3 Watershed Management Recommendations

This section of the plan describes specific recommendations to meet the watershed management goals and objectives outlined in *Section 2*. The recommendations include watershed-wide recommendations that can be implemented throughout the North Branch Park River watershed, targeted recommendations that are tailored to issues within specific subwatersheds or areas, and site-specific recommendations to address issues at selected sites that were identified during the watershed field inventories.

The recommendations presented in this section are classified according to their implementation priority. Recommendations can be viewed as short-term, mid-term, and long-term, as summarized below:

- *Short-Term Recommendations* are initial actions to be accomplished within the first one to two years of plan implementation. These actions establish the framework for implementing subsequent plan recommendations. Such actions include formation of an urban watershed stewardship organization; development of local regulations, LID and green infrastructure planning recommendations; discharge investigations; education program planning; and field inventories within previously unassessed subwatersheds. Small demonstration restoration projects could be completed during this phase, with volunteer service events, however construction of larger retrofit practices and stream restoration projects requiring extensive design, engineering, and permitting should be planned for later implementation. Project budgets for short-term recommendations could generally range from $5,000 to $100,000.

- *Mid-Term Recommendations* involve continued programmatic and operational measures, delivery of educational and outreach materials, and construction of several larger retrofit and/or stream restoration projects over the next two to five years. Progress on land conservation, especially the protection of headwaters and unique landscapes, LID and green infrastructure implementation, and discharge investigation follow-up activities should be completed during this period, as well as project monitoring and tracking. A sustainable funding and maintenance program should also be established for watershed green infrastructure through increased regional cooperation. Project budgets for mid-term recommendations could generally range from several thousand to several million dollars (for infrastructure-related projects).

- *Long-Term Recommendations* consist of continued implementation of any additional projects necessary to meet watershed objectives, as well as an evaluation of progress, accounting of successes and lessons learned, and an update of the watershed management plan. Long-term recommendations are intended to be completed during the next 5- to 10-year timeframe and beyond. The feasibility of long-term project recommendations, many of which involve significant infrastructure improvements, depends upon the availability of sustainable funding, such as stormwater utility fees.

Table 3-1 summarizes the management recommendations for the North Branch Park River watershed based upon the management objectives identified in the previous section. The recommendations are organized by implementation priority (short-, mid-, and long-term), scale

and location (watershed, targeted, or site-specific), and the groups who are responsible for implementing the recommendations. The remainder of this section presents detailed plan recommendations, including implementation priority, schedule, anticipated benefits, potential costs, funding sources, implementation responsibilities, and an evaluation framework to measure the progress of plan implementation.

Table 3-1. Watershed Management Plan Recommendations Summary

Action Items Priority Abbreviations S = short-term, M = mid-term, L = long-term Scale/Location Abbreviations W = watershed-wide, T = targeted, S = site-specific	Priority	Scale/Location	Who Should Be Involved (L = lead, A = assist)											
			Hartford	Bloomfield	West Hartford	MDC	Watershed Organization	CRCOG	Landowners	NCCD	FRWA/ PRWRI	CTDEP	NRCS	Citizens & Volunteers
Goal A - Plan Implementation														
Objective A-1. Establish Watershed Organization														
Establish independent Park River watershed organization	S	W									L	A		A
Secure funding and hire watershed coordinator	S	W					L							A
Establish NBPR advisory committee to guide plan implementation	S	W					L							A
Adopt watershed management plan through MOA	S	W	L	L	L									A
Identify potential funding sources and submit grant applications	S	W	L	L	L		L	A		A	A			
Objective A-2. Conduct Additional Field Assessments														
Perform additional stream and upland assessments	S	T					L						A	A
Goal B - Water Quality														
Objective B-1. Reduce or Eliminate CSO Discharges														
Implement CSO Long Term Control Plan (LTCP)	M/L	T				L								
Consider green infrastructure in combination with LTCP (see B-2)	M/L	T	A			L								
Objective B-2. Implement LID and Green Infrastructure														
Evaluate feasibility of incorporating green approaches in LTCP and City of Hartford stormwater management program	S	W	L			L	A							A
Implement LID/BMPs for Albany Avenue and Granby Street Outfalls	S	T	A			L	A							
Implement green infrastructure demonstration projects	S/M	W	L			L	A							
Require consideration of green approaches in MDC project design	S	W				L	A							
Modify municipal land use regulations to promote LID	S	W	L	L	L			A						A
Adopt green infrastructure and LID in municipal projects	M/L	W	L	L	L									
Implement priority stormwater retrofits	M/L	S/T	A	A	A	A	L			A				
Objective B-3. Identify and Eliminate Illicit Discharges														
Targeted illicit discharge investigations	S	T	L	L	L		A			A				
Implement municipal IDDE programs	M	W	L	L	L									
Implement priority stream cleanup efforts	S	S/T					L				A			A
Objective B-4. Protect and Restore Riparian Buffers														
Priority riparian buffer restoration projects	M/L	S/T	A	A	A		L		A				A	A
Adopt/strengthen stream buffer regulations	M	W	L	L	L									A
Incorporate minimum buffer widths into municipal wetland regulations	S	W	L	L	L			A						A
Adopt incentives for developers to restore degraded buffers	S	W	L	L	L			A						A
Amend Greater Hartford Flood Commission regulations	S	W	L											

