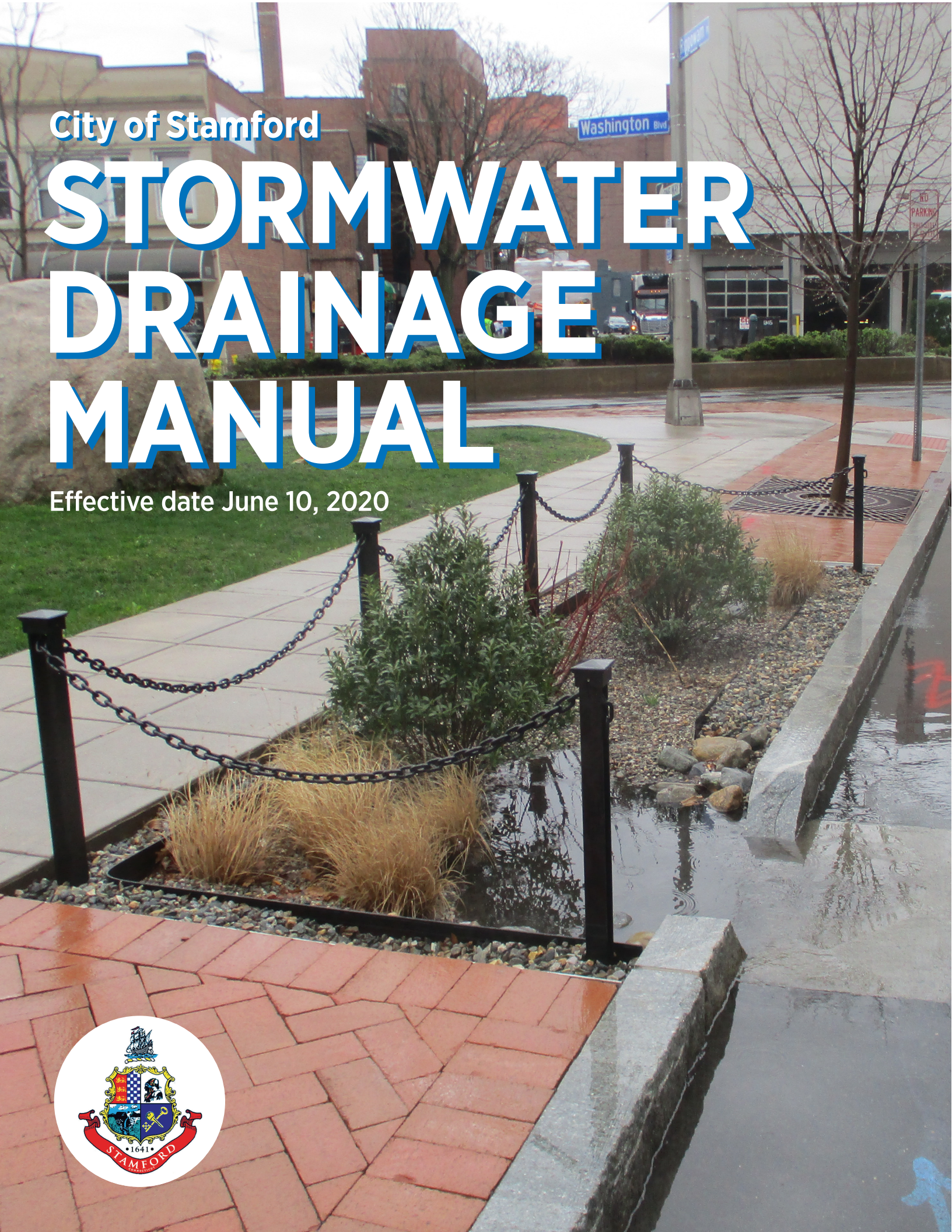


City of Stamford

STORMWATER DRAINAGE MANUAL

Effective date June 10, 2020

City of Stamford

Stormwater Drainage Manual

Effective Date: June 10, 2020

The City of Stamford Drainage Manual is available on-line.

Acknowledgements

Stormwater Committee

Ralph Blessing, Land Use Bureau Chief
Louis Casolo, PE, City Engineer
Susan Kisken, PE, Coordinator of Inspections & Plan Review
Erin McKenna, Associate Planner
Richard Talamelli, Executive Director, Environmental Protection Board
Tyler Theder, Regulatory Compliance and Administrative Officer

Fuss & O'Neill

Erik Mas, PE, Project Director
Elizabeth Troop, PE, Project Manager
Kenneth Sullenger, PE, Senior Engineer

Table of Contents

City of Stamford Stormwater Drainage Manual

List of Tables

List of Appendices

Acronyms and Abbreviations

BMPs	Best Management Practices
CSO	Combined Sewer Overflow
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDOT	Connecticut Department of Transportation
DCIA	Directly Connected Impervious Area
EPB	Environmental Protection Board
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIS	Geographic Information System
HSG	Hydrologic Soil Group
LID	Low Impact Development
MS4	Municipal Separate Storm Sewer System
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service (formerly SCS)
PE	Professional Engineer
SWPPP	Stormwater Pollution Prevention Plan
TAPE	Technology Assessment Protocol – Ecology
TARP	Technology Acceptance Reciprocity Partnership
Tc	Time of Concentration
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USACOE	Unites States Army Corps of Engineers
USGS	United States Geological Survey
WQF	Water Quality Flow
WQV	Water Quality Volume

Definitions

APPLICANT: A property owner or agent of a property owner who has filed an application for a permit from the City of Stamford.

CONSTRUCTION ACTIVITY: Activity including but not limited to clearing and grubbing, grading, excavation, and dewatering.

BEST MANAGEMENT PRACTICE OR "BMP": Schedule of activities, practices (and prohibitions of practices), structures, vegetation, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the State consistent with state, federal or other equivalent and technically supported guidance. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from material storage.

DESIGN STORM: A rainfall event of specific size, intensity, and return frequency (e.g., the 1-year storm) that is used to calculate runoff volume and peak discharge rate.

DEVELOPMENT: The modification of land to accommodate a new use or expansion of use, usually involving construction.

DISCHARGE: The emission of any water, substance or material into the waters of the State, whether or not such substance causes pollution.

DISTURBANCE (of land): Any action that causes a change in the position, location, or arrangement of soil, sand, rock, gravel or similar earth material.

DIRECTLY CONNECTED IMPERVIOUS AREA OR "DCIA": The part of the total impervious area that is hydraulically connected to the City of Stamford's MS4 system. DCIA typically includes streets, sidewalks, driveways, parking lots, and rooftops. DCIA typically does not include isolated impervious areas that are not hydraulically connected to the MS4 or otherwise drain to a pervious area.

FLOODPLAIN: Any land susceptible to being inundated by water, usually adjacent to a stream, river or water body and usually associated with a particular design flooding frequency (e.g., 100-year floodplain).

HIGH QUALITY WATERS: Surface waters where the water quality is better than necessary to meet the criteria established in the Connecticut Water Quality Standards Regulations, as amended, for the applicable classification or which may sustain a sensitive use designated for a higher classification. This definition may be superseded by future amendments to the Connecticut Water Quality Standards Regulations.

HYDRAULIC CONDUCTIVITY: The rate at which water moves through a saturated porous media under a unit potential-energy gradient. It is a measure of the ease of water movement in soil and is a function of the fluid as well as the porous media through which the fluid is moving.

IMPAIRED WATERS: Surface waters of the State designated by the Commissioner of the CTDEEP as impaired pursuant to Section 303(d) of the federal Clean Water Act and as identified in the most recent State of Connecticut Integrated Water Quality Report within Categories 4 or 5, including any subdivisions of these categories.

IMPERVIOUS COVER: See Impervious Surface

IMPERVIOUS SURFACE: Any material or structure on or above the ground that prevents water from infiltrating through the underlying soil. Impervious surface is defined to include paved parking lots, sidewalks, rooftops, driveways, patios (i.e., solid or open-joint patios or decks with an underlying impervious surface), paved roads, water surfaces (i.e., pools, ponds, fountains, etc.), and highly compacted soils.

LINEAR DEVELOPMENT: A construction or disturbance activity that is linear in nature such as, but not limited to, (i) the construction of electric and telephone utility lines, and pipelines (gas, oil); (ii) construction of tracks, rights-of-way, bridges, communication facilities and other related structures of a railroad company; (iii) roadway construction projects; (iv) construction of stormwater channels and stream restoration activities; and (v) water and sewer lines. Private roads or streets, including those associated with a larger development, shall not be considered linear development projects.

LOW IMPACT DEVELOPMENT or "LID": A site design strategy intended to maintain or replicate predevelopment hydrology through the use of small-scale controls integrated throughout the site to manage runoff as close to its source as possible.

MUNICIPAL SEPARATE STORM SEWER SYSTEM OR "MS4": Conveyances for stormwater (including roads and drainage systems, streets, catch basins, curbs, gutters, ditches, man-made channels or storm drains) owned or operated by any municipality or by any state or federal institution and discharging to surface waters of the State.

NON-STRUCTURAL CONTROLS: Pollution control techniques such as management actions and behavior modification that do not involve the construction or installation of devices.

NEW DEVELOPMENT: Any construction or disturbance of a parcel of land that is currently in a natural vegetated state and does not contain alteration by man-made activities.

NEW OR INCREASED DISCHARGE: New discharge or activity as defined in section 22a-426-8(b)(3) and increased discharge or activity as defined in section 22a-426-8(b)(2), as referenced to the Regulations of Connecticut State Agencies.

PEAK FLOW CONTROL: Criteria intended to address increases in the frequency and magnitude of a range of potential flood conditions resulting from development, and include stream channel protection, conveyance protection, peak runoff attenuation, and emergency outlet sizing.

PRE-DEVELOPMENT: The hydrologic and hydraulic condition of a project site before the proposed development occurs. In the case of redevelopment, the pre-development condition shall be the least developed state of the site in the prior 10 years as determined from City of Stamford aerial photographs. Any off-site drainage onto the site shall be considered in the context of off-site drainage patterns and land use at the time of the proposed activity. Consideration may be given for impervious cover existing for more than ten (10) years if the applicant demonstrates that these improvements legally existed prior to their removal (e.g., demolition of existing buildings, pavement, etc.).

POST-DEVELOPMENT: The conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site or tract of land. Post-development refers to the phase of a new development or redevelopment project after completion, and does not refer to the construction phase of a project.

REDEVELOPMENT: Any construction activity (including, but not limited to, clearing and grubbing, grading, excavation, and dewatering) within existing drainage infrastructure or at an existing site to modify or expand or add onto existing buildings or structures, grounds, or infrastructure.

RETAIN: To hold runoff on-site to promote vegetative uptake and groundwater recharge through the use of runoff reduction or LID practices or other measures with no subsequent point source release to surface waters as specified in this manual.

SITE: The parcel of land being developed, or a designated planning area in which the land development project is located.

STORMWATER: Waters consisting of rainfall runoff, including snow or ice melt.

STRUCTURAL CONTROLS: Devices constructed for temporary storage and treatment of stormwater runoff.

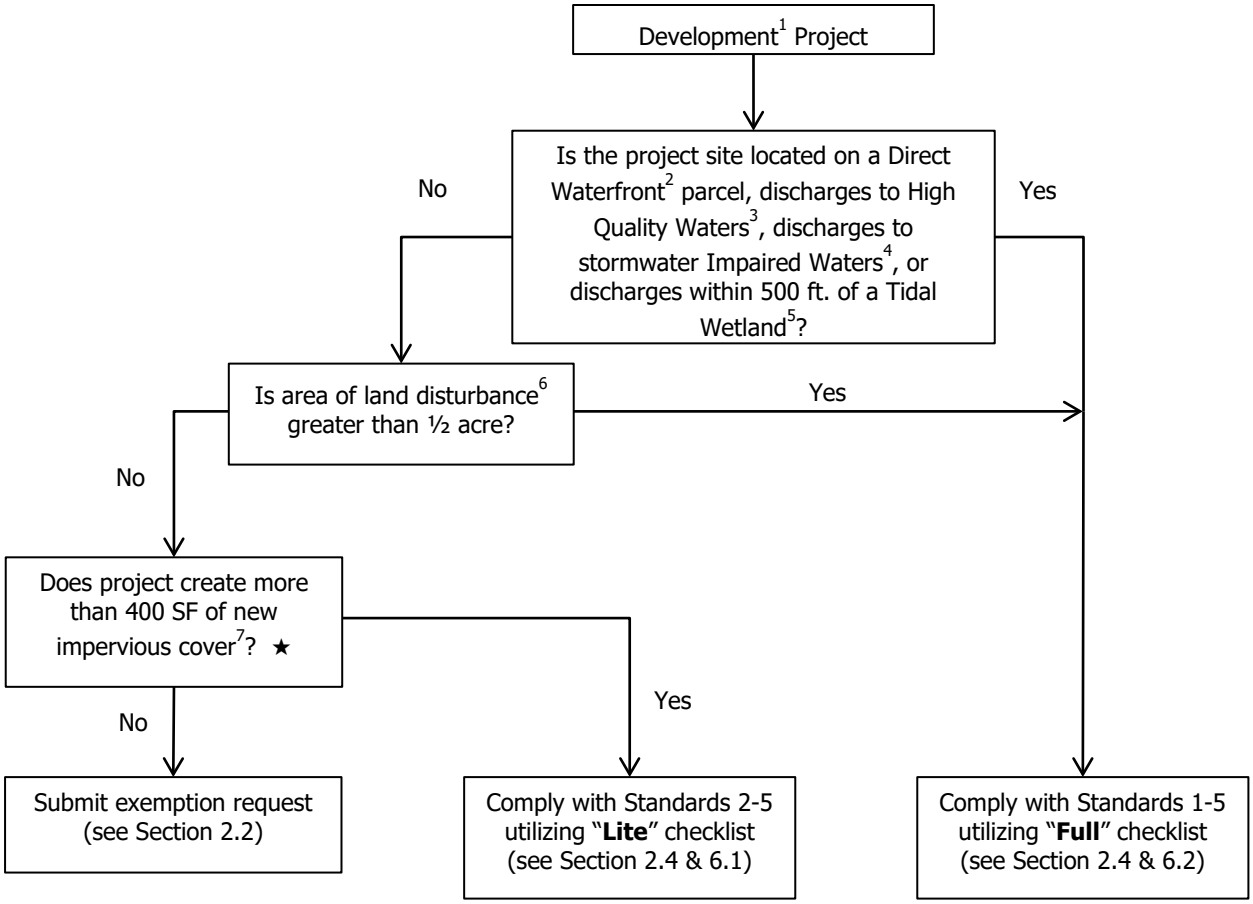
TIDAL WETLAND: Tidal wetlands are "those areas which border on or lie beneath tidal waters, such as, but not limited to banks, bogs, salt marshes, swamps, meadows, flats, or other low lands subject to tidal action, including those areas now or formerly connected to tidal waters, and whose surface is at or below an elevation of one foot above local extreme high water; and upon which may grow or be capable of growing some, but not necessarily all, of [a list of specific plant species - see Connecticut General Statutes (CGS) section 22a-29(2)]" [CGS section 22a-29, as referenced by CGS section 22a-93(7)(E)].

TOTAL MAXIMUM DAILY LOAD OR "TMDL": The maximum capacity of a surface water to assimilate a pollutant as established by the Commissioner of the Connecticut Department of Energy and Environmental Protection, including pollutants contributed by point and non-point sources and a margin of safety.

TOTAL SUSPENDED SOLIDS (TSS): The total amount of particulate matter that is suspended in the water column.

WATER QUALITY VOLUME OR "WQV": The volume of runoff generated by one inch of rainfall on a site as defined in the 2004 Connecticut Stormwater Quality Manual, as amended.

Stormwater Management Standards Applicability Flowchart



1. **Development –** The modification of land to accommodate a new use or expansion of use, usually involving construction.
2. **Direct Waterfront** – Those parcels identified on the Direct Waterfront Parcels Map located in *Appendix A*.
3. **High Quality Waters** – Surface waters where the water quality is better than necessary to meet the criteria established in the Connecticut Water Quality Standards Regulations, as amended, for the applicable classification or which may sustain a sensitive use designated for a higher classification (See *Appendix H*).
4. **Impaired Waters** –Surface waters of the State designated by the Commissioner of the CTDEEP as impaired pursuant to Section 303(d) of the federal Clean Water Act and as identified in the most recent State of Connecticut Integrated Water Quality Report within Categories 4 or 5, including any subdivisions of these categories.
5. **Tidal Wetlands** – Those areas that border on or lie beneath tidal waters whose surface is at or below an elevation of one foot above local extreme high water and upon which may grow or be capable of growing some, but not necessarily all, of the plant species specified in Connecticut General Statutes section 22a-29(2) (See reference mapping in *Appendix A*).
6. **Land Disturbance** – Any action that causes a change in the position, location, or arrangement of soil, sand, rock, gravel or similar earth material.
7. **Impervious Cover** – Any material or structure on or above the ground that prevents water from infiltrating through the underlying soil.

