

COMMUNITIES IN FOCUS

LOCAL STORM WATER MANAGEMENT PROGRAMS

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Baltimore, Maryland

Population: 631,366

Baltimore's storm water system is managed by Department of Public Works, Bureau of Water and Waste Water. The City of Baltimore's storm water management ordinance can be found in Article 7, Sections 21 through 28 of the City of Baltimore Code. Baltimore has adopted the Maryland Storm Water Design Manual to serve as the City's official guide for storm water principles, methods and practices.¹ Storm water management plans are required for all development.² The Code also requires the use of non-structure storm water management practices, such as natural area conservation, rooftop and non-rooftop runoff disconnections, sheet flow buffers, grass channels and environmentally sensitive development, to minimize increases in new development runoff.³

The [Maryland Storm Water Design Manual](#) establishes BMPs and design criteria to control runoff from new development and redevelopment projects. Under Maryland regulations, a 20% reduction in impervious surfaces is required for redevelopment projects.⁴ The Storm Water Design Manual provides methods in which structural, non-structural and environmentally sensitive storm water management practices may be used to meet the reduction requirements.

Maryland has developed 14 performance standards to prevent adverse impacts from storm water runoff which apply to any construction activity that disturbs 5,000 square feet or more of earth.⁵ These standards are outlined in Chapter 1 of the Storm Water Design Manual.

The Storm Water Design Manual includes storm water credits for innovative site design planning that can be used to achieve the performance standards:

- ♦ natural conservation area credit
- ♦ rooftop disconnection credit
- ♦ non-rooftop disconnection credit
- ♦ sheetflow to buffer
- ♦ grass channel
- ♦ environmentally sensitive development

Use of these methods can reduce the volume retention or management control feature size requirements necessary under the performance standards. These work by reducing the amount of impervious area of a property which is used to calculate the amount of storm water control required for a property. As a result, BMP costs are reduced. Under the Storm Water Design Manual, an operation and maintenance agreement is required to ensure that the system functions as designed.

¹ Baltimore Code Art. 7, §21-3.

² Baltimore Code Art. 7, §22-1.

³ Baltimore Code Art. 7, §22-4.

⁴ Code of Maryland Regulations 26.17.02.

⁵ Additions or modifications to existing single family structures, developments disturbing less than 5,000 square feet of land, and agricultural land management activities are exempt from these requirements.

In addition to the Maryland Storm Water Design Manual, the City of Baltimore has adopted a [Storm Water Management Manual](#) which includes ultra urban BMPs. These BMPs are designed to be effective in high density, urban areas.⁶ These ultra urban BMPs include:

- ♦ vegetated roof covers
- ♦ roof gardens/meadows
- ♦ roof ponding areas
- ♦ parking groves
- ♦ concrete grid and modular pavement
- ♦ parking lot storage
- ♦ bioretention islands
- ♦ below pavement infiltration basins
- ♦ alley filters
- ♦ pedestal sidewalks
- ♦ grated sidewalk infiltration/ filtration systems
- ♦ stormfilters®

The Baltimore Storm Water Management Manual includes design criteria, specifications, methodology, and planning considerations for the BMPs.

The Maryland Department of the Environment [Storm Water Management Program](#) has developed a [Model Storm Water Management Ordinance](#) that encourages the use of non-structural storm water management practices. As an incentive, the minimum control requirements may be reduced when non-structural storm water management practices are incorporated into site designs. The non-structural storm water management practices must be recorded and remain unaltered by subsequent property owners. Prior approval from the local agency is required for alteration. Alternative structural and non-structural storm water management practices may be used for new development water quality control if they meet the performance criteria of the Design Manual.

⁶ Baltimore City Stormwater Management Manual, Attachment D: Ultra Urban Best Management Practices. These practices are approved through variances where the Maryland Stormwater Design Manual BMPs are not feasible.

CHICAGO/COOK COUNTY, ILLINOIS

Population: 2.9 million.

