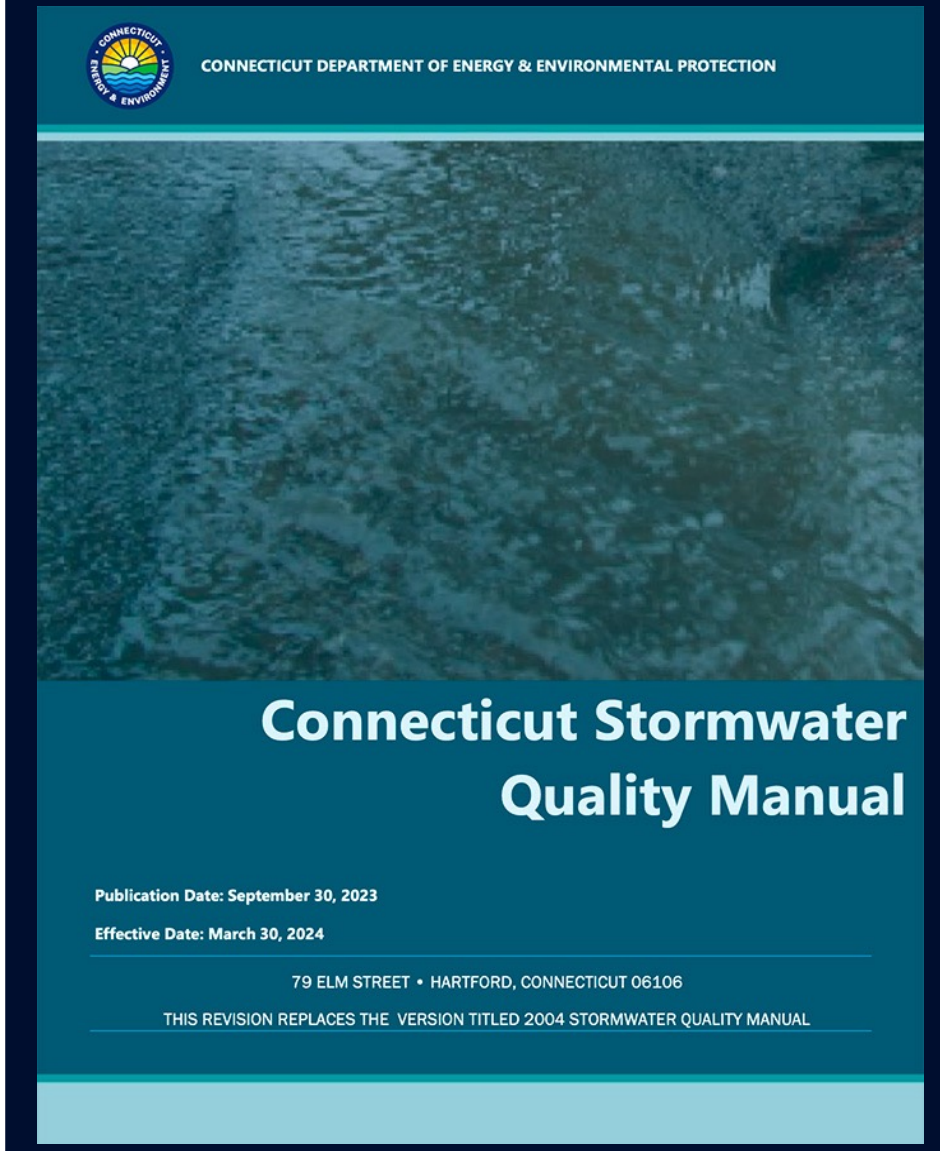
The New CT Stormwater Quality Manual:

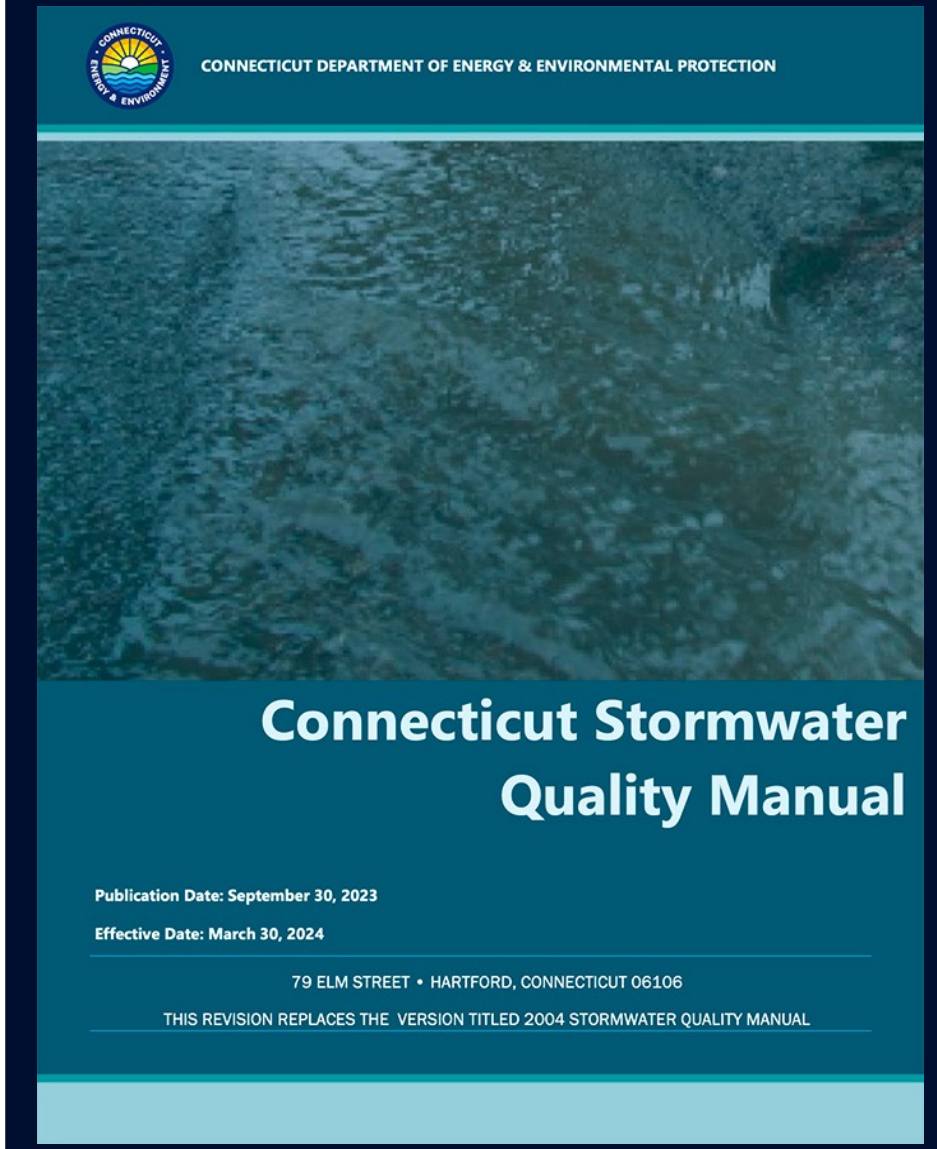
What you should know

Mary Looney, Dave Dickson
CT NEMO



Roadmap

- Manual Overview & History
- Big Picture Changes / Impacts
- Navigating the Manual
- What's Coming



What is the Stormwater Quality Manual?

'Provides guidance on the measures necessary to protect the waters of Connecticut from the adverse impacts of stormwater runoff'

- **Address stormwater from:**
  - Construction
  - Municipal Separate Storm Sewer Systems (MS4)
  - Industrial
- **Emphasis on:**
  - Source control / pollution prevention
  - Non-structural LID
  - Structural BMPs

History of the Manual

- 2004 Manual
- 2011 Low Impact Development (LID) Appendix
- 2023 Draft Revision (along with Soil Erosion & Sediment Control Guidelines revisions)
  - Public Comment Period ended March 1
  - **Release date:** September 30th, 2023
  - **Effective date: March 2024**

Adoption Timeline

9/30/23

Manual is published

- Get familiar with new Manual
- Update local regulations auth orities

3/31/24

Effective Date
(with grace period for projects which have completed preliminary design)

- Adopt updated guidance
- If grace period is applicable, communicate this to review authority. Permit must be completed before grace period ends.

9/30/24

Grace period ends

- Adopt updated guidance

Why an Update?

Evolution of:

- Understanding of stormwater impacts on water quality
- Federal / state regulations

- **Objectives:**
  - Updated stormwater BMP information
  - Improve consistency with Soil Erosion and Sediment Control Guidelines
  - Improve consistency with CT DEEP stormwater permits
  - Incorporation of climate resiliency considerations
  - Enhance usability

Why an Update?