★ Applicants shall comply with Standard 1, E from Section 2.4 of this manual when proposing a new or improved parking area serving six (6) or more spaces, regardless of the amount of new impervious cover created, or when seeking an approval or permit from the City of Stamford on a site with an existing parking area serving six (6) or more spaces, regardless of the amount of new impervious cover created

1 Introduction

1.1 Purpose of the Manual

The City of Stamford Stormwater Drainage Manual (hereinafter, Drainage Manual) provides a technical framework, stormwater management standards, and design guidance for land development activities in the City of Stamford. This manual is applicable to activities involving new development and redevelopment, undertaken by private entities, projects over which the City departments, land use boards, and other agencies have jurisdiction, as well as municipal projects. This manual is intended to be used by developers, engineers, and local regulatory authorities to design and review projects in a technically sound and consistent manner and to meet the post-construction stormwater management and Low Impact Development provisions contained in the City's Municipal Separate Storm Sewer System (MS4) Permit, which are codified in the City's Zoning Regulations.

The manual also supports the sustainability goals identified in the Stamford Master Plan 2015-2025, specifically Chapter 7, "A Sustainable Future" (City of Stamford, 2014) by encouraging the use of Low Impact Development (LID). LID is an approach to site development and stormwater management that uses the basic principle modeled after nature: manage rainfall where it lands. The goal of LID is to reduce the impacts of development by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source. Techniques are based on the premise that stormwater management should not be seen as stormwater disposal. Instead of conveying and managing/treating stormwater in large end-of-pipe facilities located at the bottom of drainage areas, LID addresses stormwater through smaller landscape features located on individual sites. LID is a versatile approach that can be applied to new development, retrofits, and redevelopment projects.

1.2 Organization of the Manual

The manual is organized as follows:

- **Section 1** – describes the purpose, organization and use of the manual, and also provides an introduction to the use and benefits of LID.
- **Section 2** – describes applicability and stormwater management standards for new development, redevelopment, linear development, and also provides guidance on modifications to these standards.
- **Section 3** – describes general design criteria for drainage facilities and structural stormwater management practices, including hydrologic and hydraulic analysis methods.
- **Section 4** – addresses specific design guidance and criteria for various types of drainage systems
- **Section 5** – contains a description of structural stormwater management practices, including their proper selection and design references.
- **Section 6** – describes submittal requirements, including the Stormwater Management Report, supporting documentation, construction plan, erosion and sediment control plan, and certifications.

1.3 How to Use this Manual

This manual is intended to be used in conjunction with other existing design guidance, including the Connecticut Department of Energy and Environmental Protection (CTDEEP) 2004 Connecticut Stormwater Quality Manual (as amended) and the Connecticut Department of Transportation (CTDOT) Drainage Manual (as amended). The Drainage Manual is generally consistent with the state-wide manuals to ensure consistency with state stormwater management policies and to eliminate potential redundancy with other existing guidance. This

manual references applicable sections of the Connecticut Stormwater Quality Manual and Connecticut Department of Transportation Drainage Manual, but also includes specific stormwater management standards tailored to the unique characteristics and issues facing the City of Stamford.

The design practices described in this manual shall be implemented by professional engineers licensed to practice in the State of Connecticut. The design engineer is responsible for field investigations, data collection and analysis, and design of stormwater management and drainage facilities based upon the guidance contained in this manual. Stormwater management is an evolving field. Existing stormwater management practices are being refined and new practices are being developed on a regular basis. The City may periodically amend this manual to reflect new or modified technologies, practices, and regulatory requirements.

1.4 Related Documents

State of Connecticut Department of Transportation

1. Standard Specifications for Roads, Bridges and Incidental Construction, Form 817, or as amended. http://www.ct.gov/dot/cwp/view.asp?a=3609&q=430362
2. 2000 Drainage Manual, as amended. http://www.ct.gov/dot/cwp/view.asp?a=3200&q=260116&dotPNavCtr=|
3. Standard Details shall be incorporated into this manual, except as revised and modified herein. http://www.ct.gov/dot/cwp/view.asp?a=2288&q=259352
4. Qualified product list. http://www.ct.gov/dot/lib/dot/documents/dresearch/conndot_qpl.pdf

State of Connecticut Department of Energy and Environmental Protection

1. 2004 Connecticut Stormwater Quality Manual, as amended. http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325704
2. 2011 Low Impact Development Appendix to the Connecticut Stormwater Quality Manual, as amended. http://www.ct.gov/deep/cwp/view.asp?a=2719&q=459488&deepNav_GID=1654
3. 2002 Connecticut Guidelines for Soil Erosion and Sediment Control, as amended. http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325660&deepNav_GID=1654%20
4. Tidal Wetlands – General Information. https://www.ct.gov/deep/cwp/view.asp?a=2705&q=323824&deepNav_GID=1625

City of Stamford

1. City of Stamford Standard Details, as amended. https://www.stamfordct.gov/sites/stamfordct/files/uploads/doc667.pdf
2. City of Stamford MS4 permit, as amended. https://www.stamfordct.gov/sites/stamfordct/files/file/file/ms4_permit_issued_6-4-13.pdf
3. City of Stamford Zoning Regulations, as amended. https://www.stamfordct.gov/sites/stamfordct/files/file/file/zoning_regulations.pdf

2 Stormwater Management Standards

2.1 Overview

This section describes the stormwater management requirements (i.e., standards) for development and redevelopment projects in the City of Stamford and the types of activities to which they apply (i.e., applicability). Stormwater management standards promote the use of stormwater treatment practices to protect water quality, reduce runoff volume, maintain groundwater recharge, and address peak flows and flooding during larger storms. The standards reflect the stormwater retention and treatment requirements for land disturbance activities, which are contained in the City's MS4 Permit. The standards are also generally consistent with the stormwater management approaches and design guidance contained in the CTDEEP Connecticut Stormwater Quality Manual and the CTDOT Drainage Manual.

2.2 Applicability and Exemptions

Applicability

The stormwater management standards apply to all new development, redevelopment, and other land disturbance activities, whether considered individually or collectively as part of a larger common plan, unless exempted as detailed below.

Exemptions

1. Projects creating less than 400 square feet of new impervious surfaces providing that all of the following conditions are met to the satisfaction of the City:

    a. The project drainage design will not adversely impact adjacent or downstream properties or City-owned drainage facilities.
    b. The project does not result in new or increased discharges to High Quality Waters or stormwater Impaired Waters as designated by CTDEEP.
    c. The project does not discharge directly to or within 500 feet of a tidal wetland, see *Appendix A.*
    d. The project is not located on a Direct Waterfront parcel.
    e. The applicant submits an exemption request, see *Appendix J.*
    f. The Engineering Bureau approves the exemption request.

    This exemption is available only until the cumulative addition of unreviewed impervious surface on a site reaches 400 square feet over the previous ten (10) years, regardless of ownership changes. Residential "teardowns" – demolition and reconstruction or replacement of an existing residential dwelling with another residence of any size – are not allowed to exercise this exemption.

2. Construction, replacement or repair of utilities (gas, water, electric, telephone, etc.) other than drainage, which will not alter terrain, ground cover, or drainage patterns.

3. Repairs to any stormwater facility or practice deemed necessary by the Engineering Bureau.

4. Routine maintenance to existing City roads that is performed to maintain the existing width, line, and grade.

2.3 Modification

An applicant may apply in writing for a modification of any of the Stormwater Management Standards found in this manual for a development application where, due to physical site or environmental conditions, it is not feasible to meet one or more of the requirements. The applicant shall provide the necessary documentation to justify and support the modification request. Requests for modifications without supporting documentation will not be considered. The Engineering Bureau may take one of the following actions:

I. Grant the modification in part or in full.
II. Deny the modification.
III. Offer the applicant the option of obtaining a third-party review from a mutually agreed upon Professional Engineer. Use of this option does not guarantee approval or acceptance of the modification request.

The third-party review shall be provided by an independent professional engineer licensed in the State of Connecticut with expertise in stormwater management and with due consideration to the requirements of this manual. Costs associated with any such third-party review shall be borne by the applicant/developer. Approval of the selected consultant shall be based upon staff review of the chosen consultant's relevant experience in stormwater management.

2.4 Stormwater Management Standards

Standard 1: Runoff and Pollutant Reduction

A. Stormwater treatment practices shall be designed to meet the retention and treatment requirements in the flow chart below. Stormwater treatment practices that are properly designed in accordance with the City of Stamford Stormwater Drainage Manual shall be considered adequate to demonstrate compliance with this standard.

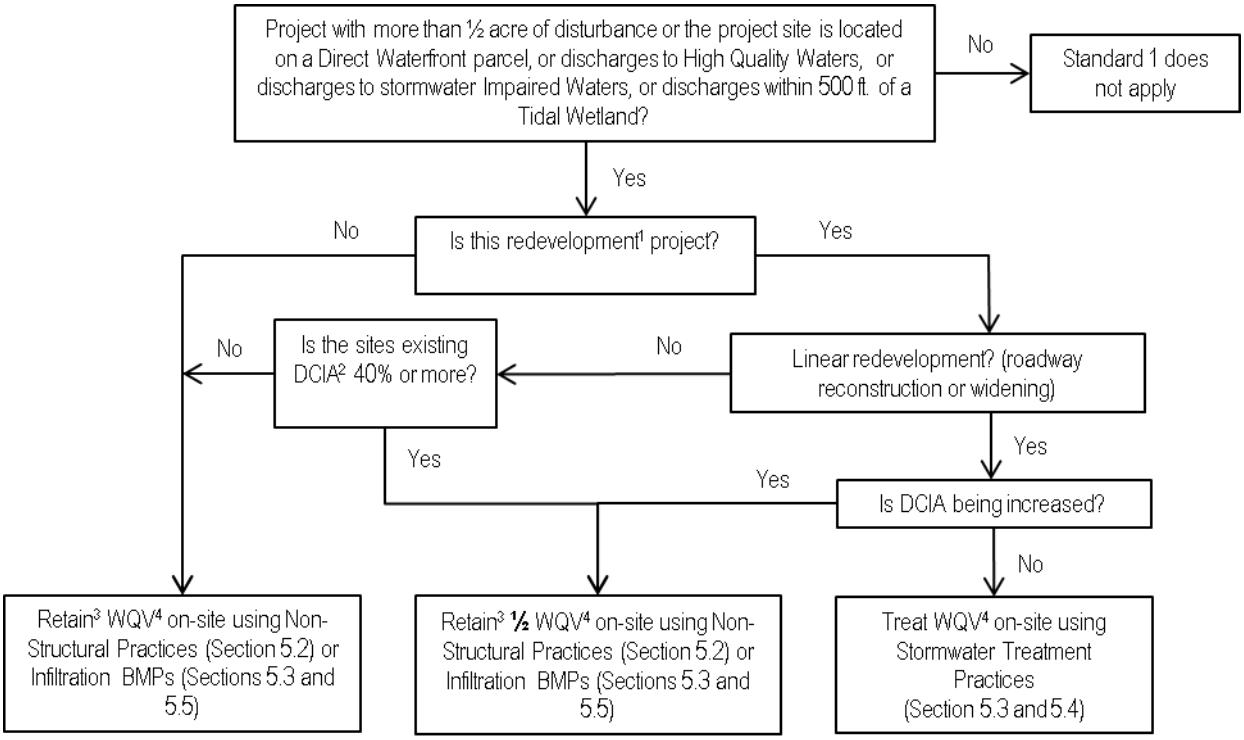
B. In cases where the applicant is not able to retain the entire amount as listed in the flow chart below, the applicant shall:

   a. Design the development to retain runoff to the maximum extent achievable using treatment practices that are technologically available and economically practicable in light of best industry practice. In such cases, the applicant shall provide additional stormwater treatment for sediment, floatables, and nutrients to the maximum extent achievable using treatment practices that are technologically available and economically practicable in light of best industry practice for the volume above that which can be retained up to the water quality volume.

   b. The applicant shall submit, for the City's review and written approval, a report detailing and documenting the site-specific factors limiting the capability of achieving this requirement. The report shall include the measures taken to maximize runoff reduction practices on the site, the reason why those practices constitute the maximum extent achievable, the alternative retention volume, and a description of the measures used to provide additional stormwater treatment above the alternative volume up to the water quality volume. Factors that may limit the capability of a project to meet Standard 1 include but are not limited to:

- Brownfield sites
- Capped landfills
- High bedrock / ledge
- Elevated groundwater
- Soil conditions

Runoff and Pollutant Reduction Requirements Flowchart



1. **Redevelopment –** Any construction activity (including, but not limited to, clearing and grubbing, grading, excavation, and dewatering) within existing drainage infrastructure or at an existing site to modify or expand or add onto existing buildings or structures, grounds, or infrastructure.
2. **DCIA (Directly Connected Impervious Area)** – The part of the total impervious area that is hydraulically connected to the City of Stamford's MS4. DCIA typically includes streets, sidewalks, driveways, parking lots, and rooftops. DCIA typically does not include isolated impervious areas that are not hydraulically connected to the MS4 or otherwise drain to a pervious area. For the purposes of compliance with Standard 1, DCIA shall be based on the current site conditions.
3. **Retain** – To hold runoff on-site to promote vegetative uptake and groundwater recharge through the use of runoff reduction or LID practices or other measures with no subsequent point source release to surface waters as specified in this manual.
4. **WQV (Water Quality Volume)** – The volume of runoff generated by one inch of rainfall on a site as defined in the 2004 Connecticut Stormwater Quality Manual, as amended.

C. Land disturbance shall be limited to areas necessary to construct proposed improvements with reasonable lawn and landscaping areas as necessary to prevent future site erosion. Turf areas shall be limited to areas of land disturbance.

D. The applicant may complete site plan review and pre-construction review meetings with the City to discuss stormwater controls and treatment practices to prevent or minimize impacts to water quality. Recognizing that every site is different with respect to potential impacts, designers are encouraged to meet with the City of Stamford Engineering Bureau early during the design process to discuss site-specific plans and design standards.

E. Where a new or improved parking lot serves six (6) or more parking spaces, regardless of the amount of new impervious cover created, stormwater treatment practices shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) and floatable debris for all anticipated flow rates calculated for the 25-year, 24-hour storm.

Where an applicant is seeking an approval or permit from the City of Stamford on a site where an existing parking lot contains six (6) or more parking spaces, regardless of the amount of new impervious cover created, stormwater treatment practices shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) and floatable debris for all anticipated flow rates calculated for the 25-year, 24-hour storm to the extent feasible and at the discretion of the City of Stamford Engineering Bureau.

F. Applicants shall consider the use of non-structural approaches before proposing to use structural stormwater treatment practices. Non-structural Low Impact Development (LID) approaches are discussed in Section 5.2 of this manual, and in the CTDEEP Low Impact Development Appendix to the Connecticut Stormwater Quality Manual.

Standard 2: Peak Flow Control

A. Stream Channel Protection – The 2-year, 24-hour post-development peak flow rate shall be: (a) less than or equal to 50 percent of the 2-year, 24-hour storm pre-development peak flow rate, or (b) less than or equal to the 1-year, 24-hour storm pre-development peak flow rate. This stormwater management standard is required for all stormwater flows (except sites with less than or equal to one acre of impervious cover) which discharge directly or indirectly into a water body or watercourse including those discharges which enter a storm sewer system prior to discharging to the water body or watercourse. This standard may be waived under certain conditions, at the discretion of the Engineering Bureau, as described in the Connecticut Stormwater Quality Manual.

B. Conveyance Protection – Provide adequate passage for flows leading to, from, and through stormwater management facilities based on the design storm criteria described in Section 3.

C. Peak Flow Control – The post-development peak flow rates from the 1-year, 2-year, 5-year, 10-year, 25-year, and 50-year, 24-hour storms shall be controlled to the corresponding pre-development peak discharge rates. Peak runoff attenuation for the 100-year, 24-hour storm may be required at the discretion of the City. The City may also, at its discretion, require the applicant to evaluate pre- and post-development peak runoff rates associated with more intense, shorter-duration storm events or less intense, longer-duration storm events to reflect potential changes in rainfall characteristics due to climate change or other factors. The Peak Flow Control Standard may be waived, at the discretion of the Engineering Bureau, for sites that discharge to a large river, lake, estuary, tidal waters, or land subject to coastal storm flows, as described in the Connecticut Stormwater Quality Manual.

D. Emergency Outlets shall be sized to safely pass the post-development peak runoff from the 100-year, 24-hour storm at a minimum in a controlled manner without eroding the outlet works and downstream drainages.

