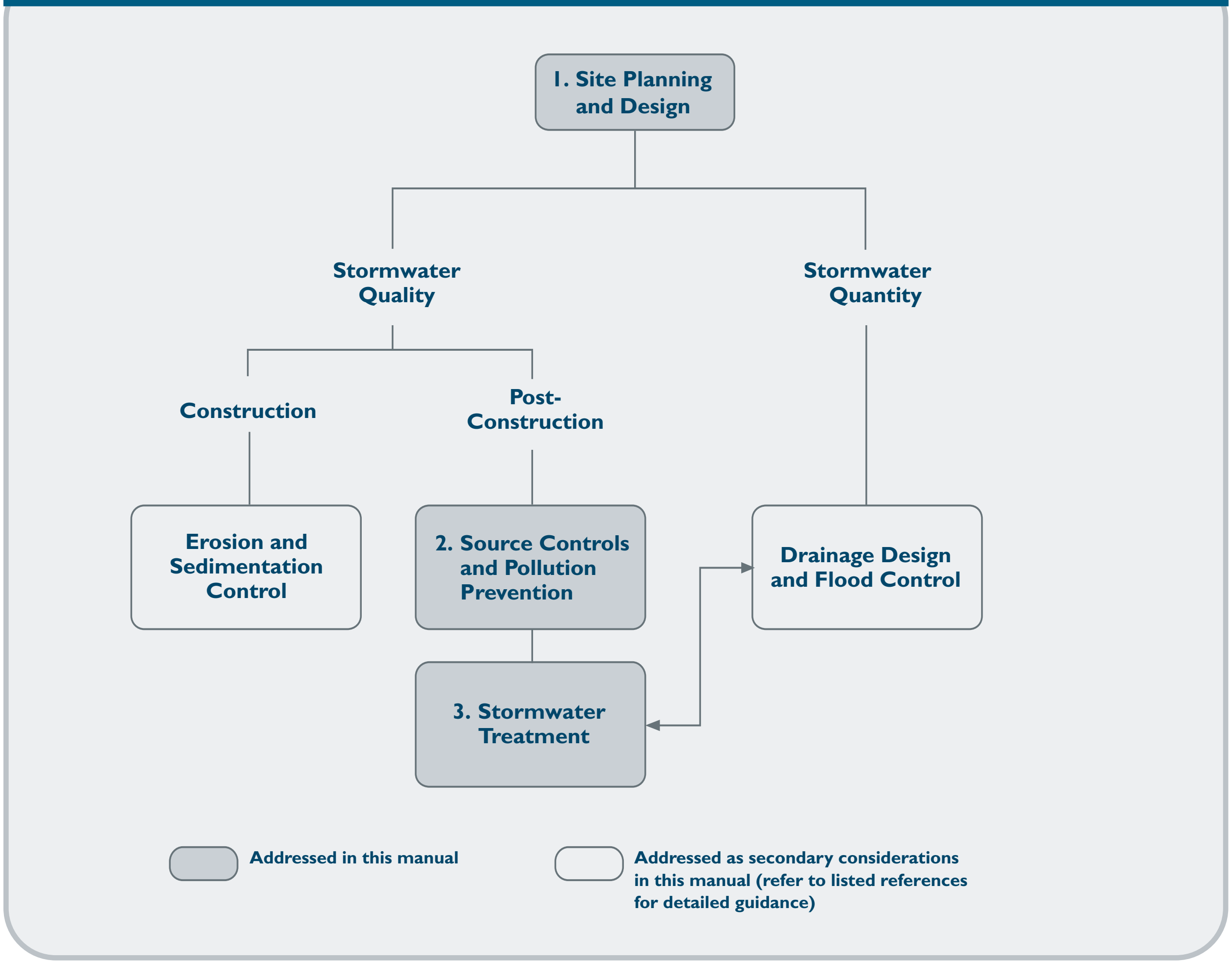
This manual primarily addresses water quality controls through site planning and design, source controls and pollution prevention, and stormwater treatment practices, which are highlighted in **Figure 3-1.** Construction erosion and sediment control, and stormwater quantity control (i.e., flood control and drainage design), are addressed as secondary topics as they relate to water quality. For instance, source controls and stormwater treatment practices can also provide peak runoff attenuation and flood control benefits. Other guidance documents, as well as local ordinances and requirements, are recommended sources of information on these topics, as discussed later in this chapter.