Evolution of:

- Understanding of stormwater impacts on water quality
- Federal / state regulations

- **What it means:**
  - Greater emphasis on construction and post-construction stormwater planning and design strategies
  - Updated water quality storm variable within water quality volume equation

LID & Disconnection Requirements

- **Construction / MS4 Permits:**
  - Disconnection of DCIA :
    - When the appropriate portion of the WQV is retained
      - Sites with greater than 40% DCIA = 50% of WQV
      - Sites with less than 40% DCIA = 100% of WQV
  - MS4 Permit:
    - Legal authority for developers to prioritize low impact development practices FIRST
    - Disconnect 1%/year
  - Construction Permit
    - Incorporate runoff reduction and LID control measures

LID: Low Impact Development

GSI: Green Stormwater Infrastructure

DCIA: Directly Connected Impervious Area

WQV: Water Quality Volume

New Manual highlights LID practices first,

DCIA disconnection/retrofits, and new standards for WQV

Side note: Update on the MS4 Permit

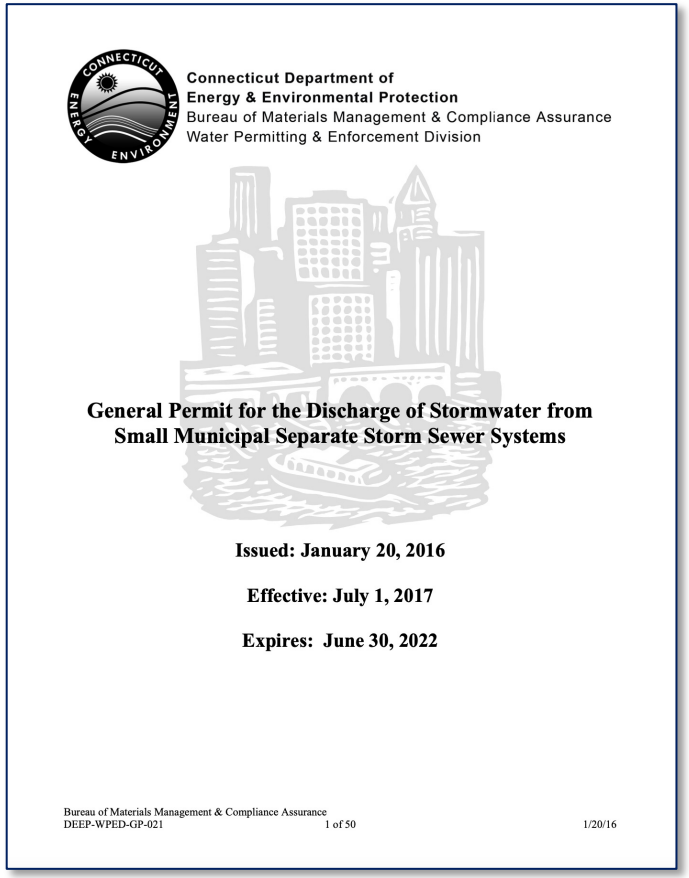
Expired: June 30th, 2022

DEEP planning for 'as is' renewal for 2 – 3 years

Same permit and requirements

No new towns added in

Meanwhile . . . stakeholder input process for MS4 modifications



Connecticut Department of
Energy & Environmental Protection
Bureau of Materials Management & Compliance Assurance
Water Permitting & Enforcement Division

General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems

Issued: January 20, 2016

Effective: July 1, 2017

Expires: June 30, 2022

Bureau of Materials Management & Compliance Assurance
DEEP-WPED-GP-021 1 of 50 1/20/16

Navigating the Manual

BACKGROUND

- Ch. 1: Introduction
- Ch. 2: Stormwater Impacts
- Ch. 3: Preventing and Mitigating Stormwater Impacts

DESIGN & IMPLEMENT

- Ch. 4: Stormwater Management Standards and Performance Criteria
- Ch. 5: Low Impact Development Site Planning and Design Strategies
- Ch. 6: Source Control Practices and Pollution Prevention
- Ch. 7: Overview of Structural Stormwater Best Management Practices
- Ch. 8: Selection Considerations for Stormwater BMPs
- Ch. 9: Stormwater Retrofits
- Ch. 10: General Design Guidance for Stormwater Infiltration Systems
- Ch. 11: Proprietary Stormwater BMPs
- Ch. 12: Stormwater Management Plan
- Ch. 13: Structural Stormwater BMP Design Guidance

DESIGN

Pathway of utilizing Low Impact Development (LID) first and foremost, followed by guidance and criteria for structural stormwater BMPs

Chapter 4:
Updated stormwater management ***standards and criteria*** *for all development & redevelopment*

→

Chapters 5/6:
Using ***LID site planning & design*** *(****non-structural)*** *first to reduce stormwater impacts and* ***source protections*** *prevent pollutants in stormwater*

→

Chapters 7/8:
Selection of ***structural stormwater BMPs*** *after low impact development has been considered / implemented where possible*

→

Chapter 9:
Guidance on selecting stormwater BMPs for ***retrofitting sites*** *which are already developed*

Chapters 10/11:
Guidance on considering ***infiltration and pretreatment*** *stormwater BMPs*

→

Chapter 12:
Updated site ***Stormwater Management Plan*** *guidance/outline reflecting changes*

→

Chapter 13:
The 'nuts and bolts' of implementing a structural stormwater BMP – design, construction, maintenance, etc.

Major changes

- **Ch. 4:** Stormwater Management Standards and Performance Criteria
  - Water Quality Storm / Volume change
- **Ch. 9:** Stormwater Retrofits
  - Reducing impacts of existing IC
- **Ch. 10:** General Design Guidance for Stormwater Infiltration
  - New chapter
- **Ch. 13:** Structural Stormwater BMP Design Guidance
  - Thorough breakdown of menu of BMPs

What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Major changes

- **Ch. 4:** Stormwater Management Standards and Performance Criteria
  - Water Quality Storm / Volume change
- **Ch. 9:** Stormwater Retrofits
  - Reducing impacts of existing IC
- **Ch. 10:** General Design Guidance for Stormwater Infiltration
  - New chapter
- **Ch. 13:** Structural Stormwater BMP Design Guidance
  - Thorough breakdown of menu of BMPs

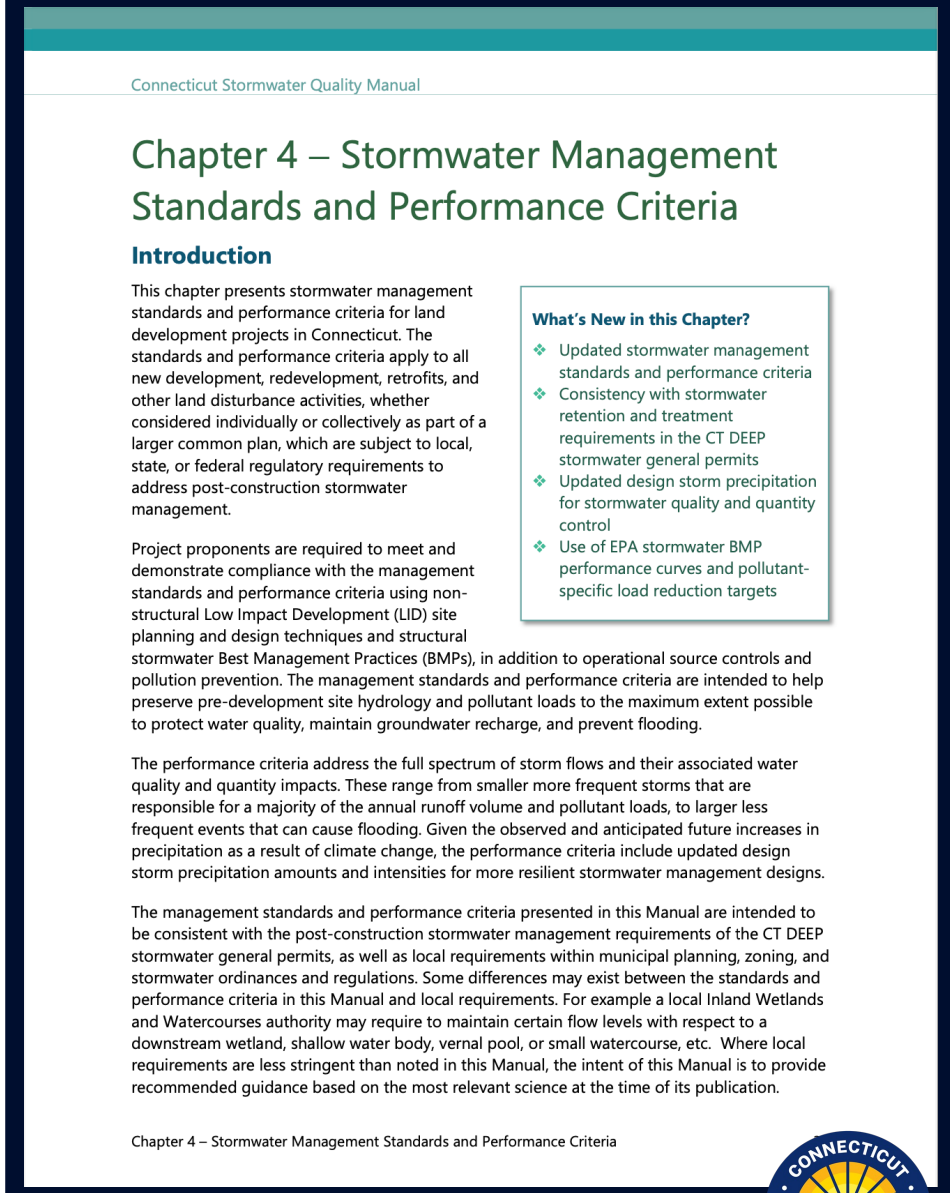
What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Ch. 4: Stormwater Management Standards and Performance Criteria

- **Purpose / Overview**
  - Updated stormwater management standards for development and retrofit
  - Updated Water Quality Storm variable within Water Quality Volume equation
  - Process for demonstrating compliance with the stormwater management standards and criteria

- **How to apply it**
  - CT DEEP stormwater permits in relation to (re)development standards and ordinances, regulations, or policies



Connecticut Stormwater Quality Manual

Chapter 4 – Stormwater Management Standards and Performance Criteria

Introduction

This chapter presents stormwater management standards and performance criteria for land development projects in Connecticut. The standards and performance criteria apply to all new development, redevelopment, retrofits, and other land disturbance activities, whether considered individually or collectively as part of a larger common plan, which are subject to local, state, or federal regulatory requirements to address post-construction stormwater management.

What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Project proponents are required to meet and demonstrate compliance with the management standards and performance criteria using non-structural Low Impact Development (LID) site planning and design techniques and structural stormwater Best Management Practices (BMPs), in addition to operational source controls and pollution prevention. The management standards and performance criteria are intended to help preserve pre-development site hydrology and pollutant loads to the maximum extent possible to protect water quality, maintain groundwater recharge, and prevent flooding.

The performance criteria address the full spectrum of storm flows and their associated water quality and quantity impacts. These range from smaller more frequent storms that are responsible for a majority of the annual runoff volume and pollutant loads, to larger less frequent events that can cause flooding. Given the observed and anticipated future increases in precipitation as a result of climate change, the performance criteria include updated design storm precipitation amounts and intensities for more resilient stormwater management designs.