E. When detention is proposed, a downstream hydrologic analysis may be required by the Engineering Bureau. Refer to Section 4.10 of this manual.

Standard 3: Construction Erosion and Sediment Control

A. Applicants shall submit a plan to control construction related impacts, including erosion, sedimentation, and other pollutant sources during construction and land disturbance activities. This plan must be developed and implemented in accordance with Section 15B of the Stamford Zoning Regulations, the Connecticut Guidelines for Soil Erosion and Sediment Control (as amended), and the requirements of the CTDEEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities.

Standard 4: Operation and Maintenance

A. The property owner shall execute a Standard City of Stamford Drainage Maintenance Agreement (See *Appendix G*) with the Environmental Protection Board to ensure long-term maintenance and functionality of proposed stormwater management facilities.

B. Construction Plans shall include provisions for long-term maintenance of stormwater management facilities including routine and non-routine inspection and maintenance tasks to be undertaken after construction is complete and the schedule for implementing these tasks.

Standard 5: Stormwater Management Report

A. A Stormwater Management Report shall be prepared for all activities that are subject to the Stormwater Management Standards. This report shall document how the proposed project complies with the Drainage Manual requirements and shall be submitted with the stamp and signature of a Professional Engineer (PE) licensed in the State of Connecticut. All Stormwater Management Reports shall contain all applicable elements listed in Section 6 of this manual and found in the checklists in *Appendix D*.

B. The Stormwater Management Report shall include the following certification:

> "Based on the above information, the proposed improvements are designed in accordance with the City of Stamford Stormwater Drainage Manual and will not adversely impact adjacent or downstream properties or City-owned drainage facilities."

3 General Design Criteria

3.1 Introduction

This section describes the criteria and calculations for the design of stormwater management systems to satisfy Stormwater Management Standards 1 and 2. The criteria are generally consistent with the stormwater management approaches and design guidance contained in the Connecticut Department of Energy and Environmental Protection's Connecticut Stormwater Quality Manual and the Connecticut Department of Transportation Drainage Manual, but also reflect the City's unique natural resources and development characteristics.

3.2 Design Storm Frequency

Storm drainage systems must be designed to adequately accommodate peak runoff for the chosen design storm to protect property and for the safety and convenience of the public. The design storm frequencies to be used for design are presented in the table below. In areas of potentially high property damage, the design storm frequencies used for design shall be increased as directed by the Engineering Bureau. Reduction of the design storm frequency used for design will be subject to Engineering Bureau approval.

Unless otherwise specified by the Engineering Bureau, the 24-hour design storm rainfall amounts and distributions shall be obtained from the latest NOAA Atlas 14 Point Precipitation Frequency Estimates and storm distributions.

Table 3-1. Design Storm Frequency for Storm Drainage Systems

Facility	South of Merritt Parkway	North of Merritt Parkway
Local Streets and Parking Lots	25-Year	10-Year
Collector and Major Roads	25-Year	25-Year
Watercourse Channels	50-Year	50-Year
Major Culverts	50-Year	50-Year
Bridges	100-Year	100-Year

3.3 Hydrologic Design Criteria

Hydrologic models shall be prepared utilizing the SCS Runoff Curve Number Method from NRCS TR-55 unless otherwise approved by the Engineering Bureau. Peak discharge rates may be calculated using the point of discharge at the downgradient property boundary, prior to discharge to the receiving water body. The topography of the site may require evaluation at more than one location if flow leaves the property in more than one direction. Calculations shall include runoff from adjacent upgradient properties. An applicant may demonstrate that a feature beyond the property boundary is more appropriate as a design point. Hydrograph routing calculations shall be used, including stage-discharge manual analysis or computer modeling methods.

Drainage area limits and areas may be established by field surveys, USGS topographic maps or GIS topographic maps. If topographic information other than a direct field survey is used as the basis for delineating drainage area boundaries (e.g., USGS or GIS topographic maps), the topographic map reference and latest map revision date must be identified in the Stormwater Management Report.

The designer shall refer to the Connecticut Department of Transportation Drainage Manual for recommended methods for calculating travel times for overland (sheet) flow, shallow concentrated flow, and channel flow. For design purposes, the minimum time of concentration is 5 minutes for paved areas and 10 minutes for all other analyses.

3.4 Hydraulic Design Criteria

Hydraulic analysis shall be consistent with the procedures and criteria established in the Connecticut Department of Transportation Drainage Manual unless otherwise approved by the Engineering Bureau.

3.5 Climate Change Considerations

The applicant shall consider the potential impacts of climate change on proposed stormwater management facilities. Designers shall consult the latest climate change projections for the site and evaluate a 50-year facility planning horizon for these changes. Potential climate change impacts include sea level rise, increased storm intensity and frequency including storm surge in coastal areas, increased annual precipitation amounts, higher groundwater elevations that may impact structural BMP selection, siting, design, and operation/maintenance of facilities. Structural BMP vulnerabilities include sea level rising and submerging outfalls, rising groundwater and reduced infiltration, storm surge inundation of facilities, and additional wind, sand, and salt exposure. Additional information and guidance for considering and adapting stormwater management facilities for climate change can be found in "Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMP Design Considerations in Coastal Communities" (Horsley Witten Group, Inc., 2015). Information on sea level rise projections can be found at the Connecticut Institute for Resiliency and Climate Adaptation (CIRCA) website (https://circa.uconn.edu/).

3.6 Flood Hazard Areas

When a property is affected by the base flood, the special flood hazard areas and regulatory floodway boundaries shall be established/depicted on the survey in the manner defined in Section 15.B of the Stamford Zoning Regulations ("Flood Prone Area Regulations of the City of Stamford"). Flood zone designation, base flood elevation, and Flood Insurance Rate Map (FIRM) references (Community Number, Panel, Suffix, and Date), including any effective Letter of Map Revision/Amendment shall be referenced on the plan. Proposed developments within a special flood hazard area shall comply with design and submittal requirements of Section 15.B of the Stamford Zoning Regulations ("Flood Prone Area Regulations of the City of Stamford").

When a property is influenced by tides, unless otherwise approved by the Engineering Bureau, the restrictive layer shall be equal to or higher than the elevation of the Connecticut Coastal Jurisdiction Line (5.5 feet NAVD 88) for stormwater design purposes.

4 Design of Drainage Facilities

4.1 General Requirements

Design of stormwater drainage facilities shall conform to the following design criteria unless written approval is obtained from the Engineering Bureau. Where specific criteria are not provided in this section, the design shall conform to the requirements of the Connecticut Department of Transportation Drainage Manual. Stormwater drainage systems shall be designed to effectively convey stormwater for the design storm frequency listed in Section 3.2.

Any connection to the City-owned storm sewer shall require the Waiver Covering Storm Sewer Connection to be filed with the City of Stamford Engineering Bureau.

4.2 Catchments

Catchments are structures by which runoff enters the storm drainage system and include catch basins, area drains, trench drains, terrace drains, and exterior drains. Catchments shall comply with the following requirements:

- Catch basins shall conform to City of Stamford Standard Detail:
    - Bell traps are required on structure outlets. PVC elbows are acceptable on private property.
    - Minimum sump depth is 2 feet for any catchment structure, measured from the invert of the lowest outlet to the floor of the basin.
- For uncovered, lower level ingress/egress basement areas, exterior drains with an uncovered drainage area less than 50 square feet shall have a minimum sump of 12 inches. Drainage areas greater than 50 square feet shall have a minimum sump of 24 inches. Sumps shall be measured from the invert of the lowest outlet out to the floor of the drain.
- Double catch basins shall have a minimum outlet pipe diameter of 15 inches.
- Catch basin spacing shall not exceed 300 feet.
- Catchment structure to catchment structure connections are not permitted.
- Roof drains, footing drains, and exterior drains are prohibited from connecting directly to a catchment structure.
- Inlet analysis shall be provided to conform to the criteria established in Section 11.8 of the CTDOT Drainage Manual.
- Gutter Flow Calculations are required for all catch basins constructed as part of road improvements or new road construction. Gutter spread shall not exceed ½ the travel-way in either direction. Calculations shall be in accordance with the methods and criteria established in Section 11.9 of the CTDOT Drainage Manual.

4.3 Manholes

Manholes shall be provided where storm sewer pipe sizes change, two or more drains converge, or a change in horizontal or vertical alignment of a conduit is required. Manholes shall comply with the following requirements:

- Maximum manhole spacing shall not exceed 300 feet.
- Manholes shall conform to the City of Stamford Standard Detail and be provided with benches/inverts.
- Manhole sizing shall conform to the following criteria from Section 11.10 of the CTDOT Drainage Manual:
    - Minimum manhole diameter is 48 inches.
    - A 60-inch diameter manhole shall be provided when storm drainage pipes are greater than 30 inches in diameter, but less than or equal to 42 inches in diameter.
    - A 72-inch diameter manhole shall be provided when storm drainage pipes are greater than 42 inches in diameter, but less than or equal to 54 inches in diameter.
    - When storm drainage pipe diameter is greater than 54 inches, a specially designed junction box shall be provided.
    - Manholes must be large enough to accommodate all pipes while maintaining adequate separation between pipes.
- Manhole steps shall be provided in manholes with a depth of 3 feet or greater and shall not be in conflict with piping.
- Any connection to the City drainage system shall be by a manhole.
- Junction boxes may be used on private residential properties.

4.4 Storm Sewers

Conveyance systems must be analyzed, evaluated, designed, and constructed to accommodate existing upstream and off-site runoff onto the site in addition to on-site improvements. Drainage pipe design and analysis shall be in accordance with the following requirements and consistent with the Connecticut Department of Transportation Drainage Manual:

- Pipes shall be designed with a minimum self-cleansing velocity of 2.5 feet per second, and a maximum velocity not to exceed 15 feet per second.
- Storm drains shall be designed as open channels, where there is a free water surface (just full or less than full), or for pressure or pipe flow under surcharged conditions. The design shall account for backwater effects and all energy losses in the system. A hydraulic analysis shall be performed to determine whether the pipe will operate as an open channel or as a pressure system. Backwater calculations shall be made for each run of pipe. Friction losses and form losses due to manholes, bends, enlargements, and transitions, shall be calculated.
- Only circular pipes of 12 inches or greater diameter shall be used within the City Right of Way per CTDOT Drainage Manual Section 11.11.
- Provide a minimum of 24 inches of cover over drainage pipes. Less than 24 inches of cover is permitted on private properties provided the drainage piping is certified by its manufacturer for the proposed depth of fill above the pipe and anticipated loading.
- Where storm sewers cross sanitary sewers, water mains, gas mains or other utilities, minimum clearance shall be 12 inches per CTDOT Drainage Manual Section 11.11. If 12 inches of clearance cannot be provided, special provisions shall be taken to protect pipes in accordance with the requirements of the utility company and subject to approval by the Engineering Bureau.
- Direct or pressure connections to the City drainage system are prohibited.

- Drainage pipes shall be installed in straight alignments, both horizontally and vertically, with manholes providing access at all angles points and junctions of two or more drainage pipes.
- Horizontal bends may be permitted on private residential properties provided they do not exceed 45 degrees and include appropriate cleanouts.

4.5 Culverts

Culverts shall be designed to convey discharges resulting from design storm frequencies specified in Section 3.2 and following design procedures contained in Chapter 8 of the Connecticut Department of Transportation Drainage Manual.

The water surface used at the inlet of the culvert to determine culvert size shall be based upon the allowable headwater (AHW), allowing for at least one foot of freeboard per CTDOT Drainage Manual Section 8.3.3, unless otherwise approved by the Engineering Bureau. AHW is one of the critical elements of culvert design and must be considered and clearly documented in the design computations.

Where a culvert is proposed downstream of an existing or proposed detention basin, the culvert sizing shall assume that zero upstream storage exists; i.e., the culvert is designed as if the stormwater detention facility did not exist.

The locations and alignment of culverts shall be consistent with the flow tendency of existing streams. New culverts or replacement culverts over streams shall comply with the CTDEEP Stream Crossing Guidelines (as amended) to accommodate high flows, minimize erosion, and support aquatic habitat.

Where successive culverts are utilized and the flow in the upper culverts is affected by headwaters in the lower culverts, a water surface profile and appropriate computations shall be submitted for review.

The effects of tidal action shall be investigated to ensure that scour or erosion resulting from high velocities due to the movement of the tidal prism will not endanger the structure, roadway, or adjacent property.

Scour protection shall be provided in accordance with Section 11.13 of the Connecticut Department of Transportation Drainage Manual.

4.6 Drainage Channels

Channels shall be designed with a section and grade that will carry the design discharge, in its flattest section, under the controlling conditions, providing freeboard as needed, and with channel lining protection to prevent erosion. The channels described in this section are intended to primarily function as conveyance systems, as opposed to water quality swales which serve as both conveyance and water quality treatment. Channels shall be designed for the storm frequencies identified in Section 3.2 and following procedures set forth in Sections 7.3 and 7.6 of the Connecticut Department of Transportation Drainage Manual. The following criteria apply to local drainage channels:

- Channel side slopes shall not exceed the angle of repose of the soil and/or lining and shall be 1V:2H or flatter in the case of rock-riprap lining and 1V:3H in the case of vegetative lining.

- The use of flexible linings (grass, other vegetation, riprap, keyed riprap, and gabions) is preferred over rigid linings such as riprap revetments. Flexible linings shall be designed according to the method of allowable tractive force. Preference shall be given to vegetation-lined channels where possible.
- The use of impervious linings (concrete, asphalt, etc.) is discouraged except for very high velocity flow and steep slopes.
- The design discharge for permanent roadside ditch linings shall have a 10-year frequency while temporary linings shall be designed for the 2-year frequency flow.
- Channel freeboard shall be a minimum of 1 foot or two velocity heads, whichever is larger. Freeboard allowances shall be provided in proportion to the potential damages that could occur in the event of overtopping.
- Where velocities in swales, ditches or channels exceed 5 fps, riprap or other protective treatment must be installed to prevent erosion.

4.7 Outlets

Runoff from proposed development sites shall utilize existing outlets to the maximum extent practicable, unless it is demonstrated that using the existing outlet would exacerbate downstream flooding or result in adverse impacts to downstream properties. Outlets shall be located such that they do not adversely affect adjacent properties or structures, and shall discharge to a natural or manmade drainage system with adequate capacity to convey the anticipated flow without causing erosion. If no direct discharge is achievable, the outlet shall be set a minimum of 10 feet from any property line, and a level spreader or other device shall be provided to distribute concentrated flow.

All outlets shall be designed to prevent erosion. The most commonly used devices for outlet protection are riprap lined aprons and preformed scour holes. In most cases, a riprap apron or preformed scour hole will provide adequate outlet protection. However where design and site conditions warrant, structurally lined outlet protection or energy dissipators may be required including check dams, drop structures, baffles, and stilling basins.

The need for trash racks shall be established based upon field conditions. If used, they shall be designed to allow for overflow when clogged. Trash racks at entrances to pipes and conduits shall be sloped between 3H:1V and 5H:1V to allow trash to slide up the rack with flow pressure and rising water level – the slower the approach of flow, the flatter the trash rack angle.

Design of storm drainage outlet protection shall be in accordance with Section 11.13 of the Connecticut Department of Transportation Drainage Manual. Energy dissipators shall be designed in accordance with FHWA, Hydraulic Engineering Circular No. 14, Hydraulic Design of Energy Dissipators for Culverts and Channels.

4.8 Footing/Underdrains

Should the project proponent determine that footing drains, underdrains, or other dewatering systems are necessary to manage groundwater, the project proponent shall retain the services of a Connecticut professional engineer experienced in groundwater hydrology to provide a design to relieve the hydrostatic pressures induced on the foundation walls and floor slabs. The discharge of any groundwater collection system shall be by gravity, whenever possible, and consideration shall be given to the elevation of the lower slab so as to avoid pumping of collected groundwater whenever possible.

The engineer by design shall control the discharge of groundwater such that there would be no adverse impacts on adjacent properties or local drainage patterns, and when necessary, shall utilize subsurface infiltration systems and level spreaders, when there is no opportunity to discharge into public drainage systems, watercourses, lakes, streams, or wetland systems.

When such opportunities do not exist, the engineer shall design other means to control the discharge of groundwater. The engineer shall quantify the amount of groundwater to be diverted and design a system that would infiltrate or dispose of groundwater such that there would be no adverse impacts on local drainage patterns or adjacent properties. The infiltration system shall be appropriately sized as determined by the professional engineer with expertise in this field. Should the system fail, create damage, hazard, nuisance or result in other adverse conditions to adjacent or downstream properties or the City infrastructure, re-evaluation and additional storage may be required. The City of Stamford Engineering Bureau accepts no responsibility for the failure of such proposed and implemented design.