Types of Green Infrastructure Used:

- ♦ green roofs
- ♦ downspout disconnection
- ♦ permeable pavement
- ♦ rain gardens
- ♦ vegetated swales

A new ordinance takes effect on January 1, 2008, which requires new developments or redevelopments of a certain size to capture the first half-inch of runoff from all impervious surfaces (roofs, driveways, sidewalks, and so forth) onsite, instead of allowing it to run into the sewers or nearby waterways. Developers can adopt a variety of techniques—such as green roofs, permeable pavement, rain barrels and cisterns, bioswales or rain gardens—to capture this initial rainfall so that the water will infiltrate and recharge the underground aquifer. For developments that do not directly discharge to waterways or to a separate municipal storm sewer system, the ordinance seeks to achieve a 15 percent reduction in impervious surfaces from existing conditions.

Chicagoans can purchase a discounted Chicago Rain Barrel for \$40, while supplies last, beginning May 21, 2007.

The City is creating a green infrastructure by utilizing unique open spaces to hold water that would normally drain directly into the sewer system. For instance, the City built a new kind of alley in a North Side community as part of a pilot project. The alley, constructed of a rigid grid system and gravel, allows rainwater to soak into the ground-reducing water flow into the sewer system and backyard flooding. Chicago Department of the Environment offered 20 grants up to \$5,000 to help design and install green roofs on residential and small commercial buildings of less than 10,000 sq. ft.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Government subsidized Rain Barrel sale	400 People purchased 55 gallon rain barrels for \$15 a piece. This program cost the city \$40,000 (excluding city labor).	760,000
Green Tech building. ⁷	The building and groups occupy a 17-acre former brownfield.	900,000
Green Roofs	City Hall has a green roof, and so do more than 80 buildings in the city.	Runoff is estimated to be less than half that of conventional roofs.

⁷ This educational building has a green roof, bioswales, rain garden, and permeable paving

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Downspout Disconnections	Study of a 1,370 acre neighborhood. Estimated a 20% reduction in peak flow if all were disconnected. The Study also concluded that if shallow rain gardens were installed at each home, total runoff would be reduced by 4% to 7%.	

DANE COUNTY, WISCONSIN

Population: 463,826

The [Land and Water Resources Department Office of Lakes and Watersheds/Dane County Lakes and Watershed Commission](#) (“Commission”) is responsible for [Erosion Control and Storm Water Management](#). In 2002, the Commission adopted the [Manure Management, Erosion Control Storm Water Ordinance](#) (“Ordinance”).⁸ This ordinance created a “maximum extent practicable” for implementation of BMPs to meet certain performance standards that takes into consideration the best available technology, cost effectiveness and other competing issues.⁹ The purposes of the Ordinance include providing “a single, consistent set of performance standards that apply to all developments in both the unincorporated and incorporated areas of Dane County” and achieving “an 80% reduction in sediment load rates to Dane County waters compared to no controls for new development, a 40% reduction in sediment load rates compared to no controls for all redevelopment and street reconstruction, and a 20% reduction in sediment load rates compared to no controls for existing developments.”¹⁰ To achieve these goals, the Ordinance also created erosion and storm water control permit and plan requirements for certain development and redevelopment activities.

Dane County also developed an [Erosion Control and Storm Water Management Manual](#) (“Storm Water Management Manual”) to help the regulated community meet the requirements of the Ordinance. The Storm Water Management Manual includes 40 management practices that may be utilized to achieve the performance standards included in the Ordinance.