The management standards and performance criteria presented in this Manual are intended to be consistent with the post-construction stormwater management requirements of the CT DEEP stormwater general permits, as well as local requirements within municipal planning, zoning, and stormwater ordinances and regulations. Some differences may exist between the standards and performance criteria in this Manual and local requirements. For example a local Inland Wetlands and Watercourses authority may require to maintain certain flow levels with respect to a downstream wetland, shallow water body, vernal pool, or small watercourse, etc. Where local requirements are less stringent than noted in this Manual, the intent of this Manual is to provide recommended guidance based on the most relevant science at the time of its publication.

Chapter 4 – Stormwater Management Standards and Performance Criteria

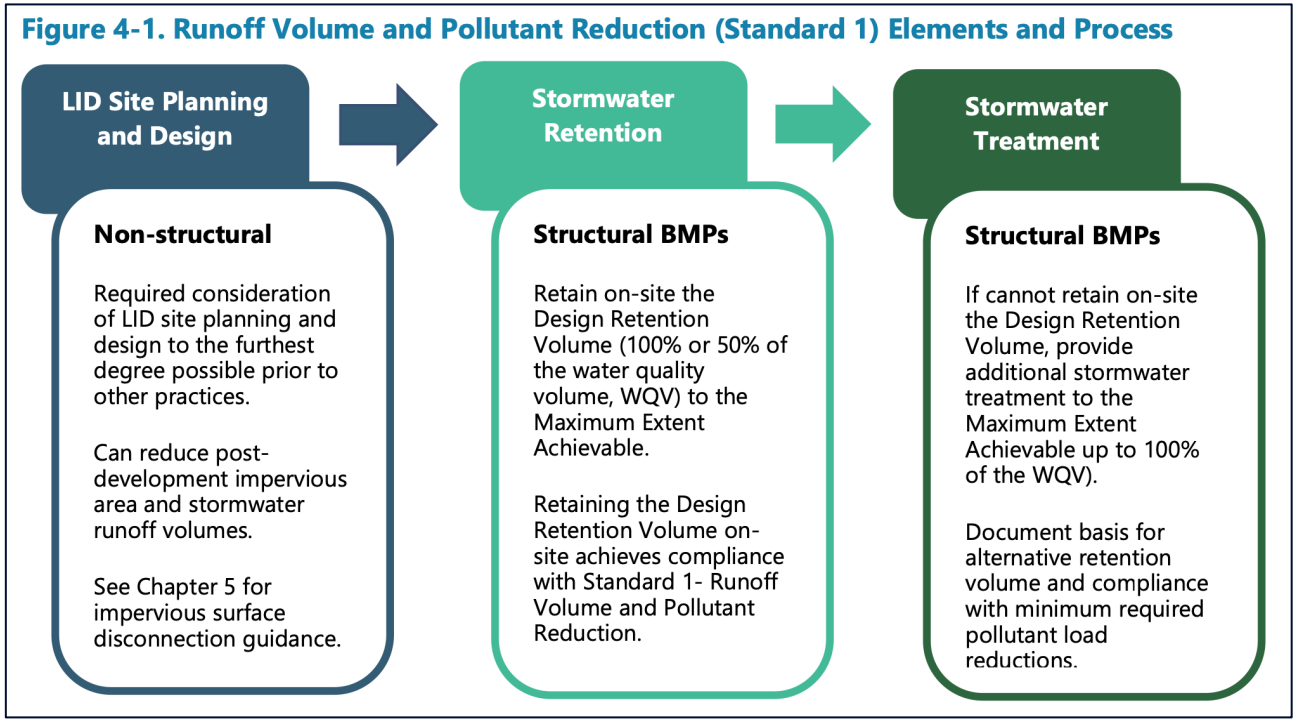
Ch. 4: Stormwater Management Standards and Performance Criteria

- Describes updated stormwater management standards and performance criteria
  - **Standard 1: Runoff Volume and Pollutant Reduction**
  - Standard 2: Stormwater Runoff Quantity Control
  - Standard 3: Construction Soil Erosion and Sediment Control
  - Standard 4: Post-Construction Operation and Maintenance
  - Standard 5: Stormwater Management Plan

Ch. 4: Stormwater Management Standards and Performance Criteria

Standard 1: Runoff Volume and Pollutant Reduction

- Consistency with CT DEEP Permits
- Incorporation of permit concepts such as on-site retention of runoff and disconnection of DCIA
- **Updated design storm precipitation for stormwater quality and quantity control**



Ch. 4: Stormwater Management Standards and Performance Criteria

Standard 1: Runoff Volume and Pollutant Reduction

- New and Redevelopment with DCIA < 40% =
  - Retain 100% of WQV
- Redevelopment with DCIA > 40% =
  - Retain 50% of WQV

Type of Project or Activity	Required Retention Volume (RRV)[1]	Additional Treatment Volume Required[1]	
		If Volume Retained Meets or Exceeds RRV	If Volume Retained Does Not Meet RRV
➢ New development[2] ➢ Redevelopment[3] or retrofit of sites that are currently developed with existing DCIA[4] of less than 40% ➢ Any new stormwater discharges located within 500 feet of tidal wetlands, which are not fresh-tidal wetlands, to avoid dilution of the high marsh salinity and encouragement of the invasion of brackish or upland wetland species	100% of site's WQV	None	(100% of site's WQV) – (Volume Retained)
➢ Redevelopment or retrofit of sites that are currently developed with existing DCIA[4] of 40% or more	50% of site's WQV	None	(100% of site's WQV) – (Volume Retained)

Ch. 4: Stormwater Management Standards and Performance Criteria

2004 Manual Water Quality Volume Equation

Description	Post-Development Storm Magnitude
Water Quality Volume (WQV) Volume of runoff generated by one inch of rainfall on the site WQV = (1")(R)(A)/12 WQV = water quality volume (ac-ft) R = volumetric runoff coefficient = 0.05+0.009(I) I = percent impervious cover A = site area in acres	First one inch of rainfall

Updated Manual Water Quality Volume Equation

$$WQV = \frac{(P)(R)(A)}{12}$$

where:

WQV = water quality volume (cubic feet)
P = 1.3 inches (90^{th} percentile rainfall event)
R = volumetric runoff coefficient = 0.05+0.009(I)
I = post- development impervious area (percent) after application of non-structural LID site planning and design strategies and before application of structural stormwater BMPs
A = post-development total drainage area of site or design point (square feet)

Ch. 4: Stormwater Management Standards and Performance Criteria

2004 Manual Water Quality Volume Equation

Description	Post-Development Storm Magnitude
Water Quality Volume (WQV) Volume of runoff generated by one inch of rainfall on the site WQV = (1")(R)(A)/12 WQV = water quality volume (ac-ft) R = volumetric runoff coefficient = 0.05+0.009(I) I = percent impervious cover A = site area in acres	First one inch of rainfall

Updated Manual Water Quality Volume Equation

$$WQV = \frac{(P)(R)(A)}{12}$$

where:

WQV = water quality volume (cubic feet)
P = 1.3 inches (90th percentile rainfall event)
R = volumetric runoff coefficient = 0.05+0.009(I)
I = post- development impervious area (percent) after application of non-structural LID site planning and design strategies and before application of structural stormwater BMPs
A = post-development total drainage area of site or design point (square feet)

‘Water Quality Storm’

Ch. 4: Stormwater Management Standards and Performance Criteria

Water Quality Volume (WQV):

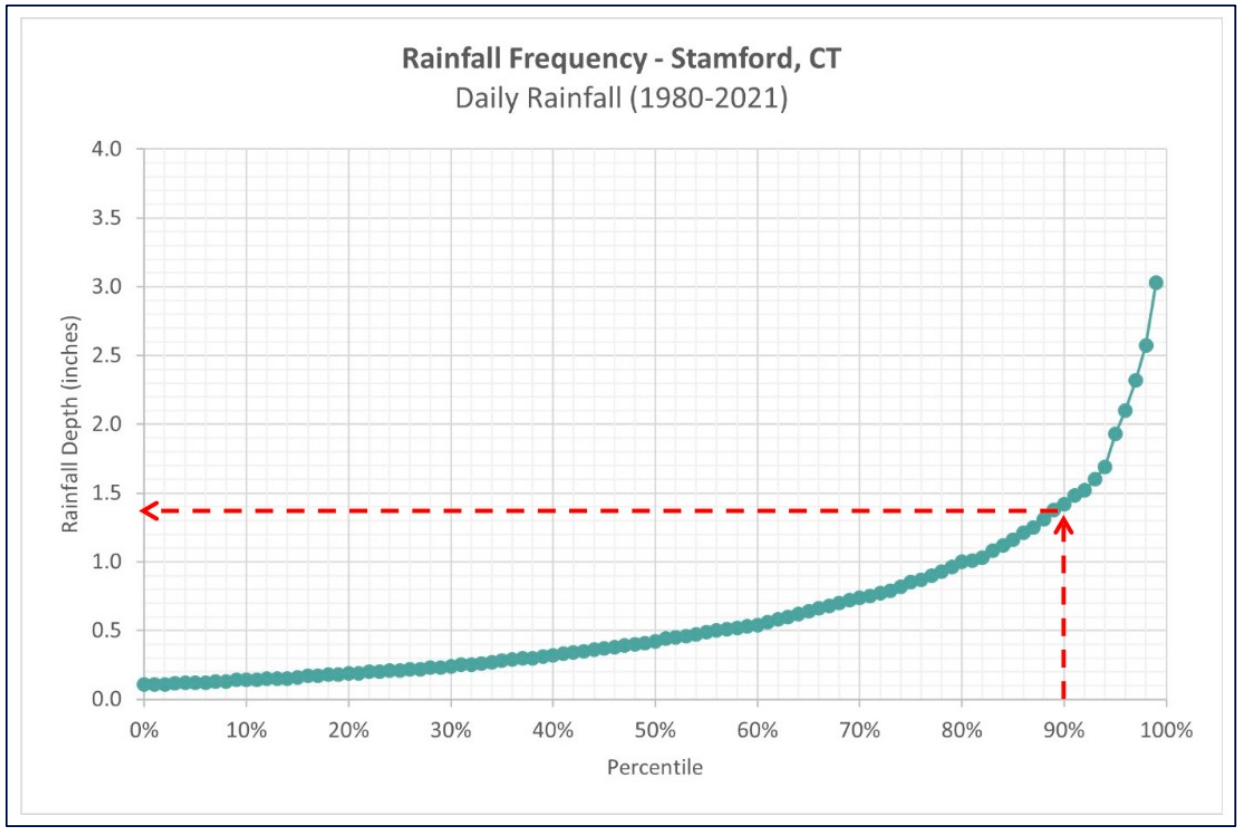
- Volume of runoff generated by Water Quality Storm
  - Calculated using the WQV equation
  - Determines how much retention is needed (standard to meet)
- "First Flush" principle
  - Assumes most pollutants in runoff are conveyed in initial portion of storm event
- Technically unchanged

VS.