Table 3-1. Watershed Management Plan Recommendations Summary

Action Items Priority Abbreviations S = short-term, M = mid-term, L = long-term Scale/Location Abbreviations W = watershed-wide, T = targeted, S = site-specific	Priority	Scale/Location	Who Should Be Involved (L = lead, A = assist)											
			Hartford	Bloomfield	West Hartford	MDC	Watershed Organization	CRCOG	Landowners	NCCD	FRWA/ PRWRI	CTDEP	NRCS	Citizens & Volunteers
Objective B-5. Implement Water Quality Monitoring Program														
Develop and implement long-term monitoring program	S	W					L				A	A		A
Implement field monitoring study of LID effectiveness	M	W	A	A	A		L			A				
Goal C - Habitat Protection and Restoration														
Objective C-1. Enhance In-stream and Riparian Habitat														
Conduct fish passage assessments	S	T					L			A				
Fish passage feasibility assessment of University of Hartford dam	S	S							L[1]			A		
Revise local stream crossing & stormwater design standards	S	W	L	L	L									
Implement priority stream restoration projects	M/L	S	L	L			L						A	A
Implement stream daylighting projects	L	S	L	L			L		A				A	
Objective C-2. Protect and Enhance Forests and Urban Tree Canopy and Restore Understory Vegetation														
Conduct watershed-wide urban tree canopy analysis	S	W					L					A		
Develop Town-based UTC goals and plan	M	W	L	L	L		A							A
Amend municipal regulations	S	W	L	L	L			A						A
Implement priority reforestation projects	M/L	T	L	L	L		A		A			A		
Engage tree wardens in watershed municipalities	S/M	W	A	A	A		L					A		
Implement reforestation/tree canopy demonstration projects	S/M	T	A	A	A		L							A
Landowner education, stewardship and incentive programs	S	W	A	A	A		L			A		A		A
Adopt City of Hartford Tree Ordinance and develop master plan	S	W	L											A
Promote urban agriculture, community gardens	M	T	L	L	L		A		A					A
Objective C-3. Control Invasive Species														
Develop invasive species management plan	M	T	A	A	A		L		A		A			A
Implement priority invasive species management projects	M/L	T	L	L	L		L		L			A		A
Goal D - Sustainable Growth and Land Use														
Objective D-1. Promote Smart Growth														
Modify municipal land use codes, ordinances, and plans	S	W	L	L	L			A						A
Objective D-2. Protect Open Space														
Priority land acquisitions and conservation restrictions	S/M	T	L	L	L		A		A			A		A
Continue to implement municipal open space plans	S	T	L	L	L									
Seek alternative funding sources for open space acquisition	S/M	T	L	L	L		A							
Promote use of open space through trail maps and events	S/M	T					L							A
Identify and protect priority farmland	M	T		L			A							A