- ♦ dry basins
- ♦ wet basins
- ♦ bioretention basins
- ♦ constructed wetlands
- ♦ construction scheduling
- ♦ deep tilling
- ♦ dewatering
- ♦ permanent diversions
- ♦ temporary diversions
- ♦ erosion matting
- ♦ gabions
- ♦ grassed swales
- ♦ infiltration basins
- ♦ infiltration trench or bed
- ♦ lined waterway or outlet
- ♦ minimizing impervious areas
- ♦ mulching
- ♦ native plants
- ♦ oil and grease separator
- ♦ parking lot/street sweeping
- ♦ pervious pavement
- ♦ polymer application
- ♦ proprietary storm water devices
- ♦ rain garden
- ♦ sediment basin
- ♦ sediment trap
- ♦ permanent seeding
- ♦ temporary seeding
- ♦ silt fence
- ♦ temporary slope drain
- ♦ sod
- ♦ stone creek dam
- ♦ stone crib
- ♦ stone outlet protection
- ♦ stone tracking pad
- ♦ stone weeper
- ♦ storm water inlet protection
- ♦ subsurface drain
- ♦ surface roughening
- ♦ tree planting
- ♦ vegetated buffer strips

⁸ Dane County Code of Ordinances, Chapter 14.

⁹ Dane County Code of Ordinance §14.41(21m).

¹⁰ Dane County Code of Ordinance §14.43(e) and (f). The reduction percentages are based upon design practices that retain soil particles greater than 5 microns resulting from a one-year 24-hour storm event (2.5 inches over 24-hours duration) for new development, particles greater than 20 microns for redevelopment, and particles greater than 40 microns for existing development. Dane County Code of Ordinance §14.51(2)(a) and (3)(a).

Dane County has developed a model ordinance for communities within the County to adopt. Cities and municipalities are required to adopt a program that is at least as restrictive as the County's.

Dane County also provides information on [rain gardens](#). According to the Dane County website, rain gardens can soak up to 30% more water than a traditional lawn. The website also provides information on [how to build a rain garden](#) along with other helpful rain garden links.

MECKLENBURG COUNTY, NORTH CAROLINA

Population: 827,445

Charlotte and Mecklenburg County have adopted soil erosion and sedimentation control ordinances to reduce the sedimentation of streams, lakes, wetland and other waters of the state. Additionally, communities within Mecklenburg County have adopted surface and water improvement management ordinances, low impact design ordinances and post construction storm water programs.¹¹ On January 1, 2007, Mecklenburg County adopted watershed specific erosion control requirements for [critical erosion control areas](#).

Mecklenburg County provides a good example of county and city/town interaction. The Town of Huntersville has incorporated [low impact development](#)¹² into its water quality ordinance. This ordinance contains mandatory low impact design techniques and requires compliance with the [Huntersville Design Manual](#).

The Huntersville Ordinance requires all storm water treatment systems be designed to achieve an average annual 85% total suspended solids removal for the developed area of the site and that all sites must employ low impact development practices to control and treat runoff from the first inch of rainfall.¹³ Additionally, no single BMP may receive runoff from an area greater than five acres. The Design Manual includes the following low impact development BMPs:

Runoff Reduction

- ♦ strategic clearing and grading practices
- ♦ proper landscaping
- ♦ vegetated buffers
- ♦ curb elimination or flat curbs

Retention BMPs

- ♦ bioretention
- ♦ cisterns
- ♦ dry wells
- ♦ rain barrels

Detention BMPs

- ♦ filter strips
- ♦ level spreaders
- ♦ grassed swales
- ♦ detention ponds

Mecklenburg County has also developed a Site Evaluation Tool that is available on their [website](#) that assesses and compares pre-development and post-development runoff, infiltration and pollutant loading rates.

¹¹ www.charmeck.org/Departments/StormWater/Storm+Water+Professionals/Regulations+and+Ordinances.htm

¹² The Huntersville Low Impact Development [website](#) includes a useful information on low impact development, including hydrologic analysis and construction and maintenance information.

¹³ Huntersville Water Quality Ordinance §8.17.6.