Water Quality Storm (WQS):

- Used to generate the Water Quality Volume equation
  - 90th percentile rainfall volume = infiltration in natural condition
    - Amount that should be managed on-site to restore and maintain pre-development hydrology
- Increasing from 1" to 1.3"

Ch. 4: Stormwater Management Standards and Performance Criteria



CT average of past 40 years from National Weather Service data used to calculate new water quality storm. Stanford average shown above.

Water Quality Storm (WQS):

- Used to generate the Water Quality Volume equation
  - 90th percentile rainfall volume = infiltration in natural condition
    - Amount that should be managed on-site to restore and maintain pre-development hydrology
- Increasing from 1” to 1.3”

Ch. 4: Stormwater Management Standards and Performance Criteria

2004 Manual Water Quality Volume Equation

Description	Post-Development Storm Magnitude
Water Quality Volume (WQV) Volume of runoff generated by one inch of rainfall on the site WQV = (1")(R)(A)/12 WQV = water quality volume (ac-ft) R = volumetric runoff coefficient = 0.05+0.009(I) I = percent impervious cover A = site area in acres	First one inch of rainfall

Updated Manual Water Quality Volume Equation

$$WQV = \frac{(P)(R)(A)}{12}$$

Updated variable for existing equation

where:

Where variable comes from

WQV = water quality volume (cubic feet)

P = 1.3 inches (90^{th} percentile rainfall event)

R = volumetric runoff coefficient = 0.05+0.009(I)

I = post- development impervious area (percent) after application of non-structural LID site planning and design strategies and before application of structural stormwater BMPs

A = post-development total drainage area of site or design point (square feet)

Ch. 4: Stormwater Management Standards and Performance Criteria

What does this mean for stormwater management?

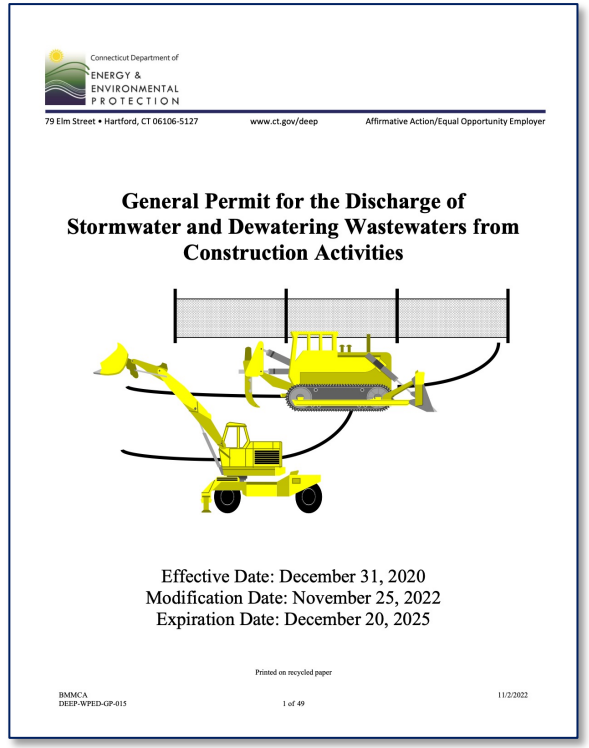
*"The standards and performance criteria apply to **all new development, redevelopment, retrofits, and other land disturbance activities**, whether considered individually or collectively as part of a larger common plan, which are subject to local, state, or federal regulatory requirements to address post-construction stormwater management."*

- Stormwater discharge permits:
  - Construction
  - Industrial
  - MS4

Ch. 4: Stormwater Management Standards and Performance Criteria

What does this mean for Construction?

- Construction stormwater permit = sites disturbing 1+ acres (Unless you have land use commission approval for 1-5 acres for locally approved sites)
    - New and Redevelopment with DCIA < 40% =
        - Water Quality Volume = 100%
        - New Water Quality storm variable
    - Redevelopments with DCIA > 40% =
        - Water Quality Volume = 50%
        - New Water Quality storm variable
    - Additional stormwater treatment for what cannot be retained


Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION
79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities

Effective Date: December 31, 2020
Modification Date: November 25, 2022
Expiration Date: December 20, 2025

Printed on recycled paper

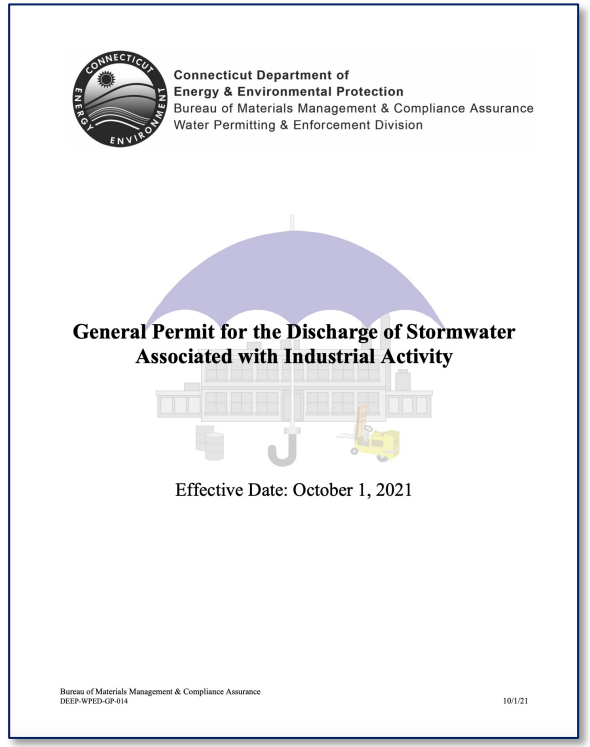
BMMCA DEEP-WPED-GP-015 1 of 49 11/2/2022

Stormwater Pollution Control Plan = adhere to Manual and Soil Guidelines

Ch. 4: Stormwater Management Standards and Performance Criteria

What does this mean for Industrial?

- Industrial stormwater permit = Any person or municipality that initiates, creates, originates, or maintains a discharge specified by the permit
    - Structural and non-structural controls must adhere to Manual
    - Construction activity onsite must adhere to CT DEEP construction permit and Manual


Connecticut Department of
Energy & Environmental Protection
Bureau of Materials Management & Compliance Assurance
Water Permitting & Enforcement Division

General Permit for the Discharge of Stormwater Associated with Industrial Activity

Effective Date: October 1, 2021

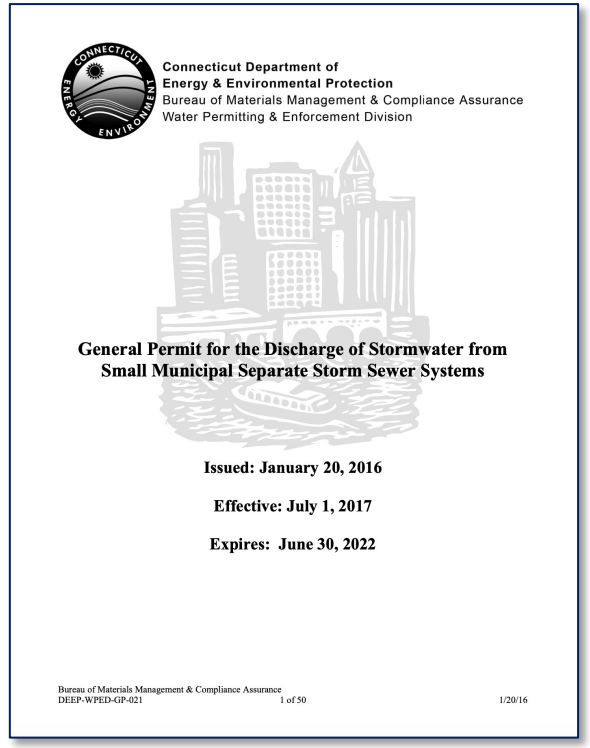
Bureau of Materials Management & Compliance Assurance
DEEP-WPED-GP-014
10/1/21

Stormwater Pollution Prevention Plan = adhere to Manual and Soil Guidelines

Ch. 4: Stormwater Management Standards and Performance Criteria

What does this mean for MS4 ?

- Disconnection:
  - DCIA considered disconnected when 'appropriate portion of WQV has been retained and or treated'
    - Same definition, same equation, new water quality storm variable
      - 100% of WQV for < 40% DCIA; 50% of WQV for > 40% DCIA


Connecticut Department of
Energy & Environmental Protection
Bureau of Materials Management & Compliance Assurance
Water Permitting & Enforcement Division

General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems

Issued: January 20, 2016

Effective: July 1, 2017

Expires: June 30, 2022

Bureau of Materials Management & Compliance Assurance
DEEP-WPED-GP-021 1 of 50 1/20/16

- Updates to Ordinances, Regulations, or Policies
  - MS4 Legal Authority requires consistency with CT Stormwater Quality Manual
    - Any reference to the 2004 Manual should be revised to reference updated Manual
    - Any reference to the old WQV equation or 1 inch retention standard should be revised

Ch. 4: Stormwater Management Standards and Performance Criteria

Zoning Regulations Example:

"The Stormwater Management Plan shall be in accordance with guidance set forth in the **2004 Connecticut Stormwater Quality Manual,** published by the Connecticut Department of Energy and Environmental Protection. The Stormwater Management Plan shall be designed to treat the water quality volume, **or runoff from the first inch of rainfall,** from the subject developed area."