Table 3-1. Watershed Management Plan Recommendations Summary

Action Items Priority Abbreviations S = short-term, M = mid-term, L = long-term Scale/Location Abbreviations W = watershed-wide, T = targeted, S = site-specific	Priority	Scale/Location	Who Should Be Involved (L = lead, A = assist)											
			Hartford	Bloomfield	West Hartford	MDC	Watershed Organization	CRCOG	Landowners	NCCD	FRWA/ PRWRI	CTDEP	NRCS	Citizens & Volunteers
Objective D-3. Promote Low-Impact, Context-Sensitive Greenways														
Develop a Greenway between Bloomfield & Hartford that protects the stream corridor and links to neighborhood cultural points of interest.	M/L	T	L	L				A	A					A
Incorporate LID and conservation design elements	M/L	T	L	L			A	A						
Objective D-4. Increase Public Access to the River														
Enhance river access on public lands	L	T	L	L	L		A							A
Develop public access inventory for the watershed	S	T	A	A	A		L			A				A
Implement signage, interpretive stations, and online resources	M	T	A	A	A		L			A				A
Provide linkages between the river and cultural institutions	M	T	L				A		A					A
Goal E - Public Education and Stewardship														
Objective E-1. Creation of Education & Stewardship Network														
Develop framework for watershed place-based K-12 education	S	W	A	A	A		L							A
Develop educational toolkit and school stewardship network	M	W	A	A	A		L							
Objective E-2. Campus Facility Managers Outreach														
Organize and host workshops to demonstrate best practices	S/M	W					L	A	A[2]					A
Encourage awareness and involvement by students and faculty	S/M	W					A		L[3]					A
Objective E-3. Residential Outreach														
Foster a "block-by-block" approach for the restoration and conservation of stream reaches and ponds.	S/M	W					L		L					L
Increase watershed stewardship signage in residential areas	M	W	L	L	L		A			A				A
Encourage and provide incentives for disconnection of roof runoff	M	W	L	L	L		A							A
Develop education/outreach materials	S	W					L	A						
Deliver education/outreach to the public	M	W	L	L	L									A
Objective E-4. Municipal and Business Outreach														
Review municipal facility compliance	S	W	L	L	L									
Improve municipal stormwater management programs	S/M	W	L	L	L									
Develop education/outreach materials	S	W					L	A						
Deliver education/outreach to the public	M	W	L	L	L									A
Increase watershed stewardship signage in commercial areas	M	W	L	L	L		A			A				A

PRWRI - Park River Watershed Revitalization Initiative
FRWA - Farmington River Watershed Association
NRCS - Natural Resource Conservation Service
CRCOG - Capitol Region Council of Governments
NCCD - North Central Conservation District
CTDEP - Connecticut Department of Environmental Protection
MDC - Metropolitan District Commission

[1]University of Hartford [2]Institutions including universities, schools, hospitals, golf courses, etc. [3]Universities and schools

3.1 Watershed-Wide Recommendations

Watershed-wide recommendations are those recommendations that can be implemented throughout the North Branch Park River watershed. These basic measures can be implemented in each of the watershed municipalities, are applicable in most areas of the watershed, and are intended to address nonpoint source pollution through municipal land use regulations and planning, green infrastructure and smart growth, public education and outreach, urban watershed forestry, and watershed monitoring. The water quality and natural resource benefits of these measures are primarily long-term and cumulative in nature resulting from runoff reduction, source control, pollution prevention, and improved stormwater management for new development and redevelopment projects.

3.1.1 Build a Foundation for Implementing the Plan

During the planning process, the project Steering Committee provided direction and local knowledge of the watershed in guiding the watershed assessments, determining priorities, and developing the management plan. As the focus of the planning process moves towards implementation, the project Steering Committee should transition to a formal watershed organization that will take a leadership role in implementing the North Branch Park River Watershed Management Plan. Because the task of raising public awareness pertains to the greater Hartford metro area, an independent organization can represent the Park River regional watershed (both the North and South Branch subwatersheds). Such an organization could be established for the entire Park River watershed, with an initial focus on the North Branch Park River and implementation of this plan, as well as future development and implementation of a similar watershed-based management plan for the South Branch Park River.

Recommended actions include:

- Establish an independent watershed organization (i.e., 501(c)3 non-profit corporation, partnership, coalition, or similar entity) for the Park River regional watershed; secure funding for and hire a watershed coordinator.
- Under the Park River watershed organization, form an advisory committee to guide the implementation of the North Branch Park River Watershed Management Plan.
- Include representatives from each of the watershed municipalities, while focusing on Hartford, West Hartford, and Bloomfield where greater than 97% of the watershed is located, and representatives from regional, state, federal and local environmental organizations, businesses, and local institutions.
- Develop a purpose statement, responsibilities, and operating procedures for the advisory committee. Advisory committee functions to guide the implementation of the North Branch Park River Watershed Management Plan may include:
  - Attend regularly scheduled committee meetings.
  - Adopt policy statements and funding decisions.
  - Provide input, guidance and resources to implement the watershed plan, including review of goals and objectives, assigning priorities and responsibilities for plan recommendations and work tasks, and monitoring progress of work products.