MILWAUKEE, WISCONSIN

Population: 586,941

Milwaukee's storm water sewer system is serviced by the [Milwaukee Metropolitan Sewer District](#) ("MMSD").¹⁴ A portion of the area serviced by the MMSD is a combined sewer system. In 1994, a deep tunnel was opened which nearly eliminated the number of combined sewer overflows.¹⁵ According to MMSD's website, Milwaukee is increasing the size of its deep tunnels to reduce the risk of basement backups.¹⁶

The [MMSD Storm Water Rules](#),¹⁷ which became effective in 2002, create storm water runoff management requirements, apply to governmental units in the MMSD service area and require the governmental units to manage land use and activities in their jurisdiction to minimize storm water and drainage impacts.¹⁸

Any development, including redevelopment, that (1) received full and final approval following the effective date of the rules, (2) involves an increase of one-half acre or more of impervious surface, and (3) is located within the ultimate sewer service area must comply with these requirements.¹⁹ The MMSD rules require consideration of the following runoff management techniques (in order of preference): (a) preservation of the natural features of development sites, including natural storage and infiltration characteristics; (b) preservation of existing natural streams, channels, and drainage ways; (c) minimization of new impervious surfaces; (d) conveyance of storm water in open vegetated channels; (e) construction of structure that provide both quantity and quality control, with structures serving multiple sites being preferable to structures serving individual sites; and (f) construction of structures that provide only quantity control, with structures serving multiple sites being preferable to structures serving individual sites.²⁰ The rules also establish maximum runoff release rates of 0.5 cubic feet per second per acre for a 100-year storm and 0.15 cubic feet per second per acre for a 2-year storm.²¹ MMSD Rule 13.11(9) requires cities and villages within the MMSD service area to adopt a storm water management ordinance that implements the requirements of Chapter 13 of the MMSD Rules.²²

Like other jurisdictions, the MMSD Storm Water Rules require site development storm water management plans to be submitted to the appropriate jurisdiction. These development plans must include information sufficient for the reviewer to determine whether the storm water runoff

¹⁴ The MMSD services 27 communities in addition to Milwaukee, covering a 420 square-mile area.

¹⁵ http://www.mmsd.com/wastewatertreatment/combined_sewers.cfm

¹⁶ http://www.mmsd.com/wastewatertreatment/overflow_reduction_plan.cfm

¹⁷ See, MMSD Rules Chapter 13.

¹⁸ MMSD Rule 13.10.

¹⁹ MMSD Rule 13.10. This rule also identifies those types of development that are exempt from the runoff management requirements.

²⁰ MMSD Rule 13.11.

²¹ MMSD Rule 13.11.

²² This rule also provides for MMSD review and approval of the local ordinances.

management requirements of MMSD Rule 13.11 are met. Also, for phased developments, the storm water management plan must consider the cumulative effect of all phases.²³

MMSD is implementing a number of other programs in an effort to reduce the volume of storm water that reaches the sewer system. As part of this effort, in 2005 MMSD amended its [Surface Water and Storm Water Rule Guidance Manual](#) (“Guidance Manual”) to incorporate a number of low impact development Best Management Practices (“BMPs”):

- ♦ downspout disconnection
- ♦ rain barrels
- ♦ cisterns
- ♦ rain gardens
- ♦ green roofs
- ♦ rooftop storage
- ♦ green parking lots
- ♦ storm water trees
- ♦ porous pavement
- ♦ inlet restrictors/ pavement storage
- ♦ bioretention
- ♦ onsite filtering practices
- ♦ pocket wetlands
- ♦ French drains and drywells
- ♦ infiltration sumps
- ♦ compost amendments
- ♦ storm water rules and redevelopment policies

Appendix L of the Guidance Manual includes an evaluation of the effectiveness of each of these storm water reduction practices and their cost effectiveness. MMSD has also created a calculation spreadsheet – the LID Quicksheet – to provide a practical way to calculate how the use of particular low impact development practices affect the required storm water detention volume under Chapter 13 of the MMSD Rules, thus providing an incentive to use low impact or green storm water management methods.²⁴

According to the City of Milwaukee’s website, the City is constructing two major bioretention facilities to remove contaminants from storm water before it is discharged to the Menomonee River.²⁵ To lead by example, Milwaukee’s Mayor has directed city departments to reduce the amount of storm water that leaves city properties by 15% and is encouraging businesses and residents to do the same. A green roof is to be installed in 2007 by the Department of Public Works on the municipal building. The City has also funded a variety of projects to reduce the flow of storm water into the sewer system, including downspout and foundation drain disconnections in certain areas, the addition of inlet restrictors on selected streets to reduce the flow of storm water into the sewer system, and incorporating more native plants in city boulevards.