Ch. 4: Stormwater Management Standards and Performance Criteria

The examples we provide below don't substitute for real legal advice! Please be sure to consult your legal experts or town attorney.

Zoning Regulations Example:

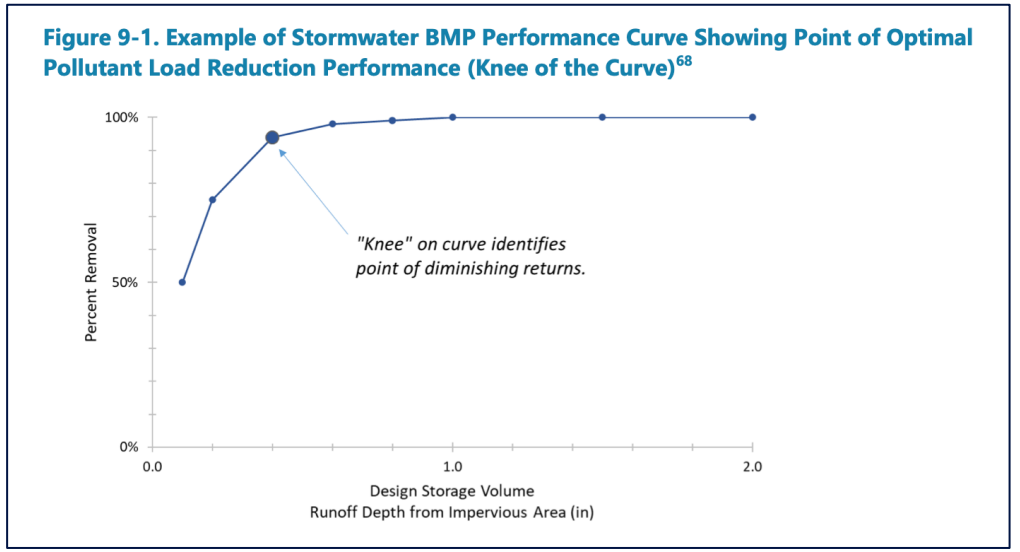
"The Stormwater Management Plan shall be in accordance with guidance set forth in the **current version of the Connecticut Stormwater Quality Manual,** published by the Connecticut Department of Energy and Environmental Protection. The Stormwater Management Plan shall be designed to treat the water quality volume, **using the water quality storm as defined by the Connecticut Stormwater Quality Manual,** from the subject developed area."

Ch. 4: Stormwater Management Standards and Performance Criteria

Pollutant Load Reductions:

When appropriate WQV cannot be maintained onsite, additional treatment is required =

*Stormwater **BMP performance curves** used to document minimum required pollutant load reductions are met or exceeded*



Small stormwater BMPS
(which can't retain appropriate WQV)

=

Still achieve substantial treatment
(pollutant load reductions)

IF APPROPRIATE WQV IS MAINTAINED THEN POLLUTANT REDUCTION IS ACHIEVED

Major changes

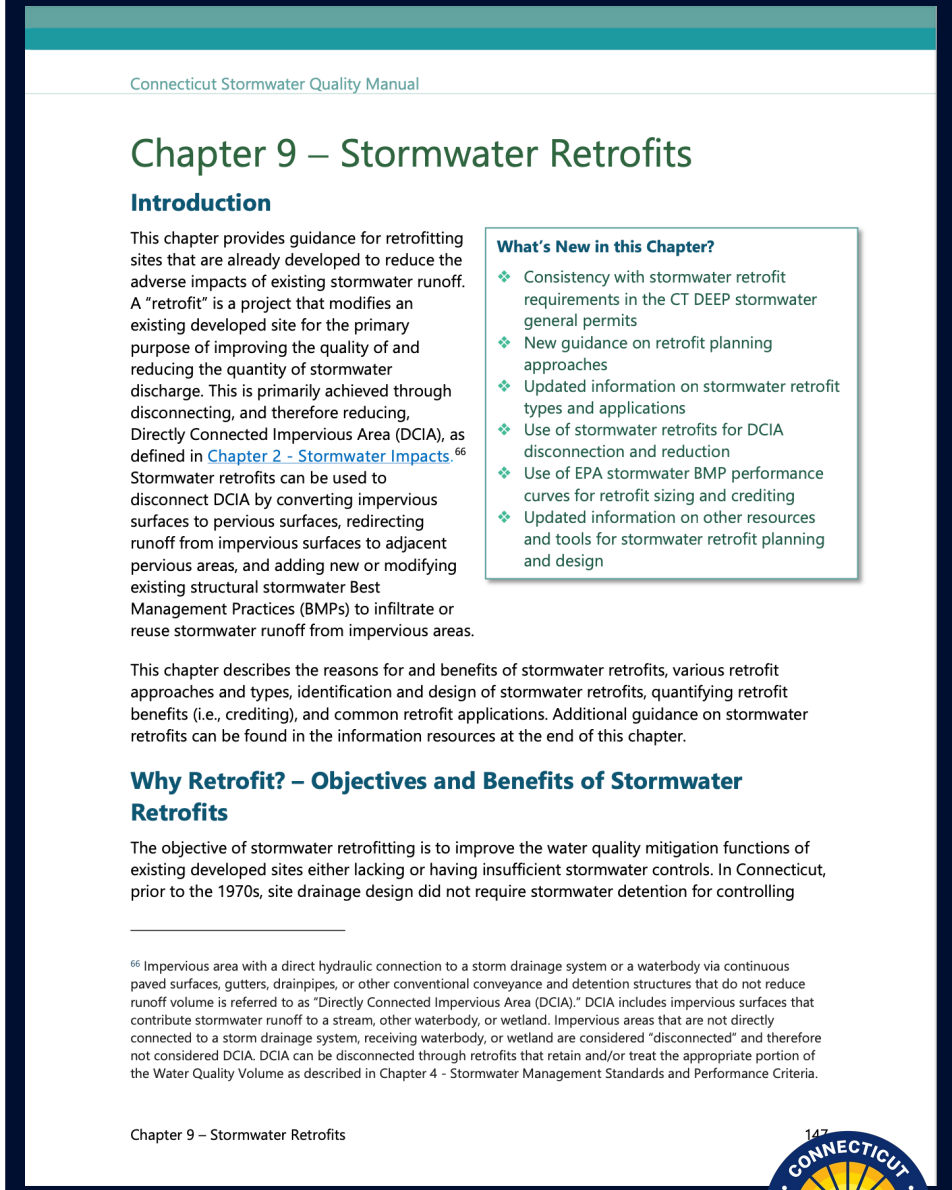
- **Ch. 4:** Stormwater Management Standards and Performance Criteria
  - Water Quality Storm / Volume change
- **Ch. 9:** Stormwater Retrofits
  - Reducing impacts of existing IC
- **Ch. 10:** General Design Guidance for Stormwater Infiltration
  - New chapter
- **Ch. 13:** Structural Stormwater BMP Design Guidance
  - Thorough breakdown of menu of BMPs

What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Ch. 9: Stormwater Retrofits

- **Purpose / Overview**
  - Consistency with CT DEEP Permits
  - Techniques for retrofitting existing developed sites
  - Conditions for which stormwater retrofits are appropriate
  - Meeting DCIA disconnection goals
- **How to apply it**
  - Further guidance and clarification for retention standards for redevelopment
    - New WQS variable within WQV equation impact what is considered 'disconnected'



Connecticut Stormwater Quality Manual

Chapter 9 – Stormwater Retrofits

Introduction

This chapter provides guidance for retrofitting sites that are already developed to reduce the adverse impacts of existing stormwater runoff. A "retrofit" is a project that modifies an existing developed site for the primary purpose of improving the quality of and reducing the quantity of stormwater discharge. This is primarily achieved through disconnecting, and therefore reducing, Directly Connected Impervious Area (DCIA), as defined in Chapter 2 - Stormwater Impacts.[66] Stormwater retrofits can be used to disconnect DCIA by converting impervious surfaces to pervious surfaces, redirecting runoff from impervious surfaces to adjacent pervious areas, and adding new or modifying existing structural stormwater Best Management Practices (BMPs) to infiltrate or reuse stormwater runoff from impervious areas.

What's New in this Chapter?

- Consistency with stormwater retrofit requirements in the CT DEEP stormwater general permits
- New guidance on retrofit planning approaches
- Updated information on stormwater retrofit types and applications
- Use of stormwater retrofits for DCIA disconnection and reduction
- Use of EPA stormwater BMP performance curves for retrofit sizing and crediting
- Updated information on other resources and tools for stormwater retrofit planning and design

This chapter describes the reasons for and benefits of stormwater retrofits, various retrofit approaches and types, identification and design of stormwater retrofits, quantifying retrofit benefits (i.e., crediting), and common retrofit applications. Additional guidance on stormwater retrofits can be found in the information resources at the end of this chapter.

Why Retrofit? – Objectives and Benefits of Stormwater Retrofits

The objective of stormwater retrofitting is to improve the water quality mitigation functions of existing developed sites either lacking or having insufficient stormwater controls. In Connecticut, prior to the 1970s, site drainage design did not require stormwater detention for controlling

[66] Impervious area with a direct hydraulic connection to a storm drainage system or a waterbody via continuous paved surfaces, gutters, drainpipes, or other conventional conveyance and detention structures that do not reduce runoff volume is referred to as "Directly Connected Impervious Area (DCIA)." DCIA includes impervious surfaces that contribute stormwater runoff to a stream, other waterbody, or wetland. Impervious areas that are not directly connected to a storm drainage system, receiving waterbody, or wetland are considered "disconnected" and therefore not considered DCIA. DCIA can be disconnected through retrofits that retain and/or treat the appropriate portion of the Water Quality Volume as described in Chapter 4 - Stormwater Management Standards and Performance Criteria.