4.9 Miscellaneous

The discharge of roof drains, sump pumps, or footing drains shall not be directed onto sidewalks, roadways, or towards adjacent properties.

- Refer to *Stamford, Connecticut – Code of Ordinances | CHAPTER 201. – REGULATION OF MUNICIPAL SEPARATE STORM SEWER SYSTEM ("MS4")*.
- Refer to *Stamford, Connecticut – Code of Ordinances / CHAPTER 214-9. – Discharge of drainwater upon sidewalks and roadways*.

Vegetated embankments shall be no steeper than 3:1 (horizontal to vertical). Riprap protected embankments shall be no steeper than 2:1 (horizontal to vertical).

Floor drains serving covered parking areas must discharge to the sanitary sewer via an oil separator; additional approval may be required by the WPCA. Roof drains of parking garages must discharge to the storm sewer after treatment by an oil/grit separator.

4.10 Bridges

The hydraulic design of bridges shall be in accordance with Section 9 of the Connecticut Department of Transportation Drainage Manual.

4.11 Storage Facilities

Storage facilities are primarily designed to reduce peak flows and are classified as detention or retention facilities. Detention facilities are those that are designed to reduce the peak discharge and only detain runoff for a short period of time. These facilities are designed to completely drain after the design storm has passed. Examples of stormwater management practices that can serve as detention facilities include surface basins; vegetated swales; subsurface chambers, pipes or reservoirs that discharge to a surface water or drainage system; and infiltration facilities. Retention facilities are designed to contain a permanent pool of water. Stormwater is temporarily stored above the normal water surface elevation during and immediately after runoff events. Examples of retention facilities include ponds, wetlands, galleries, and other underground storage. Storage facilities shall comply with the following requirements, and detailed procedures for the design of

stormwater detention and retention facilities are described in Chapter 10 of the Connecticut Department of Transportation Drainage Manual.

- Storage facilities must be set a minimum of 12 inches above ledge or seasonal high groundwater regardless of the use of a water-tight liner or system.
- Minimum freeboard of a storage facility is 12 inches (does not apply to subsurface infiltration systems). The Engineering Bureau may require additional freeboard depending on the type and location of the storage facility.
- Storage facilities shall observe the following setback requirements:
    - Minimum 10 foot separation from any structure including retaining walls
    - Minimum 10 foot separation from any property line
    - Minimum 25 foot separation from any footing drain, wall drain, or under-drain system
    - Refer to the Health Code for separation distance from wells and septic systems
- Access shall be provided to each part of the facility (e.g., sediment forebay, outlet structure).
- An emergency outlet shall be provided for all storage facilities. Emergency outlets shall be sized to safely convey the 100-year, 24-hour storm without causing significant erosion or damage to the downstream drainage system or properties beyond the erosion or damage that would occur during a similar storm event under pre-development conditions.
- High overflow/discharge point shall have a minimum 10 foot separation from any property line.
- Applicants shall assume a 40% void ratio for crushed stone.

When detention is proposed, a downstream hydrologic analysis may be required by the Engineering Bureau to determine whether peak flows, velocities, and hydraulic effects are attenuated by controlling the 1-year, 2-year, 5-year, 10-year, and 25-year, 24-hour design storms. Analysis of larger design storms may be required by the Engineering Bureau for large developments and special or sensitive situations. This analysis must be performed at the outlet(s) of the site and at critical downstream locations (stream confluences, culverts, other channel constrictions, and flood-prone areas) to a confluence point where the site drainage area represents 10% of the total drainage area above that point (see CTDEEP Stormwater Quality Manual, Chapter 7, Section 6.5).

4.12 Erosion and Sediment Control

All projects requiring approval from the Engineering Bureau shall include methods to minimize the harmful effects of soil erosion and sedimentation during construction. The proposed sedimentation and erosion control measures shall be included with the Stormwater Management Plan (see Section 6). Erosion and sedimentation control measures shall be designed in accordance with the 2002 Connecticut Guidelines for Soil Erosion and Sediment Control (as amended). All proposed developments, regardless of the area of proposed disturbance, must implement erosion and sedimentation controls prior to and throughout the duration of construction. Refer to Section 15B of the Stamford Zoning Regulations for additional soil erosion and sediment control regulations.

5 Stormwater Treatment Practices

5.1 Introduction

Stormwater treatment practices (also referred to as stormwater Best Management Practices or BMPs) are designed to collect, store, treat, and in some cases infiltrate, stormwater runoff generated from a site. Structural practices are typically used together with non-structural practices and Low Impact Development techniques to meet multiple objectives such as reducing runoff volume and peak flows and capturing/treating runoff.

5.2 Non-Structural Practices

Non-structural practices are pollution control techniques and approaches that manage stormwater at its source and do not require installation or construction of a facility or device. These practices focus on preserving open space, protecting natural systems, and incorporating existing site features into the development to manage stormwater. Non-structural practices are more effective when considered early in the design process and can reduce the need for structural practices for managing stormwater runoff. Typical non-structural practices include:

- Limiting clearing and grading
- Preserving natural areas
- Protecting riparian buffers
- Minimizing soil compaction
- Avoiding disturbance of steep slopes
- Reducing impervious surfaces
- Disconnecting stormwater and directing to vegetated areas for infiltration

Design guidance for non-structural practices can be found in the CTDEEP Low Impact Development Appendix to the Connecticut Stormwater Quality Manual.

5.3 Structural Practices

Structural stormwater BMPs can be divided into several basic classes according to the function(s) that each BMP serves including pretreatment, treatment, conveyance, infiltration, and other functions.

Pretreatment BMPs

As the first BMPs in a treatment train, pretreatment BMPs typically remove the coarse sediments that can clog other BMPs. Maintenance removal of sediment is especially critical for pretreatment BMPs, because they receive stormwater containing the highest concentrations of suspended solids. The most common pretreatment BMPs include:

- Deep sump catch basins with outlet protection
- Oil grit separators
- Proprietary devices
- Sediment forebays
- Vegetated filter strips

Pretreatment BMPs can be configured as on-line or off-line devices. On-line systems are designed to treat the entire water quality volume and safely convey larger flows. Off-line practices are typically designed to receive a specified discharge rate or volume, such as the water quality flow or water quality volume. A flow diversion structure or flow splitter is used to divert the design flow to the off-line practice. To receive pollutant removal credit, oil grit separators and deep sump catch basins with outlet protection must be configured as off-line devices.

Treatment BMPs

The major types of treatment BMPs include:

- Filtration BMPs: Filtration systems use media to remove particulates from runoff. They are typically used when circumstances limit the use of other types of BMPs, such as where space is limited– particularly in a highly urbanized setting or when it is necessary to capture particular industrial or commercial pollutants (e.g., hydrocarbons). In these circumstances, other BMPs might be cost-prohibitive or not as effective. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil. Filtration BMPs include:
    - Filtering bioretention systems, including, rain gardens, tree filters, stormwater planters, and curb extensions (LID BMPs)
    - Proprietary media filters
    - Sand filters/organic filters

- Stormwater Treatment Basins: These BMPs provide peak rate attenuation by detaining stormwater and provide pollutant removal by settling out suspended solids. The basins that are most effective at removing pollutants have either a permanent pool of water or a combination of a permanent pool and extended detention, and some elements of a shallow marsh. Common stormwater treatment basins include:
    - Extended dry detention basins
    - Wet basins

- Constructed Wetlands: Constructed stormwater wetlands are designed to maximize the removal of pollutants from stormwater runoff through wetland vegetation uptake, retention and settling. Gravel wetlands remove pollutants by filtering stormwater through a gravel substrate. Common constructed wetlands include:
    - Constructed stormwater wetland
    - Gravel wetland

Conveyance BMPs

These BMPs collect and transport stormwater to other BMPs for treatment and/or infiltration. These practices may also treat runoff through infiltration, filtration, or temporary storage. A water quality swale usually functions as a runoff conveyance channel and a filtration practice. The vegetation or turf also prevents erosion, filters sediment, and provides some nutrient uptake. Conveyance BMPs include:

- Grass channels
- Wet and dry water quality swales

Infiltration BMPs

Infiltration systems are designed primarily to reduce the quantity of stormwater runoff (as well as pollutants carried in the runoff) from a site and provide groundwater recharge. Infiltration techniques reduce runoff volume and direct the water back into the ground. Infiltration BMPs include:

- Bioretention systems, including, rain gardens, tree filters, stormwater planters, and curb extensions specifically designed for infiltration
- Infiltration systems when designed as decentralized, small-scale practices distributed throughout the site, which typically include dry wells and smaller subsurface infiltration units
- Infiltration systems when designed as larger centralized or end-of-pipe systems, which typically include infiltration basins, infiltration trenches, and larger subsurface infiltration units

Other BMPs and Accessories

Structural BMPs that do not fit into any of the categories above include:

- Green roofs
- Permeable pavement (permeable pavement is considered as an impervious surface for hydrological calculations)
- Dry detention basins
- Open cell pavers (value of CN 85 for hydrological calculations)

BMP accessories are devices that enable BMPs to operate as designed. Common BMP accessories include the following:

- Check dams
- Level spreaders
- Outlet structures

5.4 Proprietary Stormwater BMPs

Proprietary stormwater BMPs are manufactured systems that use proprietary settling, filtration, absorption/adsorption, vortex principles, vegetation, and other processes to remove pollutants from stormwater runoff. The most common types of proprietary BMPs include hydrodynamic separators, filtration systems, wet vaults, and catch basin inserts. Underground storage and infiltration systems are not considered proprietary BMPs since treatment typically occurs in the soil below the structure, not in the structure itself.

Other states, such as New York, New Jersey, and Massachusetts, have verified proprietary stormwater BMPs based upon accepted stormwater BMP performance monitoring protocols including the Technology Acceptance Reciprocity Partnership (TARP), the New Jersey Corporation for Advanced Technology protocol, the Massachusetts Stormwater Technologies Clearinghouse, EPA's Environmental Technology Verification (ETV) program, and the State of Washington Department of Ecology Technology Assessment Protocol – Ecology (TAPE).

If an applicant proposes to include a proprietary BMP as a component of the stormwater management system, the applicant shall demonstrate that the proprietary BMP has been reviewed, approved, and has a TSS removal efficiency of at least 80% as verified by one of the states or programs listed above.

The Engineering Bureau shall presume that a proprietary stormwater BMP achieves the assigned TSS removal efficiency provided the conditions under which it is proposed to be used are similar to those in the performance testing. Key considerations in making this evaluation include:

- Design flow rate or runoff volume
- Particle size distribution
- Pollutant loading
- On-line versus off-line configuration
- Tailwater effects
- Maintenance

5.5 Designing Infiltration BMPs

The following requirements shall apply to the design of stormwater infiltration BMPs, in addition to the design requirements referenced in *Appendix B* of this manual. Stormwater infiltration BMPs include dry wells, infiltration basins, infiltration chambers and galleys, infiltration trenches, permeable pavement, and bioretention systems (including rain gardens, tree filters, stormwater planters, and curb extensions) when specifically designed for infiltration.

- **Required Infiltration Rate:** Native soils shall have a minimum field infiltration rate of 0.2 inches per hour at the actual location and soil layer where infiltration is proposed. Stormwater infiltration shall not be sited in soils with field infiltration rates lower than 0.2 inches/hour due to the potential for failure. For filtering practices such as bioretention, no minimum infiltration rate is required if the system is designed with an underdrain.
- **Soil Evaluation:** Qualified Professionals[1] shall conduct an evaluation of on-site soils when designing stormwater infiltration systems.
    - Hydrologic Soil Group A, B Soils: The evaluation shall consist of test pits or borings below the proposed infiltration system to perform soil textural analysis (using NRCS methods), determine depth to seasonal high groundwater, and determine depth to bedrock as outlined in Section 5.6 of this manual.
    - Hydrologic Soil Group C, D Soils: The evaluation shall consist of field infiltration testing (Turf-tec infiltrometer, Borehole filtration, or other equivalent methods approved by the Engineering Bureau) as outlined in Section 5.6 of this manual.
- **Infiltration in Fill Materials:** When fill materials are present or are added prior to construction of the system, a soil textural analysis shall be conducted in both the fill material and the underlying native material below the fill layer. Stormwater infiltration is not permitted through fill materials composed of asphalt, brick, concrete, construction debris, and materials classified as solid or hazardous waste. Alternatively, the debris or waste may be removed in accordance with applicable State solid waste regulations and replaced with clean material suitable for infiltration.

[1] A qualified professional is an individual with demonstrated expertise in soil science, including, but not limited to, a Certified Soil Scientist, Connecticut Registered Professional Engineer, Engineer in Training (EIT certificate) with a concentration in civil, sanitary or environmental engineering, or Bachelor of Arts or Sciences degree or more advanced degree in Soil Science, Geology, or Groundwater Hydrology from an accredited college or university.

- **Maximum Draining Time:** Infiltration practices must be designed to completely drain the design volume within 72 hours after the end of the storm event.
- **Pretreatment:** Pretreatment is recommended prior to discharge to most stormwater infiltration BMPs. For some practices in highly urbanized settings, pretreatment may be economically or physically impractical due to insufficient space, insufficient grades, or utility conflicts, thereby preventing the use of otherwise effective treatment techniques. In these instances, a larger LID BMP system or a more intensive maintenance schedule may be used in lieu of pretreatment, if allowed by the Engineering Bureau. This flexibility also applies to pretreatment requirements in other sections of this manual for practices at constrained sites.
- **Separation:** There must be at least a 12-inch separation distance from the bottom of the infiltration structure to mottling, seasonal high groundwater or bedrock/ledge (this separation requirement may be waived or reduced by the Engineering Bureau on a case-by-case basis). A 3-foot separation distance is required from the bottom of the infiltration structure to seasonal high groundwater for land uses with higher potential pollutant loads (high load areas – see Table 7.5 in the Connecticut Stormwater Quantity Manual).
- Infiltration of stormwater may be prohibited or subject to additional pretreatment requirements and/or separation distance, at the discretion of the Engineering Bureau, for the following cases:
    - High load areas
    - Areas with soil or groundwater contamination such as brownfield sites
    - Public drinking water aquifer recharge areas, wellhead protection areas, or water supply intake protection areas

Infiltration BMPs shall be designed utilizing the "Static Method", as discussed below, unless an alternative method is approved by the Engineering Bureau.

- Assume the entire required design volume is discharged to the infiltration system before infiltration begins.
- Size the volume of the infiltration system to hold the required design volume. Exfiltration shall **not** be considered in sizing or modeling infiltration BMPs.
- Confirm that the bottom of the infiltration system is large enough to ensure that the system will completely drain in 72 hours or less.
    - Drawdown analysis shall be based on 50% of the average field verified saturated hydraulic conductivity (HSG C or D soils) or default (Rawls) infiltration rate (HSG A or B soils, Table 5-1).
    - The infiltration rate shall be assumed to be constant for the purpose of the drawdown analysis.
    - Only the bottom surface area shall be considered. No credit shall be afforded to sidewall exfiltration.
    - If the drawdown analysis indicates the entire volume cannot be drawn down within 72 hours, the bottom area of the infiltration BMP must be increased or the proposed treatment volume of the system must be reduced.

5.6 Soil Evaluation

When designing infiltration BMPs, a soil evaluation must be performed to verify that the anticipated infiltration rate meets or exceeds the minimum required infiltration rate and to identify the Hydrologic Soil Group (HSG) soils using classifications methodologies developed by the U.S. Natural Resources Conservation Service (NRCS).

The applicant shall prepare a plan of the site clearly delineating the Hydrologic Soil Groups throughout the entire site and the specific point(s) where infiltration is proposed. Deviations from the NRCS Soil Surveys and special conditions discovered during additional investigations (relative to infiltration potential) shall be noted on the plan and described. The plan shall identify the locations of all borings, test pits, and infiltration tests, including the location of any known prior tests. Test pit or boring logs shall be provided with the plan, identifying in cross section the soil types, seasonal high groundwater elevation, depth to bedrock and other restrictive layers, and other appropriate information. Infiltration test results/logs shall also be included.

Hydrologic Soil Group A, B Soils

Design infiltration rates may be determined from the results of a NRCS soil textural analysis and associated default infiltration rates (see *Table 5-1*). The slowest of the Hydrologic Soil Groups determined to exist at the point where infiltration is proposed shall be used.

- Example: Samples are taken at a proposed infiltration system in the actual soil layer where infiltration is proposed. One sample indicates sandy soils. The second sample indicates a sandy loam soil. The default infiltration rate used for the design analysis must use the sandy loam rate and not the sandy soil rate. Soils must not be composited for purposes of the soil textural analysis.