The City has also adopted a voluntary [Downspout Disconnection](#) program. Under this program, 13 criteria must be met prior to disconnection.²⁶ This section also requires all newly paved areas or parking lots to have a storm sewer.²⁷

²³ MMSD Rule 13.12. A site development stormwater management plan is required for a phased development where the cumulative amount of new impervious surface it

²⁴ See, Volume II, pp. 37 – 38 and Appendix L of the Guidance Manual. MMSD has also developed a [2020 Facilities Plan](#) which sets forth ongoing investments and facilities improvements to be made in order to provide a target level of protection for sanitary sewer overflows and adequate treatment under the projected 2020 population and land use conditions.

²⁵ <http://www.city.milwaukee.gov/ManagingyourStormwat13217.htm>

²⁶ Milwaukee Code of Ordinances 225-4.

Another program developed by MMSD is [Project Greenseams](#). According to the MMSD website, Project Greenseams is an innovative flood management program that permanently protects key lands containing water absorbing soils and aims to preserve land along stream corridors. Under this program, MMSD identifies and purchases undeveloped privately owned properties in areas that are expected to have major growth in the next 20 years, and parcels of open space along streams, shorelines and wetlands.²⁸ The project is run by the Conservation Fund, a non-profit organization that performs high volume real estate transactions for local land trusts and government agencies throughout the country. All land acquired will remain as open space, protecting water and providing the ability to naturally store rain and melting snow in critical areas. Under this program, property is acquired, owned and managed by a local community or land trust and is subject to a conservation easement held by MMSD. MMSD uses a number of grant programs to fund the projects.

²⁷ Milwaukee Code of Ordinances 225-5 and 252-74.

²⁸ All sales are voluntary.

MINNEAPOLIS, MINNESOTA

Population: 373,188

The City of Minneapolis began implementation of a five-year plan in 2003 to [eliminate combined sewer overflows](#) (“CSOs”). As part of this process, the City adopted the [Rainleader Ordinance](#), found in Title 3, Chapter 56 of the Minneapolis Code of Ordinances. Under the Rainleader Ordinance, rooftop drains (rainleaders) are required to be disconnected from the sewer system. A disconnection permit is required and the disconnection must be approved by the City. If a property owner fails to comply with a disconnection notice, the City may revoke any City issued license held by the property owner.

Chapter 54 of the Minneapolis [Code of Ordinances](#) contains the City’s storm water management requirements. Land disturbing activities on sites greater than one acre, including phased or connected actions, are subject to the storm water management requirements. Such projects are required to be served by storm water facilities, on and/or off-site, that meet or exceed targets according to the type of receiving water body as described in the Minneapolis Storm Water Management Design Manual.²⁹ A storm water management plan must be approved prior to issuance of any land use and building permits.³⁰ The storm water management plan must be developed in accordance with the standards found in the Storm Water Management Design Manual, which include minimizing land disturbance, maximizing infiltration and rate control such that the development does not increase peak storm water flows.

The [Metropolitan Council](#) is the regional planning agency serving the Twin Cities seven-county metropolitan area. The Metropolitan Council also owns and maintains 600 miles of regional sewers that collect flow from 5,000 miles of sewers owned by 104 communities. The Metropolitan Council created the [Urban Small Sites BMP Manual](#) to assist Twin Cities' municipalities in guiding development and redevelopment. The Urban Small Sites BMP Manual contains 40 BMPs that can be used in small urban sites located in cold climate settings. These include:

Runoff Pollution Prevention

Impervious Surface Reduction

- ♦ street design
- ♦ cul-de-sac design
- ♦ parking lot design
- ♦ turf pavers
- ♦ green rooftops

Housekeeping

- ♦ pavement management
- ♦ BMP maintenance
- ♦ landscape design
- ♦ animal management

²⁹ Minneapolis Code of Ordinances §54.50.