- Chair or participate in subcommittee(s) that may be formed to further implementation of the plan.
- Final approval of reports and products.
- Assist in submitting grant applications and seeking funding opportunities.
- Report the status of the watershed plan activities with the represented organizations and groups.
- Providing input and guiding the activity of contracted services.
- Comment on federal, state and municipal permit applications for consistency with the management plan.
- Periodically review and update action items in the plan (at least every 5 years).
- Develop annual work plans (i.e., specific "to-do" lists).
- Plan and lead public outreach activities.
- Host annual public meetings to celebrate accomplishments, recognize participants, review lessons learned, and solicit feedback on plan updates and next steps.

- Encourage adoption of the watershed plan by the watershed municipalities through a Memorandum of Agreement (MOA), Intermunicipal Agreement, or similar mechanism to encourage inter-municipal coordination and accountability and to formalize the municipalities' agreement to support the watershed planning effort through funding, staff, or other resources.
- Review and prioritize potential funding sources that have been preliminarily identified in this plan (see *Section 3.5.2*), and prepare and submit grant applications for projects identified in the watershed plan.

3.1.2 Low Impact Development and Green Infrastructure

What is Low Impact Development and Green Infrastructure?

Low Impact Development (LID) and green infrastructure are the preferred approaches by EPA and CTDEP for stormwater management in urban and suburban areas. The two terms are often used interchangeably, but are generally used in different contexts.

LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. The goal of LID is to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source. Instead of conveying and managing/treating stormwater in large, costly end-of-pipe facilities located at the bottom of drainage areas, LID addresses stormwater through small, cost-effective landscape features located at the lot level. LID is a versatile approach that can be applied equally well to new development, urban retrofits, and redevelopment projects.

Figure 3-1. Examples of Low Impact Development Practices

a. Site Planning

b. Reduced Clearing Limits

c. Vegetated Swales

d. Increased Flow Travel Time

e. Parking Lot Bioretention

f. Stormwater Planters

g. Permeable Pavement

h. Green Roofs

Source: Larry Coffman, Low Impact Development Center (a through f), University of Connecticut (g and h).

Green infrastructure is a relatively new term and, similar to LID, refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspire, or reuse stormwater. However, while LID is generally used to describe development approaches and practices at the site level, the term "green infrastructure" is typically used in a broader range of contexts and scales. LID hydrologic calculations are based on site-specific conditions within a watershed, while green infrastructure refers to features within a larger water resource management system. At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are components of green infrastructure. On a smaller scale, green infrastructure practices also include rain gardens, permeable pavement, green roofs, green streets, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation. These approaches reduce the amount of runoff discharging to surface waters and keep rainwater out of sewer systems so it does not contribute to sewer overflows (EPA Green Infrastructure Website, Accessed June 24, 2010).

Table 3-2 summarizes various types of green infrastructure practices approaches and the scales at which they are typically applied. Many of the site and neighborhood-scale practices are also considered LID techniques.

Table 3-2. Green Infrastructure Practices and Approaches

Scale	Green Infrastructure Practices and Approaches
Site	Green Roofs Rain Harvesting Downspout Disconnection Planter Boxes Rain Gardens/Bioretention Permeable Pavement Vegetated Swales Stormwater Wetlands Stormwater Infiltration Systems Brownfield Redevelopment Infill and Redevelopment
Neighborhood	Green Parking Green Streets & Highways Trees & Urban Forestry
Watershed	Wetland/Riparian Buffers Urban Forests

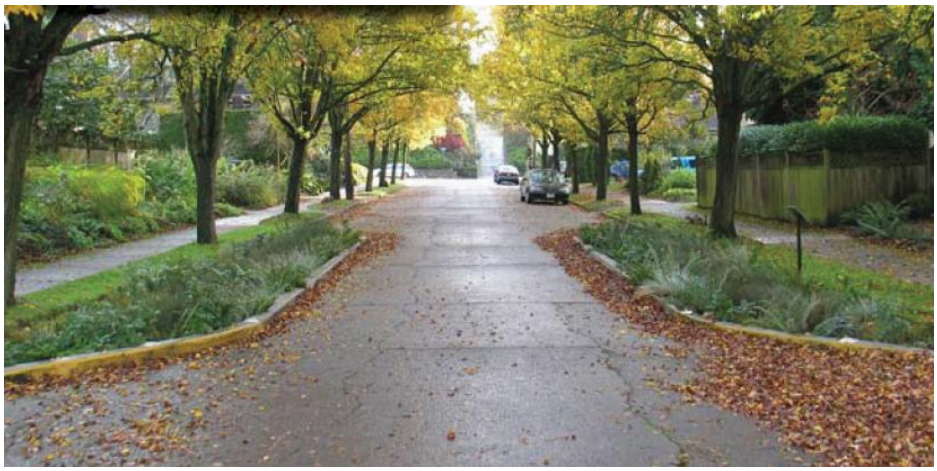
Source: Adapted from EPA Green Infrastructure Website, Accessed June 24, 2010.