Test Pits/Borings

- Perform test pits or soil borings to a minimum depth of 2 feet below the proposed bottom of the infiltration system.
- Excavate test pits or install encased soil borings at a frequency of 1 test pit or boring per 500 square feet of infiltration area, but no fewer than 2 test pits or borings per location where infiltration is proposed. Test pit/soil boring stakes are to be left in the field for inspection purposes and survey, and shall be clearly labeled as such.
- Test pits should be of adequate size, depth, and construction to allow a person to enter and exit the pit and complete a soil profile description.
- If borings are drilled, continuous soil borings should be taken using a bucket auger, probe, split-spoon sampler, or Shelby tube. Samples should have a minimum 2-inch diameter.
- Determine depth to seasonal high groundwater (if within 2 feet of the proposed bottom of the infiltration system). Depth to seasonal high groundwater may be identified based on redoximorphic features in the soil. When redoximorphic features are not available, installation of temporary push point wells or piezometers should be considered. Ideally, such wells should be monitored in the spring when groundwater is highest and results compared to nearby groundwater wells monitored by the USGS to estimate whether regional groundwater is below normal, normal or above normal.
- Determine depth to bedrock (if within 2 feet of the proposed bottom of the infiltration system).

NRCS Soil Textural Analysis

- A NRCS soil textural analysis is performed using test pits or soil borings. The soil textural analysis shall be completed using standard USDA soil physical analyses (Black, et. al., 1965), i.e., particle size analyses. Classification of soil texture shall be consistent with the USDA Textural Triangle.
- Soil texture represents the relative composition of sand, silt and clay in soil. Soil texture is determined using procedures described in the USDA, 2007, National Soil Survey Handbook, Section 618.67 (Texture Class, Texture Modifier, and Terms Used in Lieu of Texture). See https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054240#618.
- Soils must not be composited from one test pit or bore hole with soils from another test pit or bore hole for purposes of the textural analysis. The NRCS also has online tools to assist in the soil texture analysis, once the relative proportions of sand, silt, and clay have been determined (see https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167).

Default (Rawls) Infiltration Rates

Table 5-1. Default Infiltration Rates for HSG A and B Soils

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches/Hour)
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	Field Testing Required
Sandy Clay Loam	C	Field Testing Required
Clay Loam	D	Field Testing Required
Silty Clay Loam	D	Field Testing Required
Sandy Clay	D	Field Testing Required
Silty Clay	D	Field Testing Required
Clay	D	Field Testing Required

Source: Rawls, Brakensiek and Saxton, 1982.

Hydrologic Soil Group C, D Soils

Field infiltration testing is required for all stormwater infiltration systems proposed in Hydrologic Soil Group C or D Soils. Acceptable test methods include:

- Turf-tec infiltrometer method (see *Appendix C*)
- Borehole infiltration test (see *Appendix C*)
- Other equivalent methods approved by the Engineering Bureau

Septic percolation testing is not an acceptable test for estimating saturated hydraulic conductivity.

Infiltration testing shall be performed within the footprint and below the bottom of the proposed infiltration system. Infiltration testing shall be performed at a frequency of 1 test per 500 square feet of infiltration area, but no fewer than 2 tests per location where infiltration is proposed.

- The slowest of the field-measured infiltration rates determined to exist at the point where infiltration is proposed (reduced by a factor of 2) shall be used for design.

5.7 BMP Selection Criteria

The Connecticut Stormwater Quality Manual provides information on the selection of structural stormwater management practices for a particular site. The primary factors to consider in the selection of an appropriate system of stormwater BMPs include:

- Land use
- Physical/site feasibility
- Downstream resources
- Maintenance factors
- Winter operation

The Connecticut Stormwater Quality Manual describes how each of these factors affects the selection of stormwater BMPs, including a series of tables that summarize the selection criteria for each type of stormwater BMP.

5.8 Design Guidance for Stormwater BMPs

This manual does not attempt to duplicate the extensive guidance that is available in other existing design manuals including the Connecticut Stormwater Quality Manual and stormwater manuals of other jurisdictions. Because stormwater management is an evolving field, existing stormwater management practices are being refined and new practices are being developed on a regular basis. *Appendix B* of this manual contains a summary of recommended references for the selection, design, construction, and maintenance of structural stormwater BMPs (including Low Impact Development or LID practices). The list of recommended design references in *Appendix B* may be updated by the City as necessary to reflect new developments and trends in stormwater management. Additionally, the design references in *Appendix B* may contain information, guidance, or requirements that conflict with information, guidance, or requirements specified in the City of Stamford Stormwater Drainage Manual. In these instances, the information, guidance, or requirements specified in the City of Stamford Drainage Manual shall apply.

6 Submittal Requirements

All projects subject to the stormwater management Standards in Section 2.4 of this manual shall submit a Stormwater Management Report to the Engineering Bureau for review and approval. In addition, the applicant shall obtain approval from the Engineering Bureau for any revisions to the approved construction plans prior to proceeding with the work. The Engineering Bureau shall determine if the revisions are substantial and may require the applicant to update and resubmit the Stormwater Management Report and construction plans for approval prior to proceeding with the work.

The Stormwater Management Report must demonstrate how the project conforms to the standards and design requirements contained in this manual. The Stormwater Management Report must be a stand-alone document. References or assumptions made based on previously submitted documents must be included via appropriate excerpts, pages, tables, or maps.

The level of detail required for a Stormwater Management Report submission varies with the project type, scope, location, and whether stormwater management Standard 1 applies. Projects that are not required to comply with Standard 1: Runoff and Pollutant Reduction may submit a "Lite" Stormwater Management Report in accordance with Section 6.1. Any project required to comply with Standard 1: Runoff and Pollutant Reduction shall submit a "Full" Stormwater Management Report in accordance with the additional requirements outlined in Section 6.2.

The following sections outline the minimum requirements for a Stormwater Management Report. This information is provided to aid the design engineer or applicant in preparing a Stormwater Management Report and to help the Engineering Bureau and other reviewers evaluate the adequacy of submittals.

More detailed requirements for Stormwater Management Reports are contained in the checklists provided in *Appendix D*. All items listed in the checklists shall be provided in the Stormwater Management Report unless otherwise noted. The applicant must provide a brief explanation when information for a checklist item is not provided.

6.1 "Lite" Stormwater Management Report

The "Lite" Stormwater Management Report shall be submitted for projects that are not required to comply with Standard 1: Runoff and Pollutant Reduction. The report shall consist of information needed to demonstrate compliance with all of the applicable standards and design requirements contained in this manual. The report shall have the following elements unless waived by the Engineering Bureau.

I. Stormwater Management Report

- A. Applicant / Site Information
- B. Project Description and Purpose
- C. Existing Conditions Description
- D. Summary of Applicable General Design Criteria
- I. Summary of Compliance with Standards 2, 3, and 4
- J. Summary of Compliance with Applicable Drainage Facility Design Requirements
- K. Signed Certification in Accordance with Standard 5B

II. Supporting Calculations (as appendix to Stormwater Management Report)

- N. Hydrologic and Hydraulic Design Calculations

O. Hydrologic and Hydraulic Model, Existing and Proposed
P. Downstream analysis, where required by the Engineering Bureau

III. Supporting Mapping (as appendix to Stormwater Management Report)
Q. Pre-Development Drainage Area Mapping (11"x17" or 8.5"x11")
R. Post-Development Drainage Area Mapping (11"x17" or 8.5"x11")

IV. DCIA Tracking Worksheet (as appendix to Stormwater Management Report)

6.2 "Full" Stormwater Management Report

The "Full" Stormwater Management Report shall be submitted for projects that are required to comply with Standard 1: Runoff and Pollutant Reduction. The report shall have the following elements unless waived by the Engineering Bureau.

I. Stormwater Management Report
A. Applicant / Site Information
B. Project Description and Purpose
C. Existing Conditions Description
D. Summary of Applicable General Design Criteria
E. Project Type in Accordance with Standard 1 Definitions
F. Summary of LID Site Constraints
G. Summary of Proposed Stormwater Treatment Practices
H. Summary of Compliance with Standard 1
I. Summary of Compliance with Standards 2, 3, and 4
J. Summary of Compliance with Applicable Drainage Facility Design Requirements
K. Signed Certification in Accordance with Standard 5B

II. Supporting Calculations (as appendix to Stormwater Management Report)
L. Water Quality Volume / Water Quality Flow Calculations
M. Stormwater Treatment Practice Sizing Calculations
N. Hydrologic and Hydraulic Design Calculations
O. Hydrologic and Hydraulic Model, Existing and Proposed
P. Downstream analysis, where required by the Engineering Bureau

III. Supporting Mapping (as appendix to Stormwater Management Report)
Q. Pre-Development Drainage Area Mapping (11"x17" or 8.5"x11")
R. Post-Development Drainage Area Mapping (11"x17" or 8.5"x11")

IV. DCIA Tracking Worksheet (as appendix to Stormwater Management Report)

V. Proposed LID Review Map

6.3 Supporting Documentation

The following supporting documentation shall be provided as requested by the Engineering Bureau:

- Information on wetlands (function and values)
- Flood studies

The following supporting documentation shall be provided if the applicant is proposing an infiltration BMP as listed in Section 5.3 of this manual:

- Soil textural analysis (soil maps, borings, and test pits)
- Soil boring and test pit results
- Saturated hydraulic conductivity test results

Other supporting documentation may be requested at the discretion of the Engineering Bureau.

6.4 Erosion and Sediment Control Plan

Land development projects in the City of Stamford shall include methods to minimize the harmful effects of soil erosion and sedimentation during construction as outlined in the Stamford Zoning Regulations. The land development application submittal shall include an Erosion and Sediment Control Plan that indicates the proposed sedimentation and erosion control measures. The Erosion and Sediment Control Plan shall meet the requirements listed in Chapter 3 of the 2002 Connecticut Guidelines for Soil Erosion and Sediment Control, as amended and be submitted on 24" x 36" (minimum) sheets unless otherwise approved. Erosion and Sediment Control Plans shall be signed and sealed by a Professional Engineer licensed in the State of Connecticut. Refer to Section 15.C of the Stamford Zoning Regulations for additional sediment and erosion requirements.

6.5 Certificate of Occupancy

The following documents and signed certifications are required to be submitted for all projects that are subject to the stormwater management Standards in Section 2.4 of this manual prior to the issuance of a Certificate of Occupancy or Completion:

- **Final Improvement Location Survey** – An improvement location survey prepared and submitted by a Connecticut licensed land surveyor, depicting pipe inverts, diameters and sizes, structure inverts, sump inverts, and other information to adequately describe the post-construction stormwater management system. The Final Improvement Location Survey must be submitted on 24" x 36" (minimum) sheets unless otherwise approved and as a georeferenced electronic file certified by a licensed land surveyor.
- **Signed and Stamped Stormwater Management Certification Form** – A certification by a professional engineer licensed in the State of Connecticut stating that the proposed improvements have been implemented in compliance with the approved drawings and in accordance with the City of Stamford Stormwater Drainage Manual and will not adversely impact adjacent or downstream properties or City-owned drainage facilities.[2] (*see Appendix K)*
- **Signed and Certified Directly Connected Impervious Area (DCIA) Tracking Worksheet** – See *Appendix E*.
- **City of Stamford Drainage Maintenance Agreement, (Agreement Covenant)** – See *Appendix G.*

[2] The Engineer's certification shall be based upon periodic site inspections and the review of the final Improvement Location Survey. Reference shall be made to Improvement Location Survey, title, date, and preparer.

Other Certifications requested by the Engineering Bureau may include:

- Wall Certification
- Landscape Certification
- Landscape Maintenance Agreement
- Waiver Covering Storm Sewer Connection
- Waiver Covering Granite Block, Depressed Curb, and Driveway Aprons
- Flood Certification

Final inspection by the City of Stamford Engineering Bureau is required prior to the receipt of a signature endorsing the issuance of a Certificate of Occupancy/Completion and release of surety. Inspection will be performed only after all documents and certifications outlined in the Checklist for Certificate of Occupancy have been received (Appendix D).

6.6 Submittal Checklists

A full checklist for submission requirements can be found in Appendix D. All checklists must be completed and submitted. Checklists include detailed requirements for submission for plans and reports that may not be covered in Section 6 of this manual.

7 References

City of Stamford. (2014). Retrieved June 20, 2018, from City of Stamford: https://www.stamfordct.gov/sites/stamfordct/files/u358/final_draft_12.16.14_0.pdf

CTDEEP. (2002). Retrieved June 20, 2018, from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2720&q=325660&deepNav_GID=1654%20

CTDEEP. (2004). Retrieved June 20, 2018, from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325704

CTDEEP. (2011). Retrieved June 20, 2018, from Connecticut Department of Energy and Environmental Protection: http://www.ct.gov/deep/cwp/view.asp?a=2719&q=459488&deepNav_GID=1654

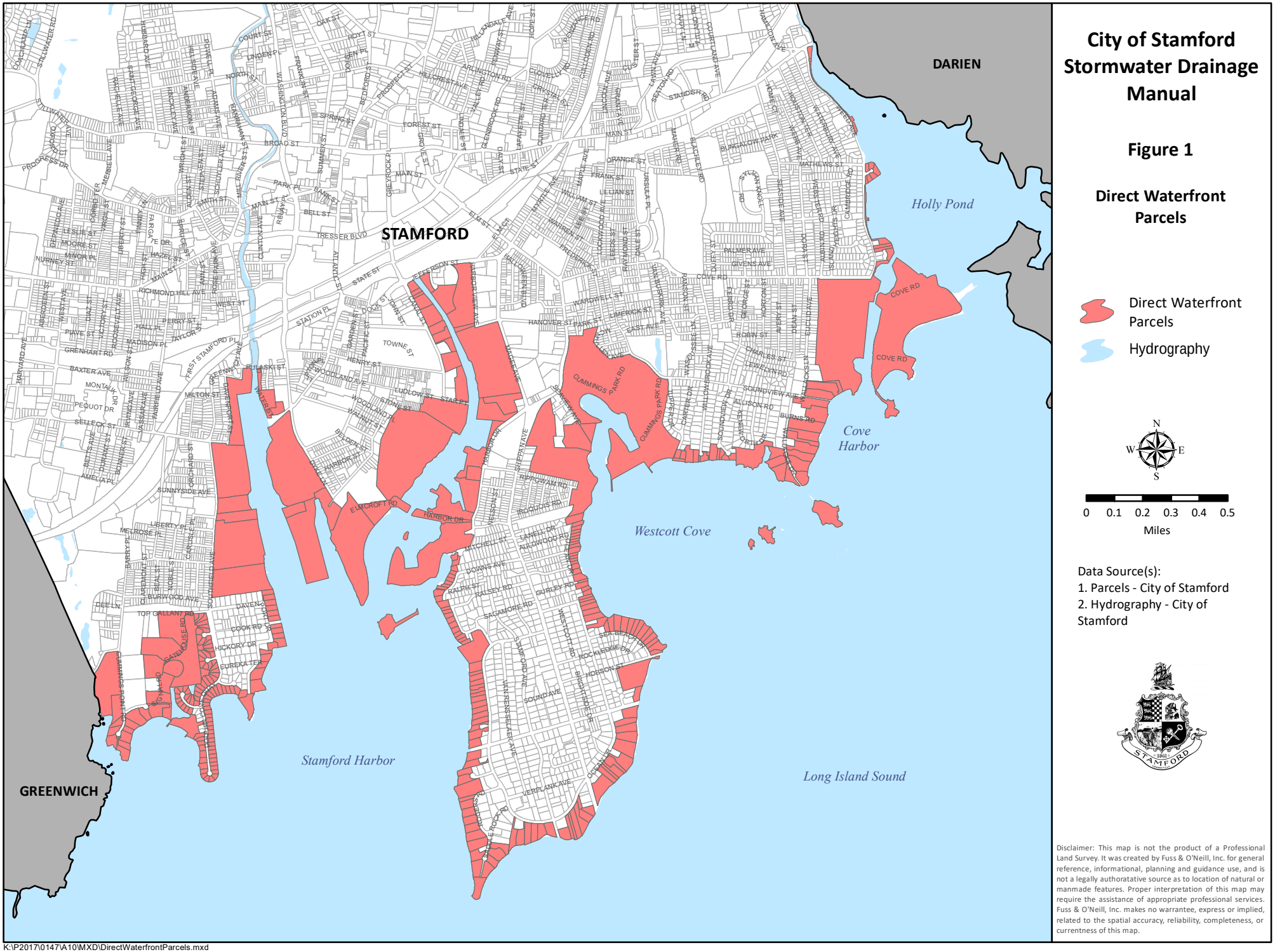
CTDOT. (2000). Retrieved June 20, 2018, from Connecticut Department of Transportation: http://www.ct.gov/dot/cwp/view.asp?a=3200&q=260116

Department of the Army, U. A. (1998). *Engineering and Design Manual - Section EM 110-2-2902 Conduits, Culverts, and Pipes.*

Horsley Witten Group, Inc. (2015). *Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMp Design Considerations in Coastal Communities.* Massachuetts Office of Coastal Zone Management.