3.2 Guiding Stormwater Management Principles

A comprehensive stormwater management strategy should prevent or mitigate urban runoff problems and protect beneficial uses of receiving waters in a cost-effective manner. The stormwater management measures described in this manual are designed to accomplish this objective by adhering to the following guiding principles:

- *Preserve pre-development site hydrology (i.e., runoff, infiltration, interception, evapotranspiration, groundwater recharge, and stream baseflow) to the extent possible*
- *After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solids loadings by 80 percent. For high quality receiving waters and sites with the highest potential for significant pollutant loadings, reduce post-development pollutant loadings so that average annual post-development loadings do not exceed pre-development loadings (i.e., no net increase)*

Figure 3-1 Relationship of Stormwater Management Elements



- *Preserve and protect wetlands, stream buffers, natural drainage systems and other natural features that provide water quality and quantity benefits*
- *Manage runoff velocity and volume in a manner that maintains or improves the physical and biological character of existing drainage systems and prevents increases in downstream flooding/streambank erosion*
- *Prevent pollutants from entering receiving waters and wetlands in amounts that exceed the systems' natural ability to assimilate the pollutants and provide the desired functions*
- *Seek multi-objective benefits (i.e., flood control, water quality, recreation, aesthetics, habitat) from stormwater control measures*

3.3 Site Planning and Design

Effective site planning and design (Chapter Four) consists of preventive measures that address the root causes of stormwater problems by maintaining predevelopment hydrologic functions and pollutant removal mechanisms to the extent practical. Site planning that integrates comprehensive stormwater management from the outset is the most effective way to address the adverse water quality and quantity impacts of stormwater runoff from new development and redevelopment projects. Often these site design techniques can reduce or eliminate the need for costly peak flow attenuation and stormwater treatment. This manual emphasizes the use of effective site planning and design techniques early on in the site development process to achieve the greatest stormwater quantity and quality benefits. Site planning and design practices described in this manual include:

- *Alternative site design for streets and parking lots and lot development*

- *Low Impact Development (LID) management practices*
- *Watershed planning*

3.4 Source Control Practices and Pollution Prevention

Source control practices and pollution prevention (Chapter Five) are operational practices that can reduce the types and concentrations of pollutants in stormwater runoff by limiting the generation of pollutants at their source. The guiding principle behind these techniques is to minimize contact of stormwater with potential pollutants, thereby reducing pollutant loads and the size and cost of stormwater treatment. This manual emphasizes the use of source control practices and pollution prevention, in conjunction with effective site planning and design, to reduce the need for and scope of stormwater treatment. Source control practices commonly implemented at residential, commercial, and industrial sites are discussed in this manual, including:

- *Street and Parking Lot Sweeping*
- *Roadway Deicing/Salt Storage*
- *Storm Drainage System Maintenance*
- *Other Road, Highway, and Bridge Maintenance*
- *Illicit Discharge Detection and Elimination*
- *Commercial and Industrial Pollution Prevention Plans*
- *Animal Waste Management*
- *Lawn Care and Landscaping Practices*
- *Model Stormwater Ordinances*
- *Public Education*

3.5 Construction Erosion and Sedimentation Control

As described in Chapter One, soil erosion and sedimentation control is addressed by the Soil Erosion and Sediment Control Act (CGS §§22a-325 through 22a-335, inclusive). The primary goal of the Act is to reduce soil erosion from stormwater runoff and nonpoint sediment pollution from land being developed. Controlling soil erosion and sedimentation during construction is addressed through a combination of measures that are described in a site-specific Erosion and Sediment Control (E&SC) Plan. The basic principles of effective soil erosion and sediment control include:

- *Use effective site planning to avoid sensitive areas such as wetlands and watercourses*
- *Keep land disturbance to a minimum*
- *Stabilize disturbed areas*
- *Phase land disturbance on larger projects, starting subsequent phases after disturbed areas are stabilized*
- *Keep runoff velocities low*
- *Protect disturbed areas from stormwater runoff*
- *Properly install perimeter control practices*
- *Limit construction during months when runoff rates are higher due to decreased infiltration or extreme rainfall events*
- *Implement a thorough maintenance and follow-up program*
- *Assign responsibility for the maintenance program*