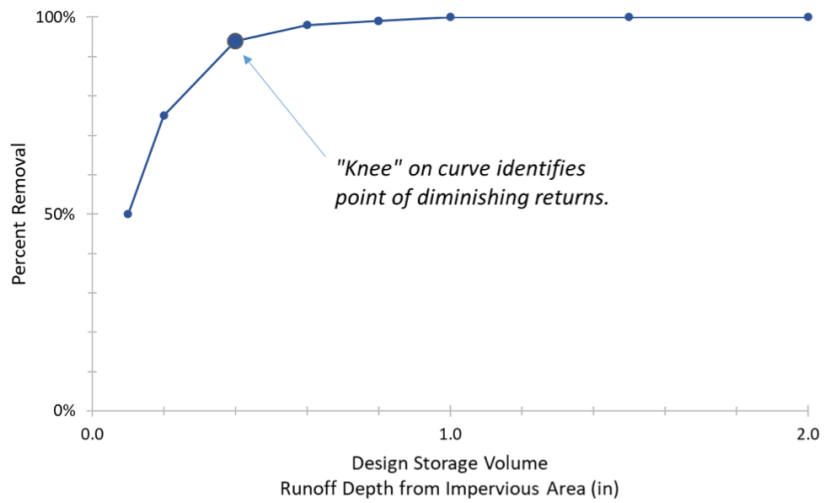
Chapter 9 – Stormwater Retrofits 147

Ch. 9: Stormwater Retrofits

Included in this chapter:

- Types of Retrofits
- Considerations for selection of appropriate retrofits
- Sizing and crediting for retrofits
  - Based on new WQS variable
- Using the performance curve (Ch. 4)
  - Estimates long-term pollutant removal performance based on size of BMP
  - Small retrofits can achieve substantial pollutant load reductions

Figure 9-1. Example of Stormwater BMP Performance Curve Showing Point of Optimal Pollutant Load Reduction Performance (Knee of the Curve)[68]



Ch. 9: Stormwater Retrofits

3 ways to get credit for disconnection:

1. Impervious Area Conversion – Full credit

2. Impervious Area (Simple) Disconnection – Full credit

3. New or Modified Structural BMP – Full or partial credit

Ch. 9: Stormwater Retrofits

1. Impervious Area Conversion (non-structural)
   - Existing impervious surface converted to pervious surface;
   - Pre-development infiltration rate and storage capacity of underlying soils restored to pre-development conditions
   - Soil is amended to support vegetation

Full Credit

Ch. 9: Stormwater Retrofits

2. Impervious Area (Simple) Disconnection (non-structural)

- Runoff from rooftops, driveways, roads, etc re-directed as sheet flow to pervious area
- Appropriate required retention volume retained/infiltrated on-site: currently based on **the 1.3 inches WQS**
- Minimum Criteria is met (Chapter 5)

Full Credit

Ch. 9: Stormwater Retrofits

3. New or Modified Structural BMP

- Applicable WQV is fully retained on-site, **OR**
- If not fully retained on-site:
  - Additional stormwater treatment without retention is provided
  - Minimum required avg annual pollutant load reductions are met or exceeded

Partial Credit:

- Additional stormwater treatment requirement not fully met, but treated to Maximum Extent Achievable
  - *Amount of partial credit based on DCIA reduction percentage (from performance curve) multiplied by impervious area draining to stormwater BMP*

Ch. 9: Stormwater Retrofits

Partial Credit:

- *Amount of partial credit based on DCIA reduction percentage (from performance curve) multiplied by impervious area draining to stormwater BMP*

Stormwater Retrofit Manual = Appendix B – Performance Curves

Pollutant	Design Storage Volume: Runoff Depth from Impervious Area (in)								
	0	0.10	0.20	0.40	0.60	0.80	1.00	1.50	2.00
TP	0%	59%	81%	96%	99%	100%	100%	100%	100%
TN	0%	75%	92%	99%	100%	100%	100%	100%	100%
Bacteria	0%	60%	87%	99%	100%	100%	100%	100%	100%
TSS	0%	79%	95%	100%	100%	100%	100%	100%	100%
Metals	0%	91%	99%	100%	100%	100%	100%	100%	100%

Pollutant	Design Storage Volume: Runoff Depth from Impervious Area (in)								
	0	0.10	0.20	0.40	0.60	0.80	1.00	1.50	2.00
Effective IA	0%	66%	88%	100%	100%	100%	100%	100%	100%
Runoff	0%	61%	84%	97%	99%	100%	100%	100%	100%

Major changes

- **Ch. 4:** Stormwater Management Standards and Performance Criteria
  - Water Quality Storm / Volume change
- **Ch. 9:** Stormwater Retrofits
  - Reducing impacts of existing IC
- **Ch. 10:** General Design Guidance for Stormwater Infiltration
  - New chapter
- **Ch. 13:** Structural Stormwater BMP Design Guidance
  - Thorough breakdown of menu of BMPs

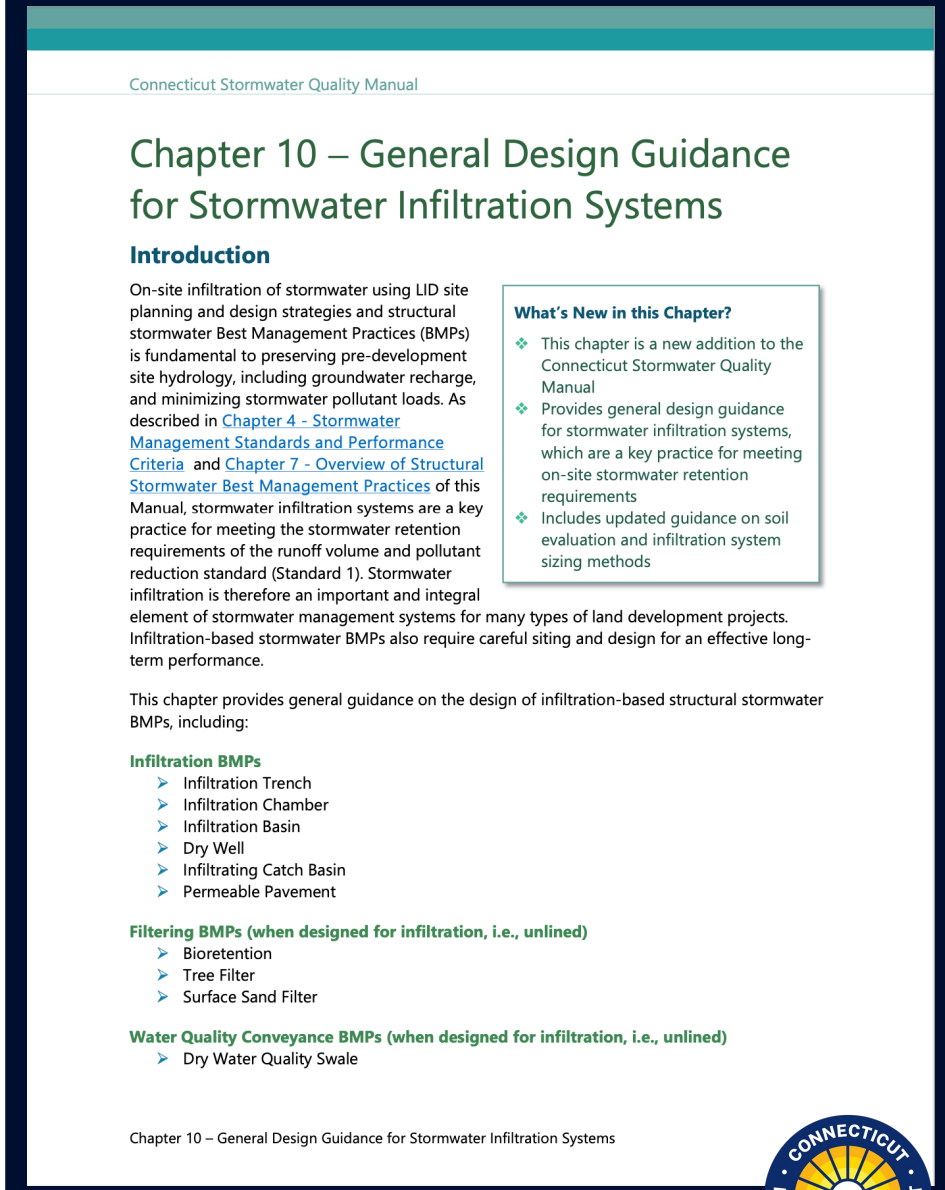
What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Ch. 10: General Design Guidance for Stormwater Infiltration

New chapter to the Manual

- **Purpose / Overview**
  - Guidance on selecting & designing stormwater **infiltration systems**
    - e.g., dry wells, perv. pavements, bioretention, swales, tree filters
  - Site **suitability**
    - Soil evaluation methods
    - Sizing methods
    - Placement
- **How to apply it**
  - Site evaluation & planning for infiltration practices



Connecticut Stormwater Quality Manual

Chapter 10 – General Design Guidance for Stormwater Infiltration Systems

Introduction

On-site infiltration of stormwater using LID site planning and design strategies and structural stormwater Best Management Practices (BMPs) is fundamental to preserving pre-development site hydrology, including groundwater recharge, and minimizing stormwater pollutant loads. As described in Chapter 4 - Stormwater Management Standards and Performance Criteria and Chapter 7 - Overview of Structural Stormwater Best Management Practices of this Manual, stormwater infiltration systems are a key practice for meeting the stormwater retention requirements of the runoff volume and pollutant reduction standard (Standard 1). Stormwater infiltration is therefore an important and integral element of stormwater management systems for many types of land development projects. Infiltration-based stormwater BMPs also require careful siting and design for an effective long-term performance.

What's New in this Chapter?