Additional Benefits of LID and Green Infrastructure

In addition to reducing the overall volume of stormwater runoff, pollutant loads, and the frequency of sewer overflows, green infrastructure offers a number of other environmental, economic, and human health benefits, which are often accentuated in urban and suburban areas. These additional benefits include (Green Infrastructure Statement of Intent, EPA, April 19, 2007):

- *Cleaner Water* – Vegetation and green space reduce the amount of stormwater runoff and, in combined systems, the volume of combined sewer overflows.

Figure 3-2. Examples of Green Infrastructure Practices



a. Stormwater Curb Extensions

b. Stormwater Planters

c. Rain Harvesting

d. Urban Forestry

Source: EPA, 2008.

- *Enhanced Watercourses, Waterbodies, and Water Supplies* – Most green infiltration approaches involve allowing stormwater to percolate through the soil where it recharges the groundwater and the base flow for streams, thus ensuring adequate water supplies for humans and more stable aquatic ecosystems.

- *Cleaner Air* – Trees and vegetation improve air quality by filtering many airborne pollutants and can help reduce the amount of respiratory illness.

- *Reduced Urban Temperatures* – Summer city temperatures can average 10ºF higher than nearby suburban temperatures. High temperatures are linked to higher ground level ozone concentrations. Vegetation creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air.

- *Increased Energy Efficiency* – Green space helps lower ambient temperatures and, when incorporated on and around buildings, helps shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling.

- *Community Benefits* – Trees and plants improve urban aesthetics and community livability by providing recreational and wildlife areas. Studies show that property values are higher when trees and other vegetation are present.

- *Cost Savings* - Green infrastructure may save capital costs associated with digging big tunnels and centralized stormwater ponds, operations and maintenance expenses for treatment plants, pumping stations, pipes, and other hard infrastructure; energy costs for pumping water around; cost of treatment during wet weather; and costs of repairing the damage caused by stormwater and sewage pollution, such as streambank restoration.

Green Infrastructure and CSO Control

Many urban areas, including the Hartford metropolitan area, utilize combined sewers to convey sewage and stormwater runoff to water pollution control facilities for treatment. Combined sewers are designed to convey sewage and a limited amount of stormwater runoff. When runoff exceeds available system capacity, combined sewer overflows (CSOs) occur as direct discharges of untreated sewage to water bodies, contributing to degraded water quality and habitat conditions such as exists in the North Branch Park River.

Conventional approaches to CSO abatement generally seek to increase storage or conveyance capacity within the sewer system. Two common designs are inline storage systems and CSO tanks. In-line storage systems add storage volume within the sewer system, while CSO tanks are large underground chambers situated at CSO discharge points. Both systems avert discharges by storing and, in some cases, also treating excess sewer flow before releasing it slowly back to the sewer system. These approaches can be effective but are often expensive and difficult to site, especially in urban areas where the availability of land is limited and land acquisition costs can be relatively high.

Green infrastructure can be both a cost effective and an environmentally beneficial approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with centralized hard infrastructure solutions. Other U.S. cities have incorporated green infrastructure approaches into their CSO control programs and are using green infrastructure to reduce stormwater pollution for compliance with municipal stormwater permit requirements (NRDC, 2006).

The preferred approach for CSO control within the North Branch Park River and other portions of the Hartford sewer system, as dictated by a federal consent decree and CTDEP consent order, consists primarily of separating the combined sewers and constructing new separate storm sewers to carry stormwater runoff. This aggressive approach is designed to eliminate CSOs during storms up to and including the typical one-year frequency event. However, it also presents an opportunity to augment sewer separation and other traditional CSO abatement efforts with green infrastructure approaches to reduce the volume of runoff and improve the quality of stormwater discharges from the new separated storm drainage outfalls to the North Branch Park River. Green infrastructure approaches can also be effective for addressing municipal stormwater permit requirements for existing and new stormwater discharges.