³⁰ Minneapolis Code of Ordinances §54.60.

Construction Practices

- ♦ grading
- ♦ sequencing
- ♦ vehicle track pads

Soil Erosion Control

- ♦ mulches
- ♦ blankets and mats
- ♦ vegetative methods
- ♦ structural methods
- ♦ silt fences
- ♦ inlet protection
- ♦ temporary sedimentation basins/traps
- ♦ check dams

Storm Water Treatment BMPs

Infiltration Systems

- ♦ on-lot infiltration
- ♦ infiltration basins
- ♦ infiltration trenches

Filtration Systems

- ♦ bioretention systems
- ♦ surface sand filters
- ♦ underground filters
- ♦ filter strips

Constructed Wetlands

- ♦ BMPs in series;
- ♦ storm water wetlands
- ♦ wet swales

Retention Systems

- ♦ wet ponds
- ♦ extended storage ponds
- ♦ wet vaults

Detention Systems

- ♦ dry ponds
- ♦ oversized pipes
- ♦ oil/grit separators
- ♦ dry swales

Flow Control Structures

- ♦ permeable weirs
- ♦ flow splitters
- ♦ proprietary flow control devices

The Urban Small Sites BMP Manual also includes Model Storm Water Ordinances.

The City of Minneapolis's website also contains information on [rain gardens and rain barrels](#) and [environmentally friendly watershed practices for businesses](#) which includes model storm water ordinances.

PHILADELPHIA, PENNSYLVANIA

Population: 1.5 million.

Types of Green Infrastructure: Developers must meet water retention regulation.

The Philadelphia Water Department is currently revising the City of Philadelphia’s storm water regulations. The new guidelines will include new approaches to storm water management that include controls to improve the quality of storm water prior to discharge, controls to reduce the erosive effects of storm water, and measures to increase groundwater recharge. The new storm water regulations will ensure that Philadelphia has an up-to-date and effective storm water program that meets the state and federal requirements and can be coordinated with the changing regulations occurring in upstream municipalities.

[Philadelphia Storm Water Regulations](#) require compliance with the most recent version of the [Philadelphia Storm Water Management Guidance Manual](#). These regulations apply to development project, either new or redevelopment project, that result in an area of earth disturbance of greater than or equal to 15,000 square feet.³¹ Redevelopment projects that demonstrate a 20% reduction in directly connected impervious area, may be exempt from the some of the post-construction storm water management requirements.³² Developers must also establish a buffer area of land immediately adjacent to any surface water body by preserving or restoring native vegetation.³³

Green Infrastructure is not mandated, but encouraged by the water retention regulations. Developers are encouraged to use the storm water guidance manual to meet those regulations.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
LID is estimated to affect one square mile		18 million gallons

³¹ Philadelphia Code of Ordinances §600.2.

³² Philadelphia Code of Ordinances §600.5.

³³ Philadelphia Code of Ordinances §600.6

PORTLAND, OREGON

Population: 540,000

The City of Portland is in the 16th year of a 20 year program to [reduce CSOs](#). According to the City's website, projects have eliminated CSOs to the Columbia Slough and reduced total CSO volume by nearly 4 billion gallons per year. These projects include installation of deep tunnels, a pump station and expansion of a wastewater treatment plant. Portland has also instituted a number of other [programs](#) to address storm water:

- ♦ [Sustainable Storm Water Management Program](#)
- ♦ [Green Streets](#)
- ♦ [Innovative Wet Weather Program](#)
- ♦ [Landscapes for Rain](#)
- ♦ [Ecoroofs](#)
- ♦ [Clean Rivers Education Programs](#)
- ♦ [Downspout Disconnection program](#)
- ♦ [Naturescaping for Clean Rivers](#)
- ♦ [Community Watershed Stewardship Grants Program](#)
- ♦ Watershed Revegetation Program
- ♦ [Watershed Management Programs](#)
- ♦ [Industrial Storm Water Program](#)

Portland is also in the process of developing a storm water marketplace where property owners and developers would invest in small on-site treatment features that contain storm water on their property and keep it out of the sewer system. The City would not waive their storm water discharge fees, or they could choose to sell their excess volume reduction to property owners who are unable to add storm water management facilities to their property.

Portland's nonconforming development regulation, §33.258.070 of the Portland Code, is aimed at upgrading nonconforming development elements that affect the appearance and impacts of a site; not intended to require extensive changes that would be extremely impractical. Categories of non-conforming development that require compliance when certain events occur, for example non-conforming development associated with an existing non-conforming use – when this occurs, the site must be brought into conformance with the storm water management regulations.

The Portland Code requires downspout disconnections, storm water quality and quantity control facilities and establishes parking lot storm water requirements. Under these regulations, the quantity of storm water leaving a site after development must be less than or equal to the quantity of storm water leaving the site prior to development. Impervious surfaces must be mitigated through retention and on-site infiltrations. Parcels created after the enactment of the regulations are required to fully manage storm water on-site or within the original parcel, in accordance with the Portland [Storm Water Management Manual](#).³⁴ All storm water runoff from parking lots must be managed in the parking lot interior or in perimeter landscaping, in accordance with the Storm Water Management Manual.³⁵

³⁴ Portland Code §17.38.025. According to the Portland Bureau of Environmental Services, a [revised](#) Stormwater Management Manual will be issued in late fall 2007.

³⁵ Portland Code §17.38.041.

Portland is leading by example and requiring new City buildings to have a green roof that covers at least 70% of the roof area.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Downspout disconnection program. Residents are paid \$53 for each downspout disconnected.	So far, 42,000 downspouts have been disconnected.	942 million gallons annually are saved from the system.
Land Acquisition	Portland has used \$110 million of voter-approved funds to acquire 8,000 acres of greenspace.	
Northeast Siskiyou Street vegetated curb extensions	The project took two weeks to install and cost \$15,000.	The vegetated curb extensions reduce peak flow from a 25-year storm event by 88%, and reduce total runoff by 85%.
Liberty Center Parking Garage Planters	The planters accept runoff from more than 36,000 square feet of impervious surfaces and can retain about a two-year storm event. The cost was \$75,500.	

SEATTLE/KING COUNTY, WASHINGTON

Population: 590,000

Types of Green Infrastructure Used:

- ♦ green roofs
- ♦ downspout disconnection
- ♦ rain gardens
- ♦ vegetated swales

All development and redevelopment projects are required to comply with a storm water runoff rate of not more than 0.2 cubic feet per acre per second during a 25 year storm. Projects with more than square feet, the peak runoff rate shall not exceed 0.15 cubic feet per acre per second during a two year storm. Projects with more than 2,000 square feet of new and replaced impervious surface are required to install and maintain a flow control facility that is sized for the volume of runoff routed through the facility.³⁶

Large projects, activities that disturb one acre or more of land or add/replace 5000 sq. ft. or more of impervious surface, are also required to comply with a peak drainage water discharge rate of no more than 0.5 cubic feet/second/acre in a 100 year 24 hour design storm for the portion of the site developed that drains to a Class A or B riparian corridor, or to a drainage control system that drains to such a corridor.³⁷ Such sites must install and maintain treatment facilities and are required to install one of the following: infiltration, wetpond, storm water wetland, biofiltrations swale, filter strip, wet vault, media filter, or an alternative technology in certain circumstances.