As shown in **Figure 3-1,** soil erosion and sediment control is a key component of any stormwater management strategy in order to reduce the impacts of stormwater runoff during construction activities. Although many of the vegetative, filtration, and infiltration stormwater management practices contained in this manual are based on the above principles, this manual does not address construction soil erosion and sediment control practices. Municipal ordinances contain specific soil erosion and sediment control requirements for developments disturbing more than one-half acre. Additionally, the 2002 revision of 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) contains detailed technical guidance on specific erosion and sediment control practices and recommended procedures for developing an effective E&SC Plan. Copies of this guidance manual have been issued to each local Planning, Zoning, and Inland Wetlands and Watercourses Office.

3.6 Stormwater Treatment Practices

Stormwater treatment practices, which are the focus of the second half of this Manual, are primarily designed to remove pollutants from stormwater runoff. In addition to water quality treatment, these practices can also provide groundwater recharge, stream channel protection, and peak runoff attenuation. As described above, stormwater treatment practices should be selected and designed only after consideration of effective site planning/design and

Table 3-2 Stormwater Pollutant Removal Mechanisms

Mechanism	Pollutants Affected
Gravity settling of particulate pollutants	Solids, BOD, pathogens, particulate COD, phosphorus, nitrogen, synthetic organics, particulate metals
Filtration and physical straining of pollutants through a filter media or vegetation	Solids, BOD, pathogens, particulate COD, phosphorus, nitrogen, synthetic organics, particulate metals
Infiltration of particulate and dissolved pollutants	Solids, BOD, pathogens, particulate COD, phosphorus, nitrogen, synthetic organics, particulate metals
Adsorption on particulates and sediments	Dissolved phosphorus, metals, synthetic organics
Photodegradation	COD, petroleum hydrocarbons, synthetic organics, pathogens
Gas exchange and volatilization	Volatile organics, synthetic organics
Biological uptake and biodegradation	BOD, COD, petroleum hydrocarbons, synthetic organics, phosphorus, nitrogen, metals
Chemical precipitation	Dissolved phosphorus, metals
Ion exchange	Dissolved metals
Oxidation	COD, petroleum hydrocarbons, synthetic organics
Nitrification and denitrification	Ammonia, nitrate, nitrite
Density separation and removal of floatables	Petroleum hydrocarbons

source controls, which can reduce the volume of runoff and the size and cost of stormwater treatment.

Stormwater treatment practices are designed for small storms to achieve water quality objectives (i.e., smaller than a one-year return frequency storm), in contrast to drainage and flood control facilities, which are typically designed for the two-year and larger storms. However, many stormwater treatment practices can also be designed for flood control purposes and vice versa. Stormwater treatment practices can be integrated into the landscape, drainage or flood control system, and other spaces of development projects. When properly located, designed, and maintained, stormwater treatment practices can be amenities for, rather than detractions from, development projects.

Pollutant Removal Mechanisms

Stormwater treatment practices remove pollutants from stormwater through various physical, chemical, and biological mechanisms. **Table 3-2** lists the major stormwater pollutant removal mechanisms and the affected stormwater pollutants.

Since many pollutants in urban stormwater runoff are attached to solid particles, treatment practices designed to remove suspended solids from runoff will remove other pollutants as well. Exceptions to this rule include nutrients, which are often in a dissolved form, soluble metals and organics, and extremely fine particulates (i.e., diameter smaller than 10 microns), which can only be removed by treatment practices other than traditional separation methods.

Primary and Secondary Stormwater Treatment Practices

Stormwater treatment practices described in this Manual include both primary treatment practices, which provide demonstrated, acceptable levels of water quality treatment, and secondary treatment practices which are not suitable as stand-alone treatment facilities but can be used for pretreatment or as supplemental practices. This Manual includes five major categories of primary stormwater treatment practices:

- *Stormwater ponds*
- *Stormwater wetlands*
- *Infiltration practices*
- *Filtering practices*
- *Water quality swales*

Examples of secondary stormwater treatment practices described in the Manual include traditional practices such as dry detention ponds, vegetated filter strips and level spreaders, oil/particle separators, and deep sump catch basins. The Manual also includes innovative and emerging technologies as secondary treatment practices. These technologies are designed to remove a variety of stormwater pollutants, but have not been evaluated in sufficient detail to demonstrate the capability to meet established performance standards. Sizing and selection criteria for stormwater treatment practices are addressed in Chapter Seven and Chapter Eight, respectively.