Obstacles to Green Infrastructure

Although many cities have begun to embrace green infrastructure for addressing sewer overflows and stormwater pollution, concerns still persist over the feasibility of green infrastructure in highly urbanized areas. This is in part because of a perception that insufficient land is available for green infrastructure implementation in cities. However, the major perceived obstacle is that green infrastructure is costly to retrofit or introduce into urban landscapes.

Although green infrastructure is in many cases less costly than traditional methods of stormwater and sewer overflow control, some municipalities persist in investing only in conventional controls rather than trying an alternative approach (NRDC, 2006). Additionally, public agencies generally do not pay for green infrastructure or LID retrofits on private property. Private property owners may marginally benefit from onsite green infrastructure in terms of increased real estate value, reduced risk of flooding, etc., but usually bear most of the cost of installation and maintenance of green infrastructure and LID practices (Montalto et al., 2007). Cities and towns that have developed successful green infrastructure programs have incentives (or perceived dis-incentives), such as stormwater utility fees. Comprehensive green infrastructure programs depend upon research to determine appropriate basin-specific water management objectives. Fortunately, such work is a meaningful evolution of green jobs.

Ongoing CSO Control and Green Infrastructure Efforts

As described in the baseline assessment report, the MDC is implementing a major infrastructure improvement program known as "The Clean Water Project" to achieve state and federal water quality goals by 2020. The Clean Water Project is a rare opportunity for systemic green infrastructure improvements to reduce stormwater run-off throughout the city. The objectives of the Clean Water Project include the reduction of combined and sanitary sewer overflows, as well as nitrogen reductions. The Long Term Control Plan would eliminate all discharge from CSOs during storms up to and including the typical one-year frequency event.

The District plans to address the CSO issues by implementing one or more of the following traditional strategies:

- Separating the combined sewer systems
- Correcting illegal connections including roof drains and sump pumps and groundwater infiltration locations
- Installing new, larger sewer pipes
- Installing storage pipes to hold storm flows and prevent storm event related discharges
- Increasing sewer treatment plant capacities

The MDC and the City of Hartford are also evaluating the use of green infrastructure approaches and LID to further manage wet weather flows, including storm runoff volume and quality. Such practices include the installation of storage beneath athletic fields, rain gardens, open channels/bio-swales, and pervious pavements which promote the infiltration of runoff into the soil instead of directing it into the storm and/or combined sewer system. Green infrastructure concepts have also been proposed for in and around the State Capitol in Hartford including the removal of impervious cover (reduction of paved areas) and the installation of stormwater swales and rain gardens. Development of the MDC green infrastructure plan and the "Green Capitols" project are ongoing. Cooperation from the City of Hartford (and the community interest necessary to support political will) is essential because the MDC only owns/manages the below-grade sewer system.

Plan Recommendations

- Ultimately, the existing CSO discharges to the North Branch Park River must be significantly reduced or eliminated to realize improvements in water quality in the river. The MDC should continue to implement its CSO Long Term Control Plan, but also consider green infrastructure and LID alternatives in combination with traditional hard infrastructure solutions to further reduce runoff volume and stormwater pollution from existing outfalls and new outfalls that result from sewer separation efforts.

- The MDC, in partnership with CTDEP, the City of Hartford, and other member communities, should conduct a comprehensive study to evaluate the feasibility and benefits of incorporating green infrastructure approaches to augment the MDC's CSO Long Term Control Plan as well as municipal (MS4) stormwater management programs. Such a study could build upon the ongoing green infrastructure planning efforts of the MDC and City of Hartford One City, One Plan (POCD) progress, as well as information contained in this watershed plan and other ongoing planning initiatives. Elements of the study should include:
    - An inventory and mapping of existing and potential conditions that will support (or detract from) green infrastructure planning including natural resources, social and economic resources.
    - Demonstration of project types with clear water quality benefits that can be implemented throughout the city for fairly fixed costs, such as infiltration and storage beneath athletic fields, bio-swales at the edge of parking lots, and rain gardens around stormwater drains that have been placed in fields and parkland.