Seattle has established a “green factor” for landscaping and screening as part of its commercial zoning code.³⁸ Landscaping that achieves a green factor score of 0.30 or greater is required for any new structure (1) containing more than 4 dwelling units; (2) more than 4000 sq. ft. of nonresidential uses; and (3) any new parking lot with more than 20 spaces. Green area factors are available for different types of landscaping including rain gardens, permeable pavement, green roofs and other landscape elements

The Seattle Pro Parks Levy provides \$16 million for land purchase for 18 new Neighborhood Parks in many of Seattle's most densely developed neighborhoods and \$10 million to preserve Green Spaces such as forested hillsides and creek corridors. In addition, \$5.7 million of the Levy's Opportunity Fund was designated toward acquisition projects. Seattle Parks has leveraged this \$31.7 million to secure \$21 million in private donations and city, county and state grants to augment the acquisition projects. By March 2007, Seattle Parks had acquired 42 acres of land.

Seattle has an innovative Natural Drainage Systems program which creates experimental bioretention ponds, swales, etc, around the city. Seattle has implemented a green street program, Street Edge Alternatives (SEA Streets) to address storm water runoff from streets. See, 2nd Avenue Project below.

³⁶ Seattle Code of Ordinances §22.802.015

³⁷ Seattle Code of Ordinances §22.802.016.

³⁸ Seattle Commercial Zoning Code Chapter 23.47A.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Viewlands Cascade	16 Stepped Vegetated Cells are used to collect storm water runoff from 72 acres. Cost: \$225,000.	Decreases storm water runoff by 75% to 80% and decreases peak flow rates by 60%.
2nd Avenue Street Edge Alternative	LID techniques used on 660' section of 2nd Avenue. Cost: \$850,000	99% reduction in storm water runoff.
King Street Center	The 327,000 square foot center uses three 5,400 gallon tanks to collect rainwater from the building's roof. The water is used for toilet flushing and landscaping.	The system saves 1.4 million gallons of water annually.
Subsidized Rain Barrel Program	More than 1,500 rain barrels have been sold at reduced rates	
Green Roofs	Seattle has installed four green roofs	Seattle has a started a multi-year data-collection initiative to study the effectiveness of green roofs.

WASHINGTON, D.C.

Population: 560,000

Types of Green Infrastructure Used:

- ♦ green roofs
- ♦ permeable pavement
- ♦ rain gardens
- ♦ vegetated swales

New Ordinances have been drafted and are being reviewed. They may be enacted as early as late fall 2007, and until then Collin Burrell's office is not available for comment.

D.C.'s green roof grant program offered complete design and build services instead of cash grants. It is for public and private buildings, but not residences. Design and construction is expected to begin this summer.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Green Roof Study.	A study evaluated the effects of installing 20 million square feet of green roofs in the city, which would cover 20% of the roof area for all city buildings over 10,000 square feet.	Modeling shows an overall reduction in runoff of 1% and a reduction in CSO discharges of 15%. The green roofs are anticipated to retain and store 430 million gallons annually and increased deep tunnel storage capacity by 30 million gallons.

TORONTO, ONTARIO, CANADA

Population: 2.5 million

Green Infrastructure Used:

- ♦ green roofs
- ♦ downspout disconnection
- ♦ wetlands
- ♦ urban forest

Four principles of storm water management:

1. Recognizing rainwater and snowmelt as a valuable resource
2. Managing wet weather flows on a watershed basis
3. Implementing the hierarchy of wet weather practices beginning with “source,” then “conveyance,” and lastly, “end-of-pipe” solution; and
4. Educating communities and involving the public.

PROJECT TYPE	PROJECT DESCRIPTION	EFFECTIVENESS
Green Roofs	Study suggested that it would cost \$36 million to install green roofs on 6% of Toronto’s roofs.	This would save an estimated 1 billion gallons of storm water annually.
Downspout disconnection	The city will disconnect residences for free and provide splash guards or rain barrels to protect residential foundations	As of June 2000, an estimated 20,000 homes had been disconnected.
More than 100 Green Roofs have already been installed.		Early findings indicate 57% average annual flow reductions.