New Development Versus Retrofits

Stormwater treatment practices can be implemented for new development projects as well as existing, developed sites. Retrofitting existing developments can improve water quality mitigation functions of older, poorly designed, or poorly maintained stormwater management systems. Incorporating stormwater retrofits into developed sites is typically more difficult than implementing treatment practices for new development due to the numerous site constraints associated with developed areas such as subsurface utilities, buildings, conflicting land uses, and maintenance access. Chapter Ten describes common stormwater retrofit options for existing development and redevelopment projects, including:

- *Stormwater collection system retrofits*
- *Stormwater management facility retrofits*
- *New stormwater controls at storm drain outfalls*
- *In-stream practices in existing drainage channels*
- *Parking lot stormwater retrofits*
- *Wetland creation and restoration*

3.7 Stormwater Quantity Control

Stormwater quantity controls include drainage and flood control. As shown in **Figure 3-1,** stormwater quantity and quality controls are related and complementary elements of an effective stormwater management strategy. Stormwater drainage systems can be designed to reduce the potential erosive velocity of stormwater runoff and maintain pre-development hydrology through infiltration and the use of vegetated conveyances, thereby preserving the water quality mitigation functions of a site. Similarly, stormwater treatment practices such as stormwater ponds and wetlands can provide dual flood control and water quality treatment benefits.

This Manual addresses the topics of drainage design and flood control as they relate to stormwater quality management. The Manual identifies stormwater treatment practices that also provide peak runoff attenuation and channel protection functions. However, this document is not intended to serve as a drainage or flood control design manual. Other recommended guidance documents and manuals on these topics include:

- *2000 Connecticut Department of Transportation Drainage Manual, October 2000*
- *Connecticut Department of Environmental Protection, Model Hydraulic Analysis, revised February 13, 2002*
- *Urban Hydrology for Small Watersheds, TR-55, Natural Resource Conservation Service (formerly Soil Conservation Service), June 1986*

In addition, municipal ordinances, as well as some DEP regulatory programs, contain specific stormwater quantity control requirements for land development projects, as described in Chapter One.

Drainage Design and Flood Control Principles for Water Quality

The traditional approach to drainage design has been to collect and remove runoff from the site as quickly as possible through the use of curbs, gutters, catch basins, and storm sewers, often resulting in the discharge of polluted runoff directly to receiving waters. While this approach effectively removes runoff from a site, it does not address water quality or downstream flooding and erosion issues. Similarly, the traditional approach to flood control has been to attenuate peak runoff to pre-development levels through the use of detention and retention ponds. While stormwater detention or retention facilities can effectively reduce peak discharge rates, they also typically prolong the duration of elevated flows and do not reduce runoff volumes unless infiltration is incorporated into their design. Historically, these facilities have not adequately addressed problems associated with water quality, runoff volume, and downstream channel erosion.

Drainage and flood control facilities should be designed according to the following principles to address water quality objectives:

- *Identify and assess existing stormwater runoff rates and volumes at the site, as well as downstream flooding and erosion concerns.*
- *Preserve pre-development hydrologic conditions, including peak discharge, runoff volume, groundwater recharge, and natural drainage paths.*
- *Reduce the potential for increases in runoff quantity by minimizing impervious surfaces and maximizing infiltration of stormwater runoff. Eliminate curbs where possible and encourage sheet flow from paved areas. If*

curbing is required, use Cape Cod curbing or other similar curbing, which allows amphibians to climb.