- This chapter is a new addition to the Connecticut Stormwater Quality Manual
- Provides general design guidance for stormwater infiltration systems, which are a key practice for meeting on-site stormwater retention requirements
- Includes updated guidance on soil evaluation and infiltration system sizing methods

This chapter provides general guidance on the design of infiltration-based structural stormwater BMPs, including:

Infiltration BMPs

- Infiltration Trench
- Infiltration Chamber
- Infiltration Basin
- Dry Well
- Infiltrating Catch Basin
- Permeable Pavement

Filtering BMPs (when designed for infiltration, i.e., unlined)

- Bioretention
- Tree Filter
- Surface Sand Filter

Water Quality Conveyance BMPs (when designed for infiltration, i.e., unlined)

- Dry Water Quality Swale

Chapter 10 – General Design Guidance for Stormwater Infiltration Systems

Ch. 10: General Design Guidance for Stormwater Infiltration

Soil Evaluation Guidance

- Initial screening
- Test pits and soil borings
- Field infiltration testing
- Evaluation documentation

General Design Guidance

- Design infiltration rate
- Maximum drain time
- Horizontal setbacks
- Vertical separation to groundwater and bedrock
- Pretreatment
- Design infiltration volume
- Sizing methods (static vs. dynamic)
- Underdrains & impermeable liners

Major changes

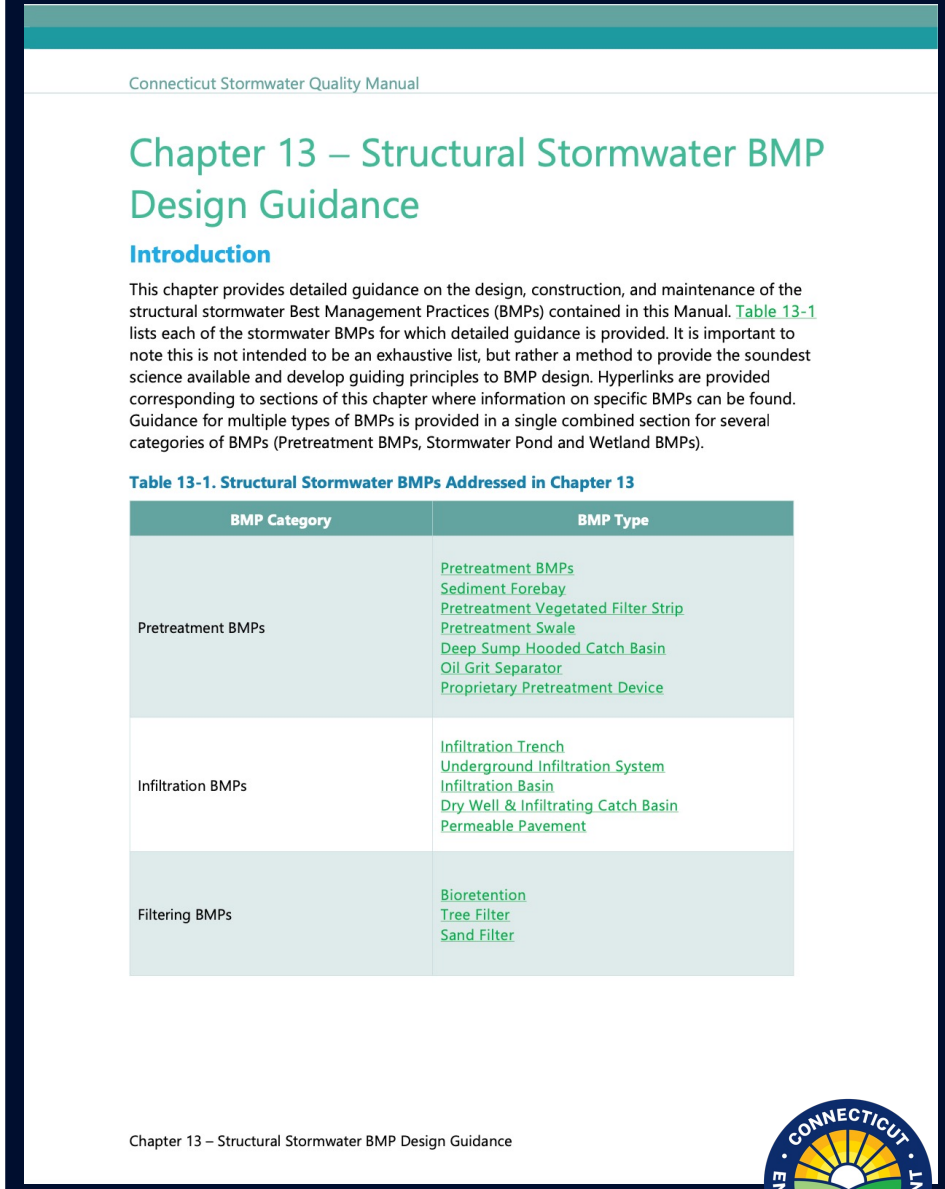
- **Ch. 4:** Stormwater Management Standards and Performance Criteria
  - Water Quality Storm / Volume change
- **Ch. 9:** Stormwater Retrofits
  - Reducing impacts of existing IC
- **Ch. 10:** General Design Guidance for Stormwater Infiltration
  - New chapter
- **Ch. 13:** Structural Stormwater BMP Design Guidance
  - Thorough breakdown of menu of BMPs

What's New in this Chapter?

- Updated stormwater management standards and performance criteria
- Consistency with stormwater retention and treatment requirements in the CT DEEP stormwater general permits
- Updated design storm precipitation for stormwater quality and quantity control
- Use of EPA stormwater BMP performance curves and pollutant-specific load reduction targets

Ch. 13: Structural Stormwater BMP Design Guidance

- **Purpose / Overview**
  - Detailed technical design guidance for each of the structural stormwater BMPs
  - Guidance on the selection, design, construction, and maintenance
  - Advantages & limitations
  - Drawings & photos
- **How to apply it**
  - Technical design, construction and maintenance of individual stormwater BMPs



Connecticut Stormwater Quality Manual

Chapter 13 – Structural Stormwater BMP Design Guidance

Introduction

This chapter provides detailed guidance on the design, construction, and maintenance of the structural stormwater Best Management Practices (BMPs) contained in this Manual. Table 13-1 lists each of the stormwater BMPs for which detailed guidance is provided. It is important to note this is not intended to be an exhaustive list, but rather a method to provide the soundest science available and develop guiding principles to BMP design. Hyperlinks are provided corresponding to sections of this chapter where information on specific BMPs can be found. Guidance for multiple types of BMPs is provided in a single combined section for several categories of BMPs (Pretreatment BMPs, Stormwater Pond and Wetland BMPs).

Table 13-1. Structural Stormwater BMPs Addressed in Chapter 13

BMP Category	BMP Type
Pretreatment BMPs	Pretreatment BMPs Sediment Forebay Pretreatment Vegetated Filter Strip Pretreatment Swale Deep Sump Hooded Catch Basin Oil Grit Separator Proprietary Pretreatment Device
Infiltration BMPs	Infiltration Trench Underground Infiltration System Infiltration Basin Dry Well & Infiltrating Catch Basin Permeable Pavement
Filtering BMPs	Bioretention Tree Filter Sand Filter

Chapter 13 – Structural Stormwater BMP Design Guidance

Ch. 13: Structural Stormwater BMP Design Guidance

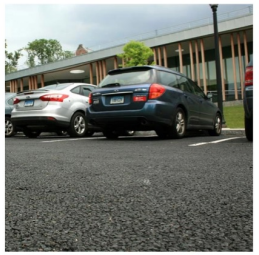
Table 13- 1 Structural Stormwater BMPs Addressed in Chapter 13

BMP Category	BMP Type
Pretreatment BMPs	Pretreatment BMPs Sediment Forebay Pretreatment Vegetated Filter Strip Pretreatment Swale Deep Sump Hooded Catch Basin Oil Grit Separator Proprietary Pretreatment Device
Infiltration BMPs	Infiltration Trench Underground Infiltration System Infiltration Basin Dry Well & Infiltrating Catch Basin Permeable Pavement
Filtering BMPs	Bioretention Tree Filter Sand Filter
Stormwater Pond and Wetland BMPs	Stormwater Pond Wet Pond Micropool Extended Detention Pond Wet Extended Detention Pond Multiple Pond System Stormwater Wetland Subsurface Gravel Wetland Shallow Wetland Extended Detention Shallow Wetland Pond/Wetland System
Water Quality Conveyance BMPs	Dry Water Quality Swale Wet Water Quality Swale
Stormwater Reuse BMPs	Rain Barrel and Cistern Rain Barrel Cistern
Other BMPs and BMP Accessories	Green Roof Dry Extended Detention Basin Underground Detention (no infiltration) Inlet and Outlet Controls

Table 13-3. Suitability of Pretreatment BMPs Based on Type of Primary Stormwater BMP

BMP Category	BMP Type	Sediment Forebay	Pretreatment Vegetated Filter Strip	Pretreatment Swale	Deep Sump Hooded Catch Basin (1)	Oil Grit Separator (2)	Proprietary Pretreatment Device (3)
Infiltration BMPs	Infiltration Trench	●	●	●	●	●	●
	Underground Infiltration System				●	●	●
	Infiltration Basin	●	●	●	●	●	●
	Dry Well	Pretreatment Not Required					
	Infiltrating Catch Basin (4)				●	●	●
	Permeable Pavement	Pretreatment Not Required					
Filtering BMPs	Bioretention	●	●	●	●	●	●
	Surface Sand Filter	●	●	●	●	●	●
	Tree Filter				●	●	●
Stormwater Pond BMPs	Wet Pond	●	●	●		●	●
	Micro pool Extended Detention Pond	●	●	●		●	●
	Wet Extended Detention Pond	●	●	●		●	●
	Multiple Pond System	●	●	●		●	●
Stormwater Wetland BMPs	Subsurface Gravel Wetland	●	●	●		●	●
	Shallow Wetland	●	●	●		●	●
	Extended Detention Shallow Wetland	●	●	●		●	●
	Pond/Wetland System	●	●	●		●	●

Ch. 13: Structural Stormwater BMP Design Guidance



Porous Asphalt (Storrs Hall, UConn, Storrs, CT)