Appendix A

Reference Maps



City of Stamford Stormwater Drainage Manual

Figure 1

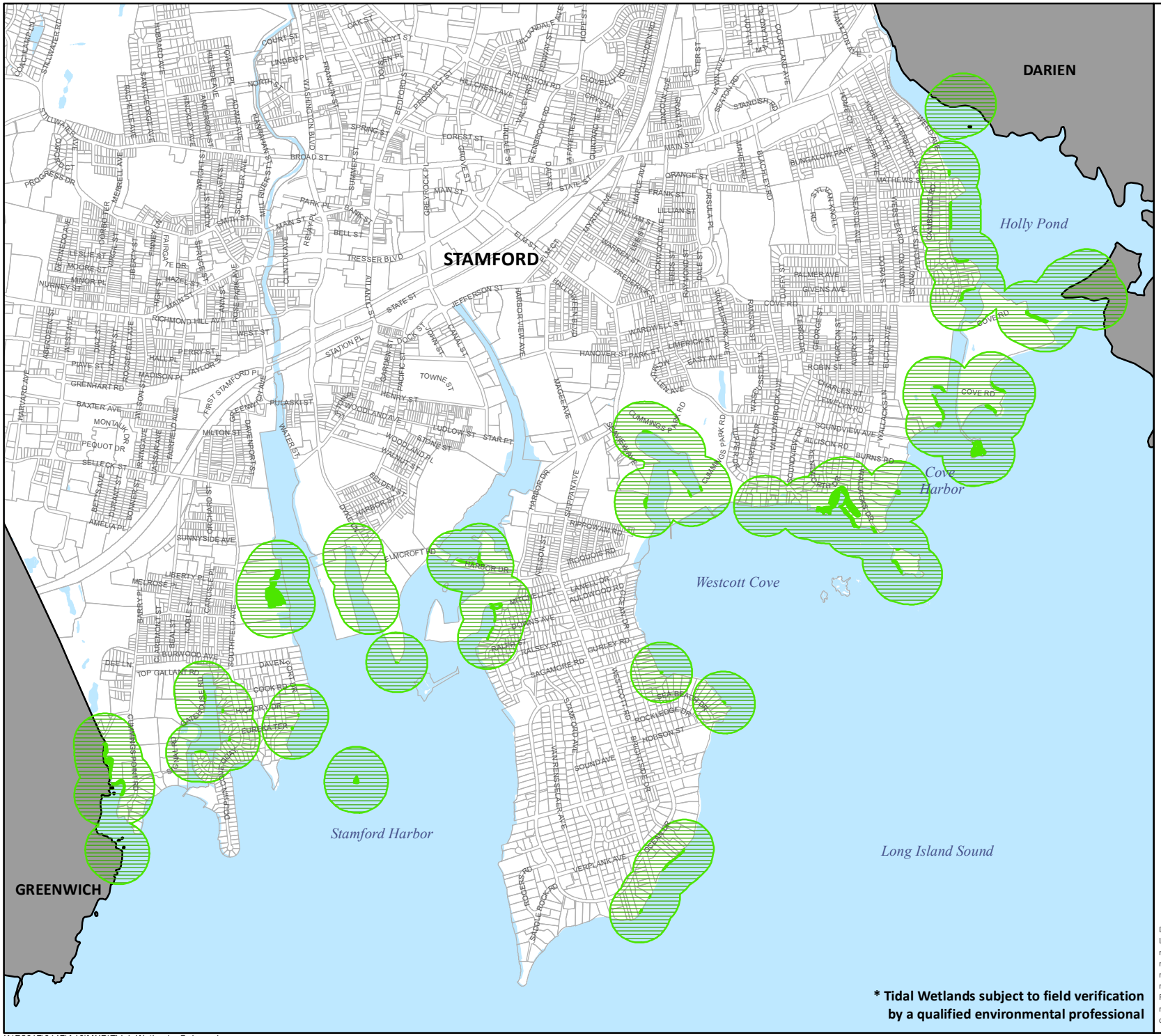
Direct Waterfront Parcels

Direct Waterfront Parcels

Hydrography

Data Source(s):
1. Parcels - City of Stamford
2. Hydrography - City of Stamford

K:\P2017\0147\A10\MXD\DirectWaterfrontParcels.mxd



City of Stamford Stormwater Drainage Manual

Figure 2

Tidal Wetlands *

Tidal Wetlands

500-ft. Buffer to Tidal Wetlands

Hydrography

N
W E
S

0 0.1 0.2 0.3 0.4 0.5
Miles

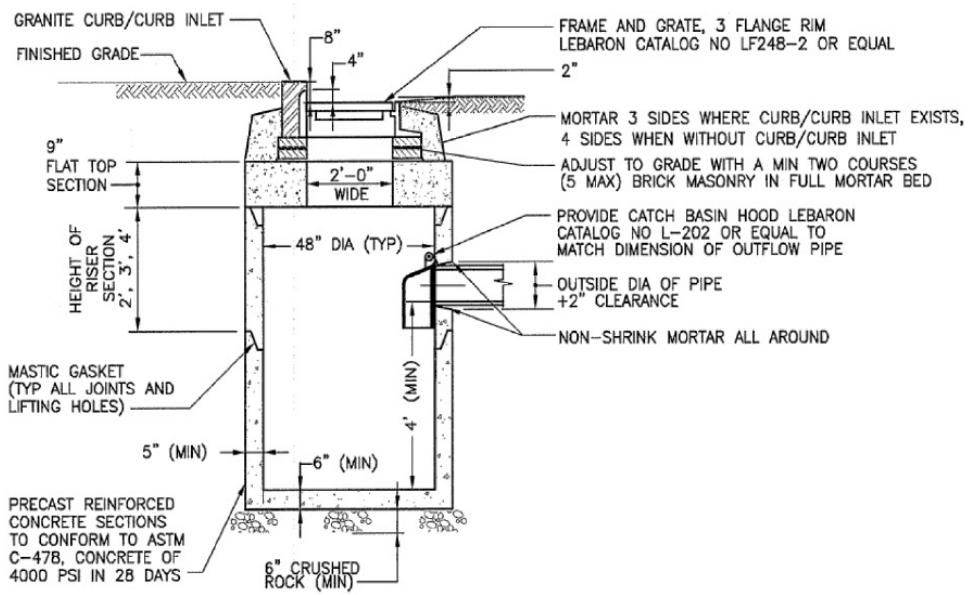
Data Source(s):
1. Tidal Wetlands - CT ECO
2. Parcels - City of Stamford
3. Hydrography - City of Stamford

K:\P2017\0147\A10\MXD\Tidal_Wetlands_Only.mxd

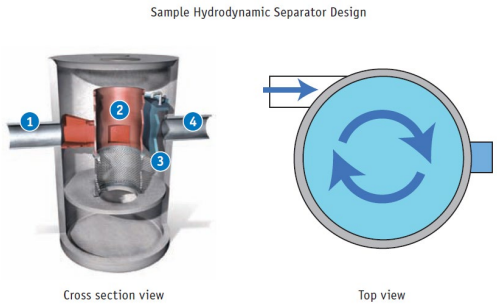
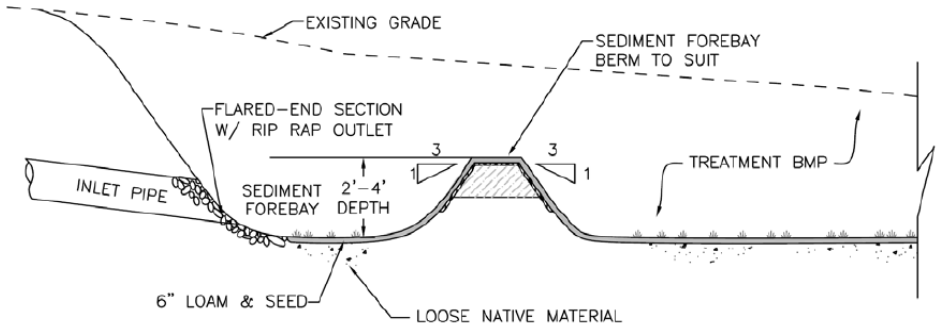
Appendix B

Structural Stormwater BMP Design References

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Pretreatment BMPs	
Deep Sump Catch Basins  Source: RIDEM, 2010	**Primary Reference:** • Connecticut Stormwater Quality Manual **Additional Information Sources:** • Connecticut Department of Transportation Drainage Manual • Rhode Island Stormwater Design and Installation Standards Manual • Vermont Stormwater Treatment Standards
Oil Grit Separator	**Primary Reference:** • Connecticut Stormwater Quality Manual (Oil/Particle Separator) **Additional Information Sources:** • Massachusetts Stormwater Handbook

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Proprietary Separators  Source: UNH Stormwater Center	**Primary Reference:** • Connecticut Stormwater Quality Manual (Innovative/Emerging Technologies) • Section 5.4 of the City of Stamford Drainage Manual for approval criteria • Manufacturer guidance **Additional Information Sources:** • Massachusetts Stormwater Handbook • Rhode Island Stormwater Design and Installation Standards Manual
Sediment Forebays  Source: RIDEM, 2010	**Primary Reference:** • Rhode Island Stormwater Design and Installation Standards Manual **Additional Information Sources:** • Vermont Stormwater Treatment Standards • Connecticut Stormwater Quality Manual • Massachusetts Stormwater Handbook

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Vegetated Filter Strips  Source: Minnesota Stormwater Manual	**Primary Reference:** • Connecticut Stormwater Quality Manual (Vegetated Filter Strips/Level Spreaders) **Additional Information Sources** • Massachusetts Stormwater Handbook • Rhode Island Stormwater Design and Installation Standards Manual • Michigan LID Manual
Treatment BMPs	
Bioretention - Rain Gardens, Tree Filters, Stormwater Planters/Bioswales, and Curb Extensions  Source: Montgomery County Maryland DEP  Source: National Association of City Transportation Officals	**Primary Reference** • Connecticut Stormwater Quality Manual **Additional Information Sources:** • UNH Stormwater Center, Bioretention Soil Specifications • City of New Haven Bioswale Construction Standard Details • Niantic Treewell Detail, Town of East Lyme • Plainville, CT Low Impact Development and Stormwater Management Design Manual • Rhode Island Stormwater Design and Installation Standards Manual • New Hampshire Stormwater Management Manual (Tree Box Filters) • Minnesota Stormwater Manual

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Constructed Stormwater Wetlands	**Primary Reference:** • Rhode Island Stormwater Design and Installation Standards Manual **Additional Information Sources:** • Connecticut Stormwater Quality Manual (Stormwater Wetlands) • New Hampshire Stormwater Management Manual
Gravel Wetlands  Source: UNHSC	**Primary Reference:** • UNH Stormwater Center, Surface Gravel Wetland Design Specifications **Additional Information Sources:** • Vermont Stormwater Treatment Standards • New Hampshire Stormwater Management Manual • Rhode Island Stormwater Design and Installation Standards Manual

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Proprietary Media Filters	**Primary Reference:** • Connecticut Stormwater Quality Manual (Innovative/Emerging Technologies) • Section 5.4 of the City of Stamford Drainage Manual for approval criteria • Manufacturer guidance **Additional Information Sources:** • Massachusetts Stormwater Handbook
Sand/Organic Filters  Source: Chesapeake Stormwater Network	**Primary Reference:** • Connecticut Stormwater Quality Manual (Filtering Practices) **Additional Information Sources:** • Vermont Stormwater Treatment Standards • Massachusetts Stormwater Handbook • New Jersey Stormwater Best Management Practices Manual (Standard for Sand Filters) • Rhode Island Stormwater Design and Installation Standards Manual

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Wet Basins  Source: UNH Stormwater Center	**Primary Reference:** • Connecticut Stormwater Quality Manual (Stormwater Ponds) **Additional Information Sources:** • Massachusetts Stormwater Handbook • Rhode Island Stormwater Design and Installation Standards Manual
Grass Channels	**Primary Reference:** • Connecticut Stormwater Quality Manual (Grass Drainage Channels)
Wet & Dry Water Quality Swales  Source: Low Impact Development Center	**Primary Reference:** • Connecticut Stormwater Quality Manual (Grass Drainage Channels) **Additional Information Sources:** • New Hampshire Stormwater Management Manual (Treatment Swales) • Rhode Island Stormwater Design and Installation Standards Manual

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Infiltration BMPs	
Bioretention - Rain Gardens, Tree Filters, Stormwater Planters/Bioswales, and Curb Extensions (infiltration design)  Source: Bioswale installation in New Haven, GNHWPCA and Fuss & O'Neill, Inc.	**Primary Reference** • Connecticut Stormwater Quality Manual **Additional Information Sources:** • UNH Stormwater Center, Bioretention Soil Specifications • City of New Haven Bioswale Construction Standard Details • Niantic Treewell Detail, Town of East Lyme • Plainville, CT Low Impact Development and Stormwater Management Design Manual • Rhode Island Stormwater Design and Installation Standards Manual • New Hampshire Stormwater Management Manual (Tree Box Filters) • Minnesota Stormwater Manual
Dry Wells	**Primary Reference:** • Connecticut Stormwater Quality Manual (Dry Wells) **Additional Information Sources:** • New Hampshire Stormwater Management Manual (Dry Wells & Infiltration Basins) • Rhode Island Stormwater Design and Installation Standards Manual

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Infiltration Basins & Infiltration Trenches  Source: Minnesota Stormwater Manual	**Primary Reference:** • Connecticut Stormwater Quality Manual (Grass Drainage Channels) **Additional Information Sources:** • New Hampshire Stormwater Management Manual (Dry Wells & Infiltration Basins) • Rhode Island Stormwater Design and Installation Standards Manual
Subsurface Infiltration Systems  Source: CULTEC	**Primary Reference:** • Connecticut Stormwater Quality Manual (Underground Infiltration Systems) **Additional Information Sources:** • Minnesota Stormwater Manual (Infiltration Practices)

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Other BMPs	
Compost-Amended Soils  Source: Michigan LID Manual	**Primary Reference:** • Virginia DCR Stormwater Design Specification No. 4, Soil Compost Amendment, Version 1.7, 2011 **Additional Information Sources:** • Minnesota Stormwater Manual (Compost and stormwater management)

Structural Stormwater BMP Design References

Stormwater BMP	Design References
Rain Barrels and Cisterns   Source: Maria Cahill, Green Girl LDS	**Primary Reference:** • New Hampshire Stormwater Management Manual **Additional Information Sources:** • EPA Soak Up the Rain: Rain Barrels • Massachusetts Stormwater Handbook • Vermont Low Impact Development Guide for Residential and Small Sites
Dry Detention Basins	**Primary Reference:** • Connecticut Stormwater Quality Manual **Additional Information Sources:** • Massachusetts Stormwater Handbook • Rhode Island Stormwater Design and Installation Standards Manual

Appendix C

Infiltration Testing Methods

Appendix C
Infiltration Test Methods for Proposed Stormwater Infiltration Systems

City of Stamford
Stormwater Drainage Manual

1. Turf-Tec Infiltrometer

The following test method is designed to estimate the field saturated hydraulic conductivity (i.e., infiltration rate) of soils below a proposed stormwater infiltration system. This method is adapted from the ASTM 3385 Double Ring Infiltrometer Method using a commercially available device manufactured by Turf-Tec International: https://www.turf-tec.com/IN2lit.html

1. Excavate a test pit to a depth that is at or below the bottom of the soil media or gravel/stone layer of the proposed stormwater infiltration system.
2. Loosen/rake the soil at the bottom of the test pit where the excavator may have compacted or smeared the soil to provide a natural soil interface into which water may infiltrate. Remove the loosened soil from the area where the test will be performed (i.e., the “test area”).
3. Push the Turf-Tec infiltrometer into the soil test area at the bottom of the test pit. Push down on the handle grips while slightly turning the instrument back and forth until the metal plate (Saturn ring) is flush with the soil surface. Do not move the instrument side to side while turning.
4. Fill both the outer and inner rings with clean water until they slightly overflow. This is accomplished easiest by filling the inner ring first and allowing it to spill over and fill the outer ring to the edge. Allow the water inside both rings to completely drain into the soil. Repeat this process two more times, for a total of three fill/drain cycles.
5. Conduct the infiltration test, as follows:
    a. Press the Stop/Reset Button once to reset the timer to read "00 00".
    b. Set the timer for 15 minutes by pressing minutes 15 times until 15:00 is displayed.
    c. Fill both the outer and inner ring with clean water until they slightly overflow.
    d. When the pointer reaches the beginning of the inch scale, start the timer immediately by pressing the start button. As the water seeps into the soil, the plastic ball attached to the tube will measure the water in inches and register it on the scale with the pointer located just below the timer.
    e. At fifteen minutes, the timer will start beeping. Stop the beeper by depressing the stop/reset button on the timer.
    f. Note the position of the pointer on the scale. Record this number on the monitoring record. This scale is in inches. In well-drained soils (where the water level fully drops prior to 15 minutes), stop the timer before the pointer reaches the bottom of the scale. Record the drop in inches and the time in minutes.
    g. Convert the readings to inches per hour.
    h. Repeat the test at least three times until the readings are relatively consistent.
    i. Calculate the average of the observed infiltration rates. The average should be reduced by a factor of 2 to determine the field infiltration rate for design purposes.