- *Encourage infiltration of stormwater through the use of vegetated depressions, swales, rain gardens and bioretention, and other vegetated drainageways to convey and hold stormwater and provide for a slow recharge to groundwater, where soils permit. Special care must be taken in areas of sensitive groundwater resources such as aquifer protection areas and groundwater supply wells in order to prevent their contamination. In addition, in areas with soil or groundwater contamination, the potential for infiltrated stormwater to mobilize contaminants must also be considered.*
- *Control increases in stormwater runoff volume and peak flows through properly designed and located stormwater management facilities. Manage stormwater so that both the volume and peak rate of runoff from the site after development does not exceed the volume and peak rate of runoff from the site prior to development.*
- *Encourage the development of watershed-based stormwater management strategies to effectively control the cumulative effects of increases in runoff volume and peak flows at critical locations throughout the watershed. Coordinate the timing of detention basin outflows to avoid increases in peak flows in downstream watercourses.*
- *Use adequate outlet protection at drainage outfalls to reduce discharge velocities, disperse flow, and prevent or reduce downstream erosion.*
- *Coordinate construction erosion and sediment control measures with post-construction stormwater management measures. For example, a sediment basin designed to trap sediment during the construction phase of a project may sometimes be converted to a detention basin or stormwater treatment facility to meet peak runoff attenuation or water quality mitigation objectives following construction.*
- *Retain on-site the volume of runoff generated by the first inch of rainfall from areas adjacent to or within 500 feet of tidal salt marshes and estuarine waters. Excessive quantities of fresh water can be a pollutant to tidal wetlands and cause a decrease in vegetative diversity and wetland productivity.*
- *Protect wetland and watercourse resources from stormwater discharges. Do not drain stormwater directly to a wetland or watercourse or to a municipal storm drainage system that drains directly to a wetland or watercourse without adequate stormwater treatment. Protect wetlands, watercourses, and submerged aquatic vegetation from scour.*

3.8 Watershed Management

Stormwater management is most effectively undertaken in the context of a watershed management plan. A watershed management plan is a comprehensive framework for applying management tools in a manner that achieves the water resources goals for the watershed as a whole (CWP, 1998). Typically, watershed management plans are developed from watershed studies undertaken by one or more municipalities located within the watershed. The watershed approach has emerged over the past decade as the recommended approach for addressing nonpoint source pollution problems, including polluted stormwater runoff. Watershed planning offers the best means to:

- *Address cumulative impacts derived from a number of new land development projects*
- *Plan for mitigation to address cumulative impacts from existing developments*
- *Focus efforts and resources on identified priority water bodies and pollutant sources in a watershed*
- *Achieve noticeable improvements to impaired waters or waters threatened with impairment*

The watershed approach is built on three main principles. First, the target watersheds should be those where stormwater impacts pose the greatest risk to human health, ecological resources, desirable uses of the water, or a combination of these. Second, parties with a stake in the specific local situation (i.e., stakeholders) should participate in the analysis of problems and the creation of solutions. Third, the actions undertaken should draw on the full range of methods and tools available, integrating them into a coordinated, multi-organization attack on the problems. The watershed approach has the following significant advantages over traditional piecemeal approaches to stormwater management that require individual land developments to provide on-site stormwater management facilities (adapted from Aldrich, 1988):

Lower capital and O&M cost: Typically, watershed management plans yield fewer and larger stormwater management facilities. Economies of scale are achievable in capital costs and especially in O&M. Strategic placement of regional facilities permits concentrating funds on areas where potential benefits are greatest. Cost sharing arrangements significantly reduce the net cost of stormwater management to the community as a whole.

Increased effectiveness on a watershed-wide basis: Often different portions of watersheds require different types of stormwater controls. Watershed planning permits the siting of a variety of on-site and regional facilities in locations where the greatest benefits are achieved.

Greater use of nonstructural measures: Often the most practical stormwater controls involve nonstructural measures such as land acquisition, floodplain zoning, subdivision drainage ordinances, and land use controls. Watershed planning provides a coordinated, comprehensive framework and decision-making process to allow the effective implementation of these measures.

Less risk of negative "spillover" effects: The piecemeal approach may adequately solve localized drainage problems, but seldom addresses downstream impacts. Thus, dynamic interactions between upstream drainage improvements may actually increase downstream flooding. An objective of watershed planning is to account for these upstream interactions and achieve solutions to both localized and regional stormwater management concerns.