Grass and Grid Pavers (Hole in the Wall Parking Lot, East Lyme, CT)

Pervious Concrete (Residential Subdivision, East Haddam, CT)

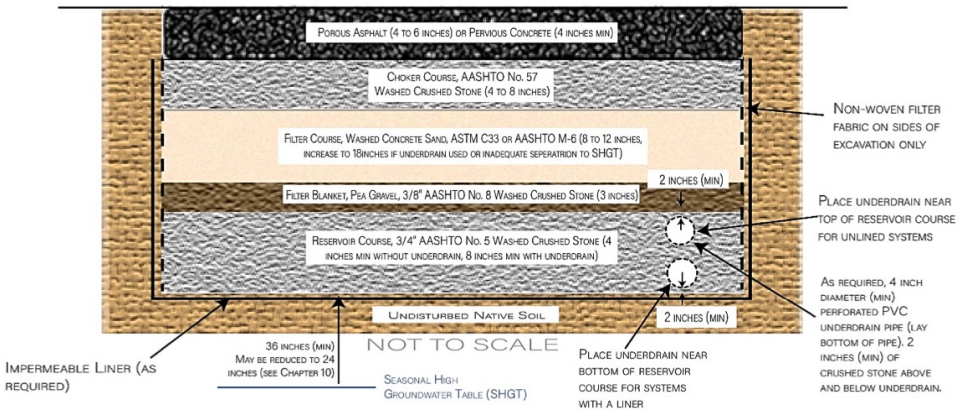
Concrete Pavers (residential driveway, Middletown, CT)

Sizing and Dimensions

Surface Area and Volume

- Permeable pavement should be designed by either the Static or Dynamic Methods as described in Chapter 10 - General Design Guidance for Stormwater Infiltration Systems.
- Size the filter and reservoir course to retain the Design Retention Volume (100% or 50% of the Water Quality Volume or WQV) and fully drain within 48 hours after the end of the design storm as described in Chapter 10 - General Design Guidance for Stormwater Infiltration Systems.
- Assume a porosity of 40% when computing the amount of available storage within the aggregate courses.
- Size the permeable pavement surface area such that the contributing drainage area to the permeable pavement does not exceed three times the surface area of the permeable pavement.

Porous Asphalt or Pervious Concrete



Connecticut Stormwater Quality Manual

Permeable Pavement

Source: UConn NEMO Program

Stormwater BMP Type	
Pretreatment BMP	□
Infiltration BMP	■
Filtering BMP	□
Stormwater Pond BMP	□
Stormwater Wetland BMP	□
Water Quality Conveyance BMP	□
Stormwater Reuse BMP	□
Proprietary BMP	□
Other BMPs and Accessories	□

Stormwater Management Suitability	
Retention*	■
Treatment	■
Pretreatment	□
Peak Runoff Attenuation	■

*Exfiltration systems only

Pollutant Removal	
Sediment*	**High**
Phosphorus	**Moderate**
Nitrogen	**Moderate**
Bacteria	**High**

*Includes sediment-bound pollutants

Implementation	
Capital Cost	**High**
Maintenance Burden	**High**
Land Requirement	**Low**

Description

Permeable pavement is an alternative paved surface and stormwater management facility designed to capture stormwater runoff and snowmelt and allow it to move through void spaces in the surface course or through the joints in paver units. The captured stormwater is filtered as it moves vertically through the surface course, a transition and filter course, and a storage bed of open-graded aggregate where it is temporarily stored. The stormwater is discharged from the system through infiltration into the underlying soil or using an optional underdrain. Permeable pavement can be used to manage stormwater that falls on the pavement surface, but it may also accept some runoff from adjacent impervious areas.

When design for infiltration, permeable pavement can provide retention of stormwater, reducing runoff volumes and recharging groundwater. Filtration of stormwater is the primary pollutant removal mechanism in permeable pavement systems, although hydrocarbons and other pollutants can biodegrade in the system. Permeable pavement can be designed to store larger volumes of water and provide peak runoff attenuation for larger storms. Similar to other Infiltration BMPs, permeable pavement systems should be lined for certain applications.

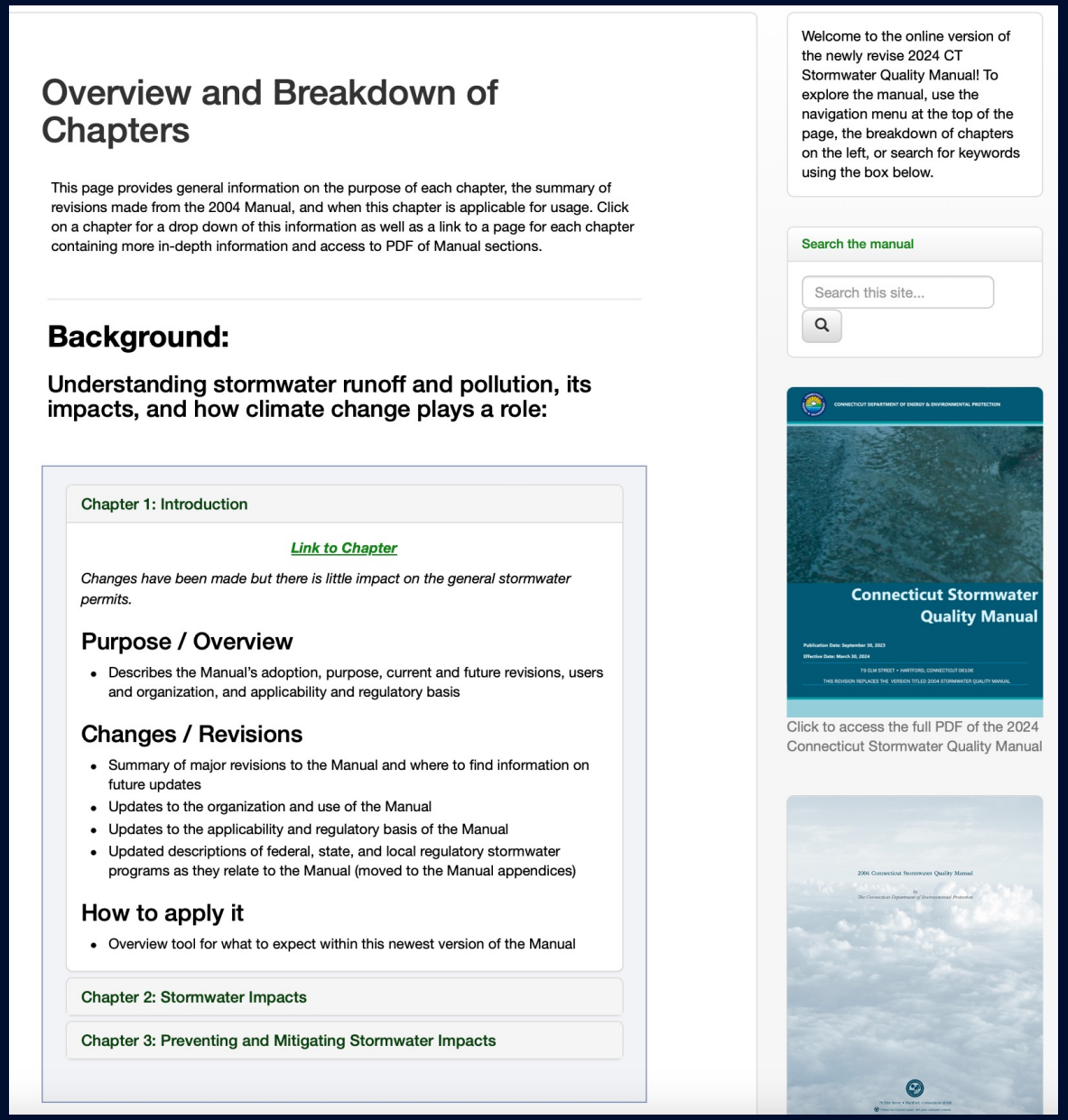
There are many types of permeable pavement systems, but the most common are porous asphalt, pervious concrete, and permeable interlocking concrete pavers (PICP). The following photographs show common types of permeable pavement installations in Connecticut.

Navigating the Manual

Website

- Broken down by chapter and usage
- Breakdown of revisions and impacts

ctstormwatermanual.nemo.uconn.edu



Overview and Breakdown of Chapters

This page provides general information on the purpose of each chapter, the summary of revisions made from the 2004 Manual, and when this chapter is applicable for usage. Click on a chapter for a drop down of this information as well as a link to a page for each chapter containing more in-depth information and access to PDF of Manual sections.

Background:

Understanding stormwater runoff and pollution, its impacts, and how climate change plays a role:

Chapter 1: Introduction

Link to Chapter

Changes have been made but there is little impact on the general stormwater permits.

Purpose / Overview

- Describes the Manual's adoption, purpose, current and future revisions, users and organization, and applicability and regulatory basis

Changes / Revisions

- Summary of major revisions to the Manual and where to find information on future updates
- Updates to the organization and use of the Manual
- Updates to the applicability and regulatory basis of the Manual
- Updated descriptions of federal, state, and local regulatory stormwater programs as they relate to the Manual (moved to the Manual appendices)

How to apply it

- Overview tool for what to expect within this newest version of the Manual

Chapter 2: Stormwater Impacts

Chapter 3: Preventing and Mitigating Stormwater Impacts

Welcome to the online version of the newly revise 2024 CT Stormwater Quality Manual! To explore the manual, use the navigation menu at the top of the page, the breakdown of chapters on the left, or search for keywords using the box below.

Search the manual

Search this site...

Click to access the full PDF of the 2024 Connecticut Stormwater Quality Manual

Resources / What's Coming

- **Website: https://ctstormwatermanual.nemo.uconn.edu**
  - Breakdown and navigation of manual by chapter

- **On the way: Webinar 2 - Low Impact Development**
  - LID focused webinar demonstrating the usage of non-structural and structural stormwater BMPs

We want to hear from you – what resources would help you understand / navigate the new version of the manual?

Mary Looney
mary.looney@uconn.edu

Dave Dickson
david.dickson@uconn.edu

Let the questions begin!