6. Remove the instrument from the soil and clean off any residual soil from the instrument rings.

2. Borehole Infiltration Test

The following method is designed to estimate the field saturated hydraulic conductivity (i.e., infiltration rate) of soils below a proposed stormwater infiltration system using a borehole falling head permeability test.

1. Install solid 4-6 inch diameter casing, 30" in length, to 24" below the proposed bottom of the stormwater infiltration system. Excavate a test pit to install the casing at the required depth, as necessary.
2. Remove any smeared soil surfaces and provide a natural soil interface into which water may infiltrate.
3. Remove all loose material from the casing.
4. Upon the tester's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment.
5. Fill the casing with clean water to a depth of 24" and allow to pre-soak for 2 hours.
6. 2 hours later, refill the casing with another 24 inches of clean water and monitor the water level (measured drop from the top of the casing) for up to 1 hour. In well-drained soils (where the water level drops 24 inches prior to 1 hour), record the time for the water level to drop 24 inches. Convert the reading to inches per hour. Repeat this procedure (filling the casing each time) three additional times, for a total of 4 observations. The observations should be averaged. The average should be reduced by a factor of 2 to determine the field infiltration rate for design purposes.
7. Upon completion of the testing, the casing should be immediately pulled, and the test pit should be back-filled.

Appendix D

Checklists

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

CHECKLISTS

Project Name: _____

Project Address _____

Property Owner(s) _____

Tax Account Number(s) _____

Engineer's Signature _____ Date: _____

All checklists must be completed and submitted. Provide a brief explanation for any items not provided. Check boxes as completed or N/A as not applicable.

	Existing Conditions Plan
	Stormwater Management Report
	Stormwater Management Plan / Construction Plan
	Certificate of Occupancy

Checklist for Existing Conditions Plan

I. General Information

	Site address
	Orientation, block, zone, City, street name
	Applicant name and legal address
	Surveyor name, address, contact information
	North arrow, bar scale, horizontal and vertical datum
	24" x 36" sheet size unless otherwise approved
	Existing conditions survey shall be prepared in accordance with the Minimum Standards for Surveys and Maps in the State of Connecticut. The class of survey shall be A-2 and T-2 and shall be represented as such on the map. The base map shall be sealed and signed by a Professional Land Surveyor licensed in the State of Connecticut.
	Drawing scale shall be set at 1" = 20' or 1" = 40' when possible

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

II. Existing Conditions Plan Elements

	Show and label all property boundaries with linear bearing / distances and curve information
	Required zoning setbacks
	Show and label monument information
	Show and label at least one permanent benchmark on the parcel with northing, easting and elevation
	Label adjacent property ownership information
	Existing contours based on NAVD 88 (no exceptions) at 2 foot contour interval or 1 foot contour interval when slope is flatter than 2 percent at a minimum of 20 ft. beyond the property boundaries of the subject parcel
	Show spot elevations at low points, high points, and where topography is flatter than 2 percent
	All buildings and structures (label current use and finished floor elevations)
	All pavement, parking, driveways, property access points
	All roadways, streets, and rights-of-way. Label streets as public or private with street name
	All patios, decks, walkways, sidewalks, curb ramps (both adjacent to and opposite and existing roadways or intersections)
	Show and label (size, material, inverts) all existing utilities (overhead and underground) within the right-of-way and the project site (label ownership) including but not limited to water, gas and electrical services, wells, storm sewers, sanitary sewers and subsurface sewerage disposal systems.
	Show and label existing conveyance systems (swales, ditches, storm drains) including dimensions, elevations, sizes, slopes, and direction of flow
	Show and label boundaries of all easements, both public and private, with type, owner, and width
	Show and label all other existing features and improvements (e.g. light poles, mature trees of 8" (dbh) diameter or greater, vegetation, walls with top and bottom elevations, fences, pavement markings)

III. Resource Areas

	Show and label limits of inland wetlands, tidal wetlands and any associated setbacks.
	Show and label existing natural site features including tree canopy, outcroppings, permanent and intermittent watercourses, waterbodies, streams
	Show and label limits of floodplain and floodway along with FIRM references (Community Number, Panel, Suffix, and Date) including any effective Letters of Map Revision/Amendment, zone designation and elevation.
	Show and label any Conservation Easement Areas
	Show and label Connecticut Coastal Jurisdiction Line (CJL)
	Show and label existing steep slopes (25% and greater)

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

Checklist for Stormwater Management Report

I. Project Report

A. Applicant / Site Information

	Applicant name, legal address, contact information (email & phone)
	Engineers name, legal address, contact information (email & phone)
	Site address and legal description
	Current / proposed zoning and land use
	Site vicinity map (8.5" x 11")

B. Project Description and Purpose

	Project description including proposed project elements and anticipated construction schedule

C. Existing Conditions Description

	Site area, ground cover, vegetation, features (roads, buildings, utilities, etc.)
	Site topography, slopes, drainage patterns, conveyances systems (swales, storm drains, etc.), stormwater discharge locations
	Receiving waterbody information including stormwater impairments and TMDL information (See the most recent State of Connecticut Integrated Water Quality Report)
	Site soils information including soil types, hydrologic soil group, bedrock / outcroppings, groundwater elevation, significant geologic features
	Provide NRCS Soils Mapping
	Resource protection areas (wetlands, streams, lakes, etc.), buffers, floodplains, floodways

D. Summary of Applicable General Design Criteria

	Methodology, design storm frequency
	Hydrologic design criteria
	Hydraulic design criteria
	Flood hazard areas

	Applying under "Lite" Stormwater Management: Skip to Section I (Refer to Flow Chart on page vii of the City of Stamford Stormwater Drainage Manual)

E. Project Type in Accordance with Standard 1 Definitions

	Area of disturbance, receiving waterbody classification (High Quality, Tidal Wetlands, Direct Waterfront)
	Project type (development, redevelopment, linear development)
	Pollutant reduction standard per flowchart Section 2.4

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

F. Summary of LID Site Constraints

	Description of sensitive areas for protection
	Mature tree inventory, which shall include 8-inch (dbh) diameter trees or greater
	Steep slopes
	Ledge and bedrock depth
	Seasonal high groundwater elevation
	Pollutant hotspots
	Summary of infiltration rates

G. Summary of Proposed Stormwater Treatment Practices

	Proposed LID controls (i.e. minimize impervious, minimize DCIA, minimize disturbance, increase time of concentrations, other LID controls and strategies)
	Location, size, types
	Design criteria and references
	Stormwater treatment practice, drainage area characteristics / details

H. Summary of Compliance with Standards 1

	Required pollutant reduction criteria
	Provided pollutant reduction (WQV) by stormwater treatment practice
	Summary of compliance with Standard 1

I. Summary of Compliance with Standards 2, 3, and 4

	Description of proposed stormwater management system
	Pre-development site hydrology with delineation of each watershed area and sub-basin
	Post-development site hydrology with delineation of each watershed area and sub-basin
	Comparison table of pre- and post-development hydrology, peak flow, volume, and percent difference
	Summary table of watershed areas and sub-basin areas, time of concentration and runoff coefficients
	Summary table demonstrating the 2-year, 24-hour post development peak flow rate is less than or equal to the lowest of either: - The pre-development 1-year, 24-hour storm peak flow rate - 50 percent of the pre-development 2-year, 24-hour storm peak flow rate
	Conveyance protection, emergency outlet sizing
	Hydraulic grade line summary and tail water elevation used in analysis
	Construction erosion and sediment control description, Standard 3
	Operation and Maintenance, maintenance tasks and schedule on construction plans per Standard 4

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

J. Summary of Compliance with Applicable Drainage Facility Design Requirements

	Description of applicable design requirements and compliance
	Description of proposed drainage facilities and compliance

K. Stormwater Management Report

	Signed and stamped by professional engineer licensed in the State of Connecticut
	Drainage impact statement in accordance with Standard 5B.

II. Supporting Calculations (as appendix to Project Report)

	Applying under "Lite" Stormwater Management: Skip to Section N

L. Water Quality Volume / Water Quality Flow Calculations

	Calculations demonstrating the total Water Quality Volume generated by the post-development site and the required retention/treatment volume per Standard 1 in cubic feet.
	Calculations demonstrating the total Water Quality Volume retained/treated by each stormwater treatment practice and the total Water Quality Volume generated by the post-development contributing drainage area to each stormwater treatment practice

M. Stormwater Treatment Practice Sizing Calculations

	Calculations demonstrating how each stormwater treatment practice has been designed and sized in accordance with the Structural Stormwater BMP Design references in Appendix B. Calculations will vary by stormwater treatment practice, but a minimum, applicants shall provide calculations in accordance with design criteria from the Connecticut Stormwater Quality Manual.

N. Hydrologic and Hydraulic Design Calculations

	Stream channel protection, Standard 2A
	Conveyance protection, Standard 2B
	Peak flow control (1-year, 2-year, 5-year, 10-year, 25-year, and 50-year storms), Standard 2C
	Inlet analysis
	Gutter flow (Site by site basis as requested by Engineering Bureau)
	Storm sewers and culverts (velocities, capacity, hydraulics)
	Hydraulic grade line required when pipe is flowing at full capacity o Provide existing and proposed summary table o Provide existing and proposed mapping, label structures
	Detention facilities (outlet structure, stage/storage, freeboard)
	Emergency outlet sizing, safely pass the 100 year storm, Standard 2D
	Outlet protection calculations, based on conveyance protection (i.e. riprap, energy dissipater)

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

O. Hydrologic and Hydraulic Model, Existing and Proposed

	Drainage routing diagram
	Summary
	Storage pond input

P. Downstream analysis (Site by site basis as required by the Engineering Bureau)

	Downstream analysis, Standard 2E

III. Supporting Mapping (as appendix to Project Report)

Q. Pre-Development Drainage Basin Area Mapping

	11" x 17" or 8.5" x 11" sheet size
	Topography, drainage patterns, drainage area boundaries and sub basins, flow paths, times of concentration
	Locations of existing stormwater discharges
	Perennial and intermittent streams, wetlands, and floodplain / floodways
	NRCS soil types, locations, boring locations, infiltration testing locations
	Vegetation and groundcover
	Existing roads, buildings, driveways, parking areas, walks, patios, pools and other impervious surfaces, decks and other structures
	Location, size, type of existing structural stormwater controls, facilities and conveyance systems

R. Post-Development Drainage Basin Area Mapping

	11" x 17" or 8.5" x 11" sheet size
	Topography, drainage patterns, drainage area boundaries and sub basins, flow paths, times of concentration
	Locations of proposed stormwater discharges
	Perennial and intermittent streams, wetlands, and floodplain / floodways
	NRCS soil types, locations, boring locations, infiltration testing locations
	Vegetation, ground cover and proposed limits of clearing/disturbance
	Proposed, roads, buildings, driveways, parking areas, walks, patios, pools and other impervious surfaces, decks and other structures
	Location, size, type of proposed structural stormwater controls, facilities and conveyance systems

IV. DCIA Tracking Worksheet (as appendix to Project Report)

	DCIA Tracking Worksheet (Use form found in Appendix E)

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

V. Proposed LID Review Map

	Applying under "Lite" Stormwater Management - Proposed LID Review Map NOT required.

A. General

	Site address
	Applicant name, legal address, contact information
	Engineers name, address, contact information
	North arrow, bar scale, horizontal and vertical datum
	Drawing scale shall be set at 1"=20' or 1"=40' when possible
	Signed and stamped by a Licensed Professional Engineer in the State of Connecticut
	11" x 17" or 24" x 36" sheet size unless otherwise approved
	Existing and proposed contours based on NAVD 88 at 2 foot contour interval or 1 foot contour interval when slope is flatter than 2 percent
	Locations of existing stormwater discharges
	Roads, buildings, driveways, parking areas, walks, patios, pools and other impervious surfaces, and decks and other structures
	Location, size, ownership of stormwater conveyance systems (swales, pipes, etc.)

B. LID Constraints:

	Boring / test pit locations
	Infiltration testing locations and results
	Vegetation and proposed limits of clearing / disturbance
	NRCS soils mapping
	Steep slopes
	Surface waters / Perennial and intermittent streams
	Resource protection areas and buffers, wetlands, floodplain / floodways
	Existing vegetation and mature trees, which shall include 8-inch (dbh) diameter trees or greater
	Poor soils (HSG C & D)
	Shallow bedrock / ledge
	Seasonal high groundwater elevation
	Other site constraints (e.g. brownfield caps)

C. Proposed Stormwater Treatment Measures:

	Location, size, type, limits, and WQV provided by each proposed stormwater treatment practices
	Drainage area to each proposed stormwater treatment practice (total area, impervious area, WQV)

D. Site Summary Table:

	Total site area, disturbed area, pre- and post-development impervious areas
	Required pollutant reduction volume (retention or detention)
	Provided pollutant reduction volume (retention or detention)

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

Checklist for Stormwater Management Plan / Construction Plans

A. General

	Site orientation, address and legal description
	Applicant name, legal address, contact information
	Engineers name, address, contact information
	North arrow, bar scale, horizontal and vertical datum
	Drawing scale shall be set at 1"=20' or 1"=40' when possible
	Stamped by a Licensed Professional Engineer in the State of Connecticut
	24" x 36" sheet size unless otherwise approved

B. Site Development Plans

	City of Stamford Standard Notes
	As required by the Drainage Maintenance Agreement, provide a written narrative describing the nature of the proposed development activity and the program for operation and maintenance of drainage facilities and control measures throughout the life of the project.
	Existing and proposed contours based on NAVD 88 at 2 foot contour interval or 1 foot contour interval when slope is flatter than 2 percent
	All required spot elevations to clearly depict positive pitch
	Top and bottom elevation of all walls
	Roads, buildings, driveways, parking areas, walks, patios, pools and other impervious surfaces, and decks and other structures
	All utilities and easements
	Location, size, maintenance access, type of proposed structural stormwater controls and facilities with elevations and inverts
	Location, size, maintenance access, type of proposed non-structural stormwater controls and facilities with elevations and inverts
	Location, size, type of proposed stormwater infrastructure, inlets, manholes, infiltration and detentions systems, control structures with elevations and inverts
	Location, size, ownership of stormwater conveyance systems (swales, pipes, etc.) with elevations and inverts
	Identify roof leaders, curtain drains and foundation drains with elevations and inverts
	Proposed water quality treatment systems, size and model type
	Final stabilization measures which may include slope stabilization

C. Erosion and Sedimentation Control Plan

	Phasing and schedule
	Construction access and staging and stock pile areas
	Operation and maintenance of erosion and sedimentation controls
	Tree protection
	Downstream protection such as location of silt fencing
	Limit of disturbance
	Construction fencing

City of Stamford
Engineering Bureau
888 Washington Boulevard, 7th Floor Stamford, CT 06901
Phone 203-977-4189

D. Construction Details

	Standard City of Stamford details
	Infiltration system details
	Control structure details
	Water quality treatment details
	Infiltration testing results

Checklist for Certificate of Occupancy

	Final Improvement Location Survey
	Stormwater Management Certification Form
	Final DCIA Tracking Worksheet
	Standard City of Stamford Drainage Maintenance Agreement (Agreement Covenant)

Other Certifications at the discretion of the Engineering Bureau and/or EPB

	Wall Certification
	Landscape Certification
	Landscape Maintenance Agreement
	Waiver Covering Storm Sewer Connection
	Waiver Covering Granite Block, Depressed Curb, and Driveway Aprons
	Flood Certification

Appendix E

Directly Connected Impervious Area Tracking Worksheet

What is DCIA?

Directly Connected Impervious Area (DCIA) is the part of the total impervious area that is hydraulically connected to the City of Stamford MS4 system (e.g., parking lot draining to a Stamford catch basin or piped directly to a City of Stamford storm sewer). DCIA does not include isolated impervious areas where runoff is able to infiltrate before reaching the MS4, (e.g., a roof drain discharging to a large grassy area, a parking lot draining to an infiltration BMP, etc.).