Watershed management plans should include recommended criteria for stormwater source controls and treatment practices in the watershed. These criteria are based on watershed-specific factors such as physical attributes, land use, pollution sources, and sensitive receptors, and are the basis for selecting and locating stormwater controls in the watershed. At a minimum, a watershed management plan should contain the elements listed in **Table 3-3** to address stormwater-related issues.

The watershed management plan should address integrating flood control and stormwater management controls with community needs, including open space, aesthetics, and other environmental objectives such as habitat or river restoration. This synchronization with other programs can create better funding opportunities and enhance the overall benefit of the stormwater management practices in the watershed.

On-Site Versus Regional Approaches

Watershed management plans can identify conditions and locations in the watershed where regional stormwater management facilities may be more appropriate or effective than on-site controls. On-site and regional stormwater management approaches are illustrated schematically in **Figure 3-2.** These approaches apply to both stormwater quality and quantity controls.

In the on-site approach, land developers have responsibility for deploying treatment practices and runoff controls at individual development sites. Developers are responsible for constructing on-site stormwater management facilities to control stormwater pollutant loadings and runoff from the site. The local government is responsible for reviewing the design of stormwater management facilities relative to specified design criteria, for inspecting the constructed facilities to ensure conformance with the design, and for ensuring that operation and maintenance plans are implemented for the facilities (Novotny, 1995).

The regional approach involves strategically siting stormwater management facilities to control stormwater runoff from multiple development projects or large drainage areas. Local or regional governments assume the capital costs for constructing the regional facilities. Capital costs are typically recovered from upstream developers as development occurs. Individual regional facilities are often sited and phased in as development occurs according to a comprehensive watershed management plan. Municipalities generally assume responsibility for operation and maintenance of regional stormwater facilities (Novotny, 1995).

Both approaches have a number of advantages and disadvantages, which are summarized in **Table 3-4.** Most of the advantages of the regional approach can be attributed to the need for fewer stormwater management facilities that are strategically located throughout the watershed (Novotny, 1995). However, the on-site approach addresses stormwater pollution close to its source, offers greater opportunities to preserve pre-development hydrologic conditions, and reduces the overall volume of stormwater runoff. Historically the on-site approach to stormwater management has been more common in Connecticut. The major drawbacks that have limited the widespread use of the regional approach include significant required advanced planning, financing, and land acquisition. Local governments must finance, design, and construct regional stormwater facilities before the majority of the watershed is developed, with reimbursement by developers over build-out periods of many years (WEF and ASCE, 1992). Due to these limitations, the regional approach generally is more appropriate for:

- *Highly developed watersheds with severe water quality and flooding impacts, where stormwater controls for new development alone cannot adequately address the impacts in these areas*
- *Watersheds where the timing of peak runoff may increase downstream flooding if on-site peak runoff attenuation criteria are applied uniformly throughout the watershed*

(Pennsylvania Association of Conservation Districts et al., 1998). In most watersheds, a mix of regional and on-site controls is desirable and has the greatest potential for success when implemented as part of a comprehensive watershed management plan. (DEP, 1995).