- Hydrologic and hydraulic modeling to quantify the potential benefits of green infrastructure in terms of reductions in runoff volume, stormwater pollutant loads, and sewer overflow discharges. The modeling should incorporate a cost-benefit analysis for comparison of the cost-effectiveness of green infrastructure with traditional stormwater management approaches.
- Identification of public land areas available for long-term green infrastructure management such as City of Hartford property, most notably Flood Commission properties, state-owned properties within the watershed, and other available municipal and state properties within the watershed.
- Identification of privately-owned land, such as institutional and corporate campuses, that could provide additional long-term green infrastructure system benefits within the watershed and residential neighborhoods.
- Evaluation of various types of green infrastructure practices, through demonstration projects that can be monitored in order to select the practices that are most feasible in the Hartford area such as:
  - Rain gardens
  - Green streets
  - Pervious pavement
  - Green roofs
  - Green walls/columns (integrating vertical city construction with a vertical watershed concept)
  - Downspout disconnection
  - Outfall retrofits
- Evaluation of the potential benefits of expanded stream buffers and restored urban forests, including identification of future high-density development locations within the watershed.
- Evaluation of various green build-out scenarios similar to approaches taken by other cities in the U.S.
- Evaluation of long-term program costs and financing alternatives, including incentive mechanisms for implementation of LID and green infrastructure on private property (stormwater fee discounts, development incentives, grants, and rebates and installation financing). The MDC and City of Hartford should explore the feasibility of a stormwater utility, borrowing from lessons learned from the recent CTDEP stormwater utility pilot projects and the ongoing work by the CTDEP to incorporate LID into state permits and policy.
- Identify selected pilot locations within problem areas to demonstrate the feasibility and effectiveness of green infrastructure approaches. The northwestern neighborhoods of Hartford located within the North Branch Park River watershed are a potential candidate given the existing combined sewer system in this area and proposed plans for sewer separation.
- As recommended in the City of Hartford's recently adopted Plan of Conservation and Development ("One City, One Plan"), resolve the issue of shared stormwater responsibility between the City and the MDC.

- The MDC should design and construct LID measures and/or end-of-pipe structural Best Management Practices (BMPs) for new stormwater discharges to the North Branch Park River and its tributaries as a result of sewer separation projects, including planned stormwater outfalls associated with the Upper Albany Avenue and Granby

Street separation projects to ensure that stormwater runoff is not discharged directly into the river.

- The MDC recently included language in engineering design proposals requiring their design consultants to consider LID and green infrastructure approaches as alternatives to traditional hard infrastructure in all projects of the MDC Clean Water Project. Green infrastructure approaches should be given primary consideration and implemented whenever feasible to better manage stormwater runoff and reduce NPS pollution.

- Implement the MDC "Green Capitols" and similar green infrastructure downtown demonstration projects generated by the "iQuilt" initiative. In addition, the MDC can work with the City of Hartford on green infrastructure projects that will benefit residential neighborhoods, such as athletic fields, parklands, and green streets. However the neighborhood civic groups and the City of Hartford must provide leadership through the design process. Additional information on EPA's *Greening America's Capitals* project is available at http://www.epa.gov/smartgrowth/greencapitals.htm.

- Upstream watershed municipalities (Bloomfield and West Hartford) should incorporate LID and green infrastructure into municipal projects: 1) protect headwaters from development, 2) focus on areas where waters become impaired, and 3) implement green infrastructure projects to mitigate stormwater runoff, including roadway projects using "green streets" approaches. These watershed municipalities can take a leadership role by also incorporating LID green infrastructure into a high-profile demonstration project at a publicly-owned facility. All green infrastructure sites should be regularly monitored and actively used for educational purposes.

- Watershed municipalities should incorporate LID and green infrastructure stormwater requirements into their local land use regulations to: 1) satisfy existing and future Phase II Stormwater Program regulatory requirements, 2) provide incentives, for example funding or simply accelerated permitting, and require LID practices and green infrastructure approaches to be implemented for new development and redevelopment projects, and 3) address other local drainage and natural resource protection issues identified by the municipalities.

3.1.3 Land Use Regulations

The land use regulatory review that was performed as part of the plan development process identified areas for improvements in municipal local land use regulations and related land use planning documents to better protect water resources throughout the watershed. The following sections summarize recommendations for the three primary municipalities in the watershed – Bloomfield, Hartford, and West Hartford – as well as several other governmental entities in the watershed. A copy of the complete land use regulatory review is included on CD in *Appendix C* of this watershed management plan.

Bloomfield

Bloomfield adopted new Zoning Regulations in the summer of 2009, which strengthened provisions for innovative stormwater management design, erosion and sediment control, and

protection of steep slopes and hillsides through the use of the Talcott Mountain Overlay District. Bloomfield also has progressive Inland Wetlands and Watercourses regulations, including riparian buffer protection through minimum buffer widths (100 feet for the North Branch Park River) and the preservation of natural buffers, a progressive upland review area, defined as 200 feet from watercourses and 100 feet from wetlands, and provisions for protection of vernal pools.