Part 2: Project Details

The information provided in this section will help determine the water quality requirement for your site. Additional instructions for each entry are included here:

1. Type of Development - Choose from the following three options: New Development, Redevelopment, and Linear Redevelopment (See Section 2.4).
2. Enter the total area of all parcels and/or Rights-of-Way (for linear redevelopment) containing development (this is considered the "Site", as defined in *Definitions* on Page v).
3. Enter the total area of land disturbance (as defined in *Definitions* on Page iv) for the project.
4. See mapping in *Appendix A* for locations of these resources in Stamford.
5. Enter the total area of **current** on-site DCIA. This includes any impervious area that is currently draining directly to the City of Stamford storm sewer system.
6. Determine if DCIA, based on the above explanation, will increase with the proposed development. For this answer, do not consider the influence of any proposed BMPs in the calculation of DCIA, even though the purpose of the BMPs will be to reduce the on-site DCIA. For example, if a proposed parking lot is designed to drain to a BMP, but would otherwise drain to the City storm sewer system, include this parking lot area in determining whether DCIA will increase. ***Note: this question is only relevant for linear redevelopment projects***.
7. Enter the total proposed impervious area associated with the development. This includes pre-development impervious area on the site that will not be removed as part of the proposed development.

Part 3: Water Quality Target Total

Required retention or treatment volumes will be calculated here depending on the inputs provided in Part 2. Enter the proposed retention/treatment volume for the development in the final box. If the proposed retention/treatment volume exceeds the required retention/treatment volume, this box will turn green indicating the applicant has met the pollution reduction requirement. Alternatively, Standard 1 may not apply if certain conditions are met. In this case, skip to Part 4.

Part 4: Proposed DCIA Tracking

Values to be entered here are pre-development total impervious area and proposed-development DCIA. The other values should have already been entered in Part 2. Unlike Part 2 Step 6, the number entered here for proposed-development DCIA should consider proposed BMPs. For example, a proposed parking lot draining to a BMP that retains/treats the full 1" of runoff may be considered disconnected and thus should not be included in this total.

Part 5: Post-Development (As-Built Certified) DCIA Tracking

Enter the post-development total impervious area and post-development DCIA here. These numbers should reflect as-built conditions, and thus may differ slightly from the respective numbers entered in Part 4.

Directly Connected Impervious Area Tracking Worksheet
City of Stamford Drainage Manual

Note to user: complete all cells of this color *only*

Part 1: General Information

Project Name	
Project Address	
Project Applicant	
Date of Submittal	
Tax Account Number	

Part 2: Project Details

1. What type of development is this? (choose from dropdown)		
2. What is the total area of the project site?		ft^2
3. What is the total area of land disturbance for this project?		ft^2
4. Does project site drain to High Quality Waters, a Direct Waterfront, or within 500 ft. of Tidal Wetlands? (Yes/No)		
5. What is the current ***DCIA*** for the site?		ft^2
6. Will the proposed development increase ***DCIA*** (without consideration of proposed stormwater management)? (Yes/No)		
7. What is the proposed-development ***total impervious area*** for the site?		ft^2

Part 3: Water Quality Target Total

Does Standard 1 apply based on information above?		
Water Quality Volume (WQV)		ft^3
Standard 1 requirement		
Required treatment/retention volume		ft^3
Provided treatment/retention volume for proposed development		ft^3

Part 4: Proposed DCIA Tracking

Pre-development ***total impervious area***		ft^2
Current ***DCIA***		ft^2
Proposed-development ***total impervious area***		ft^2
Proposed-development ***DCIA*** (after stormwater management)		ft^2
Net change in ***DCIA*** from pre-development to proposed-development		ft^2

Part 5: Post-Development (As-Built Certified) DCIA Tracking

Post-development (per as-built) ***total impervious area***		ft^2
Post-development (per as-built) ***DCIA*** (after stormwater management)		ft^2
Net change in ***DCIA*** from pre-development to post-development		ft^2

Certification Statement

I hereby certify that the information contained in this worksheet is true and correct.

Engineer's Signature _____ Date _____ Engineer's Seal _____

Appendix F

Example Post LID Review Map

SUMMARY TABLE

TOTAL SITE AREA	XX	TOTAL DISTURBED AREA	XX
PRE–DEVELOPMENT IMPERVIOUS	XX	POST–DEVELOPMENT IMPERVIOUS	XX
REQUIRED RETENTION/TREATMENT VOLUME	XX	PROVIDED RETENTION/TREATMENT VOLUME	XX
POST–DEVELOPMENT DCIA	XX	POST–DEVELOPMENT DCIA	XX
DIFFERENCE IN DCIA		XX	

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.			XX/XX	XX

SEAL

SEAL

SCALE:
HORZ.: NOT TO SCALE
VERT.:
DATUM:
HORZ.:
VERT.:
0 N/A
GRAPHIC SCALE

CITY OF STAMFORD

EXAMPLE POST LID REVIEW MAP

STORMWATER DRAINAGE MANUAL

STAMFORD CONNECTICUT

PROJ. No.:
DATE:

FIG. X

Appendix G

Standard City of Stamford Drainage Maintenance Agreement (Agreement Covenant)

Block _____ .

AGREEMENT COVENANT

AGREEMENT made this____ day of_____by and between _____of_____in the City of Stamford, County of Fairfield and State of Connecticut (hereinafter referred to as "Owner"); and the **CITY OF STAMFORD**, a municipal corporation lying within the County of Fairfield and State of Connecticut, acting herein by its duly authorized Mayor, David R. Martin (hereinafter referred to as the "CITY"), the **ENVIRONMENTAL PROTECTION BOARD OF THE CITY OF STAMFORD**, acting herein by its duly authorized Chairman, Gary H. Stone (hereinafter referred to as the "EPB").

WITNESSETH

WHEREAS, OWNER has commenced the planning and construction of a new _____on land owned by it and as more particularly described on Schedule "A" annexed hereto and made of part hereof (hereinafter referred to as the "Property"); and

WHEREAS, certain drainage facilities ("Drainage Facilities"), including but not limited to_____as more particularly described on Schedule "B" attached (the "Construction Plans") shall be installed in connection with the aforesaid construction and in accordance with the Construction Plans and _____Permit No._____issued by the_____Board of the City of Stamford (_____) issued

therefore, ("Permit") and;

WHEREAS, OWNER, the CITY and EPB share a joint concern that the Drainage Facilities be maintained in a functioning condition so as to avoid pollution of surface and groundwaters, flooding and/or improper drainage.

NOW, THEREFORE, in consideration of ten dollars and other good and valuable consideration receipt of which is hereby acknowledged by the OWNER, it is hereby agreed as follows:

1) OWNER shall clean the drainage facilities or cause such facilities to be cleaned by periodic removal of accumulated sediment and debris in a good and workman-like manner, at least two (2) times during every twelve (12) month period, which times shall be in the period between April and June and between October and December and more often as the City may determine to be necessary.

2) OWNER shall sweep, or cause to be swept, garage facilities, driveways and roadway surfaces located on the Property at least once per calendar quarter.

3) OWNER shall utilize only sand or calcium chloride in connection with the de-icing of areas within the Property meaning and intending that road salt (Sodium Chloride) shall not be used for said purpose.

4) OWNER shall repair or replace any defects or defective drainage

facilities so as to maintain the drainage facilities, at all times, in a fully functional capacity.

5) OWNER shall file as-built drainage plans with the EPB immediately upon the completion of work. Said plans shall be prepared by a professional engineer/surveyor registered in the State of Connecticut.

6) OWNER grants the CITY and/or EPB, its agents, and employees, the right to enter the Property at all reasonable times upon twenty-four (24) hours notice to the OWNER for the purpose of inspecting the Property to determine if OWNER is complying with the requirements hereunder. A representative of the Owner shall have the right to accompany the City and/or EPB on their inspection of the Property.

7) If, after an inspection is made pursuant to Paragraph Six (6) hereof, the CITY and/or EPB determines that the owner has failed to comply with the aforesaid undertakings, then the CITY and/or EPB shall give written notice of said determination to the then OWNER of the Property which notice shall also specify the said failure. Said notice shall be sent by registered or certified mail to the last known address of said Owner. If the Owner disputes the claim, he shall give written notice thereof to City and/or EPB within ten (10) days of receipt of said notice, and the EPB shall hold a hearing as promptly as possible to decide the merits of the disputed claim. If the claim is not disputed within

said ten (10) days, the OWNER shall have thirty (30) days from the receipt of said notice to correct said failure, unless it is impossible to cure said defect within said time, in which case, the necessary repairs shall be immediately commenced and diligently pursued to completion within a reasonable time.

8) If the said failure is not remedied within the time frame herein stated, the CITY and/or EPB may proceed to cure the same and charge the actual cost thereof to the OWNER of the Property.

9) OWNER agrees to reimburse the CITY and/or EPB for reasonable legal fees and court costs if it becomes necessary for the CITY and/or EPB to sue for reimbursement of sums expended by the CITY and/or EPB in performance of OWNER'S obligation.

10) OWNER agrees and covenants to indemnify and save harmless the CITY and the EPB against any and all claims, suits, actions or judgments arising out of the delay in the performance of any of their obligations pursuant to this Agreement.

11) OWNER agrees that this covenant and restriction shall apply to and run with the land. It shall be binding on all future owners, administrators, executors, successors and assigns.

12) The OWNER hereby represents to the CITY and EPB that he/she is the owner, in fee simple, of all of the property described in "Schedule A" attached hereto and made a part hereof.

13) OWNER agrees that this Agreement and restrictive covenant upon execution of the same, shall be recorded on the land records at the OWNER'S expense at the time that a permit is issued for the Property herein and while the OWNER is in title.

14) OWNER agrees not to assert the invalidity of this document.

15) OWNER agrees that nothing herein shall be construed to be a limitation upon the right of the EPB to assert and enforce any rights it may have under federal, state or City statute, ordinance or regulation.

16) This agreement shall be governed by the laws of the State of Connecticut.

IN WITNESS WHEREOF, the said parties hereto have hereunto set their hands and seals, the day and year first above written.

WITNESSED:

_____ **THE CITY OF STAMFORD**

BY: _____

_____ David R. Martin
Its duly authorized Mayor

(ACKNOWLEDGEMENT ON THE FOLLOWING PAGE)

_____ **THE ENVIRONMENTAL PROTECTION BOARD**

_____ BY: _____

Gary H. Stone
Its duly authorized Chairman

_____ **OWNER**

_____ BY: _____

_____ **OWNER**

_____ BY: _____

_____

STATE OF CONNECTICUT}
} ss: STAMFORD Date: _____
COUNTY OF FAIRFIELD }

Personally appeared David R. Martin, Mayor of the City of Stamford, signer and sealer of the foregoing instrument, and acknowledged the same to be his free act and deed and the free act and deed of said City, before me.

_____
Commissioner of the Superior Court
or Notary Public

STATE OF CONNECTICUT}
} ss: STAMFORD Date: _____
COUNTY OF FAIRFIELD }

Personally appeared Gary H. Stone, Chairman of the Environmental Protection Board of the City of Stamford, signer and sealer of the foregoing instrument, and acknowledged the same to be his free act and deed and the free act and deed of said Commission, before me.

_____
Commissioner of the Superior Court
or Notary Public

STATE OF CONNECTICUT }
} ss: STAMFORD Date: _____
COUNTY OF FAIRFIELD }

Personally appeared _____, signer and sealer of the foregoing instrument, and acknowledge the same to be_____free act and deed, before me.

_____
Commissioner of the Superior Court
or Notary Public

Appendix H

High Quality Waters List

The Connecticut Department of Energy and Environmental Protection is in the process of developing a list of high quality waters for the State. Once the list is formally adopted this sheet will be replaced.

Appendix I

City of Stamford Standard Notes

Standard City of Stamford Notes:

1. A Street Opening Permit is required for all work within the City of Stamford Right-of-Way.
2. All work within the City of Stamford Right-of-Way shall be constructed to City of Stamford requirements, the State of Connecticut Basic Building Code and the Connecticut Guidelines for Soil Erosion and Sedimentation Control.
3. The Engineering Bureau of the City of Stamford shall be notified three days prior to any commencement of construction or work within the City of Stamford Right-of-Way.
4. Trees within the City of Stamford Right-of-Way to be removed shall be posted in accordance with the Tree Ordinance.
5. Prior to any excavation the Contractor and/or Applicant/Owner, in accordance with Public Act 77-350, shall be required to contact "Call Before You Dig" at 1-800-922-4455 for mark out of underground utilities.
6. All retaining walls three (3) feet or higher measured from finished grade at the bottom of the wall to finished grade at the top of the wall and retaining walls supporting a surcharge or impounding Class I, II or III-A liquids are required to have a Building Permit. Retaining walls shall be designed and inspected during construction by a Professional Engineer licensed in the State of Connecticut. Prior to the issuance of a Certificate of Occupancy, retaining walls shall be certified by a Professional Engineer licensed in the State of Connecticut.
7. Certification will be required by a professional engineer licensed in the State of Connecticut that work has been completed in compliance with the approved drawings.
8. A Final Improvement Location Survey will be required by a professional land surveyor licensed in the State of Connecticut.
9. Connection to a city-owned storm sewer shall require the Waiver Covering Storm Sewer Connection to be filed with the City of Stamford Engineering Bureau.
10. Granite block or other decorative stone or brick, depressed curb, driveway apron and curbing within the City of Stamford Right-of-Way shall require the Waiver Covering Granite Block Depressed Curb and Driveway Aprons to be filed with the City of Stamford Engineering Bureau.
11. Sediment and erosion controls shall be maintained and repaired as necessary throughout construction until the site is stabilized.
12. To obtain a Certificate of Occupancy, submittal must include all items outlined in the Checklist for Certificate of Occupancy (Appendix D of the City of Stamford Drainage Manual).
13. Reference EPB Permit #, Zoning Permit #, Zoning Board of Appeals #, Subdivision #, if applicable.

Appendix J

Exemption Request Form

City of Stamford
Engineering Bureau
Stamford Government Center – 888 Washington Blvd., Stamford, CT 06901
Phone: 203 977 4189

STORMWATER MANAGEMENT STANDARDS –EXEMPTION REQUEST FORM

Project Name _____

Project Address _____

Property Owner(s) _____

Tax Account Number(s) _____ Zone(s) _____ Lot Area _____

Check all that apply to the proposed project:

□ a. The project drainage design will not adversely impact adjacent or downstream properties or City-owned drainage facilities.

□ b. The project does not result in new or increased discharges to High Quality Waters or stormwater Impaired Waters as designated by CT DEEP.

□ c. The project does not discharge directly to or within 500 feet of a tidal wetland, see Appendix A.

□ d. The project creates less than 400 square feet of impervious coverage.

□ e. The project site is not located on a Direct Waterfront parcel.

IMPERVIOUS AREA WORKSHEET

This worksheet shall be used to quantify impervious surfaces associated with existing and proposed construction.

	Existing Conditions Impervious Surfaces (sq ft)	Proposed conditions Impervious Surfaces (sq ft)	Proposed New Impervious Surfaces (sq ft) Column 2 minus column 1
House / Buildings			
Driveways			
Sidewalks / Paths			
Swimming Pools			
Patios			
Tennis Court / Sport Court			
Other			
TOTALS			

Owner / Agent Signature: _____ Date: _____

Do not write below this line

CITY APPROVAL

Engineering Bureau Signature: _____ Date: _____

Appendix K

Stormwater Management Certification Form

City of Stamford
Engineering Bureau
Stamford Government Center – 888 Washington Blvd., Stamford, CT 06901
Phone: 203 977 4189

STORMWATER MANAGEMENT CERTIFICATION FORM

Project Name _____

Project Address _____

Property Owner(s) _____

Tax Account Number(s) _____ Zone(s) _____ Lot Area _____

Project Engineer _____CT PE #_____

Engineering Firm's Name_____

Firm Address _____

Phone _____ Email _____

I hereby declare that the above referenced project's stormwater drainage system has been designed in accordance with the City of Stamford Stormwater Drainage Manual, as amended. Furthermore, I declare that the stormwater drainage system(s), grading, site stabilization and other related site work for the project have been constructed substantially in accordance with the approved plans referenced in the Building Permit, B-_____ and field changes approved by the City of Stamford Engineering Bureau. Based on our Stormwater Management Report, Field Inspections, Field Inspection Records, and the Improvement Location Survey depicting "As-Built" conditions and entitled_____ prepared by _____ dated _____ and revised _____, it is our professional opinion that the stormwater drainage system as designed and constructed will not have an adverse impact on offsite properties or offsite drainage infrastructure.

Attach field Inspection Reports and support photos during and after installation.

Engineer Signature: _____ Date: _____

Engineer's Seal: _____