Table 3-3 Elements of a Watershed Management Plan

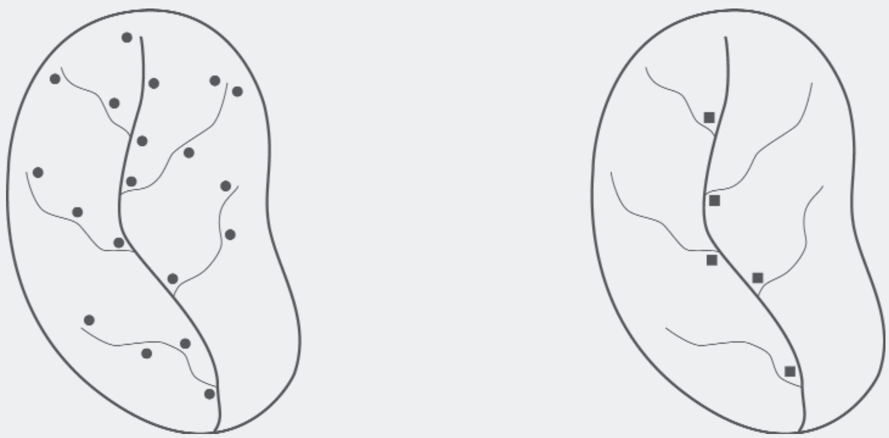
Plan Elements	
Watershed delineation and identification of watershed characteristics such as topography, soils, surficial geology, impervious cover, and land use (current and projected)	A runoff hydrograph analysis of the watershed for floods of an appropriate duration, including a 24 hour event, with average return frequencies of 2, 10, 25, and 100 years for existing and future land uses
Inventory of flood hazard areas as identified by Flood Insurance Studies or DEP, plus historic floods and damages	The relationship between the computed peak flow rates and gauging station data, with modification or calibration of the hydrographs to obtain a reasonable fit where necessary
An evaluation of watercourses, including areas of limited flow capacity, bank or bed erosion, sediment deposition, water quality, principle water uses and users, recreation areas, morphology classification, and channel stability	Identification of the peak rate of runoff at various key points in the watershed, and the relative timing of the peak flows
An inventory and evaluation of hydraulic structures, including culverts, bridges, dams and dikes with information on their flow capacity and physical condition	Identification of points in the watershed where hydraulic structures or watercourses are inadequate under existing or anticipated future conditions
An inventory of significant water storage areas, including principal impoundments, floodplains, and wetlands	Recommendations on how the subwatershed's runoff can be managed to minimize any harmful downstream (flooding) impacts
Identification of sensitive and impaired wetlands and waterbodies	Existing and projected future pollutant loads, impacts of these loads, and pollution reduction goals
Evaluation of functional value of wetlands to identify sensitive and high quality wetland resources	Existing and projected aquatic habitat disturbances and goals for habitat restoration
Sensitive groundwater recharge or aquifer protection areas	Recommendations for watershed-specific stormwater treatment controls, conceptual design, and operation and maintenance (O&M) needs and responsibilities
Identification of existing problem land uses and impacts on water quality	Water quality monitoring program
Land use restrictions in sensitive areas	Prioritized implementation plan for recommendations
Inventory of local wetlands, conservation, planning and zoning, and subdivision regulations of the watershed municipalities to identify potential regulatory changes for addressing stormwater impacts	Identification of public water supply watershed areas and DEP-delineated aquifer recharge areas.

Table 3-4 Comparison of On-Site and Regional Stormwater Management Approaches		
Approach	**Advantages**	**Disadvantages**
On-Site	❍ Requires little or no advanced planning ❍ Addresses stormwater pollution close to its source, thereby reducing the volume of stormwater runoff and the need for treatment controls ❍ Provides greater groundwater recharge benefits	❍ Results in a large number of facilities that may not be adequately maintained by developers or home-owners ❍ Consumes on-site land that could be used for other purposes ❍ May increase downstream flooding and quantity control problems
Regional	❍ Reduced capital costs through economies of scale in designing and constructing regional facilities ❍ Reduced maintenance costs because there are fewer facilities to maintain ❍ Greater reliability because regional facilities are more likely to receive long-term maintenance ❍ Nonpoint pollutant loadings from existing developed areas can be affordably controlled at the same regional facilities that are sited to control future development ❍ Regional facilities provide greater opportunities for multipurpose uses such as recreational and aesthetic benefits, flood control, and wildlife ❍ Can be used to treat runoff from public streets which is often missed by on-site facilities ❍ Identifies opportunities to reduce regional stormwater pollutant loadings and provides a schedule for imple-menting appropriate controls	❍ Significant advanced watershed planning required ❍ Requires up-front financing ❍ Requires land availability and acquisition ❍ May promote "end-of-pipe" treatment mentality rather than the use of on-site controls to reduce stormwater runoff volume and the need for stormwater treatment ❍ Greater administrative responsibility for municipali-ties and local governments ❍ Some treatment practices are not appropriate for large drainage areas (swales, filter strips, media fil-ters, and oil/particle separators)

Source: Adapted from Novotny, 1995; DEP, 1995; Pennsylvania Association of Conservation Districts et al., 1998; WEF and ASCE, 1992.

Figure 3-2 On-site and Regional Stormwater Treatment Approaches

On-Site | **Regional**



Developers provide treatment practices on individual developments sites

Municipalities provide strategically located regional treatment facilities

Source: Adapted from Novotny, 1995.

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