The Bloomfield Subdivision Regulations, including standard specifications and details for the design and construction of subdivision improvements, were last modified in 1992 and are outdated with respect to stormwater quality management and storm drainage. Bloomfield is also in the process of revising its Plan of Conservation and Development, which presents an opportunity to incorporate a number of key planning initiatives and recommended regulatory revisions that will help protect water resources from potential impacts associated with future land development in Bloomfield.

Specific land use regulatory and planning recommendations for Bloomfield include:

- Promote watershed planning, smart growth, open space protection, green infrastructure, and LID principles in the revised Plan of Conservation and Development, including adoption of the North Branch Park River Watershed Management Plan.
- Modify the Stormwater Runoff section of its zoning regulations to include a set of stormwater management standards. Development of stormwater management standards would allow Bloomfield to establish clearer, specific performance standards that all projects must meet in order to obtain P&Z approval. At a minimum, the revised standards should reference the Connecticut Stormwater Quality Manual (as amended). The stormwater standards could include LID practices recommended for use in Bloomfield and could be tailored to protect specific water bodies or sensitive resources in the Town of Bloomfield.
- Explore the feasibility of a stormwater utility or other stormwater program financing options, borrowing from lessons learned from the recent CTDEP stormwater utility pilot projects and the ongoing work by the CTDEP to incorporate LID into state permits and policy.
- Consider establishing an administrative process or public funding to support open space planning and acquisition.
- Bloomfield may require that due regard be given to the preservation and enhancement of scenic points and vistas, ridgelines, and contours of the land but does not specifically regulate development along ridgelines. Bloomfield should consider modifications to its zoning regulations to regulate development along ridgelines.
- Adopt regulations or make specific recommendations concerning the use of pesticides on town property.
- Consider limits on net increase in stormwater runoff volume in addition to peak flow as a result of development.
- Strengthen the landscape provisions of the Zoning Regulations by requiring maximum tree preservation, replacement and diversity of tree species.
- Review current setbacks and lot dimensions in subdivisions for potential to relax side yard setbacks and allow narrower frontages to reduce road length and site

imperviousness, and to relax front setback requirements to reduce driveway length and lot imperviousness.

- Review existing parking ratios to see if lower ratios are warranted and feasible. The required parking ratio for a particular land use (other than commercial retail) should be enforced as both a maximum and minimum to limit excess parking space construction and impervious cover. Consider allowing the Commission to approve parking lots with more spaces than the allowed maximum provided all of the spaces above the maximum number are composed of a pervious surface, and where adequate stormwater management is provided. Also consider parking spaces held in reserve for phased developments, thereby avoiding the situation where unnecessary parking is not constructed if future phases of development do not occur.
- Modify the parking area landscaped area requirements in the zoning regulations to promote parking lot bioretention and other LID practices.
- Modify the Subdivision Regulations (last revised in 1992) to reflect updated stormwater quality standards, LID and green infrastructure, drainage design, and street design (complete or green streets).
- Revise storm drainage design standards and regulations such that new or modified stream crossings are designed consistent with the Connecticut DEP Stream Crossing Guidelines.
- Consider modifying the zoning regulations to promote the use of and remove common barriers to implementing smart growth principles. General recommendations include:
  - Use urban dimensions in urban places to allow for more compact development
  - Revise/reduce parking requirements to reduce unnecessary impervious cover (see above)
  - Increase density and intensity in centers
  - Modernize street standards
  - Designate and support preferred growth areas and development sites
  - Use green infrastructure and LID to manage stormwater (see above)
- Consider unique species or communities in regulations for open space, alternative or traditional subdivision regulations.
- Consider habitat fragmentation in regulations for open space, or for alternative/traditional subdivisions.

Hartford

The City of Hartford adopted a new Plan of Conservation and Development ("One City, One Plan") in June 2010. Development of the Plan of Conservation and Development involved a comprehensive public discussion on measures to promote neighborhood revitalization. In the process, community interest groups requested adoption of the North Branch Park River Watershed Management Plan. Interest was also expressed by stakeholders in updating the city's Inland Wetlands and Watercourses Regulations and stormwater management requirements of the Zoning Regulations. Overall, the stated goals of the Plan of Conservation and Development include many of the goals and recommendations of this watershed management plan. The regulatory review also identified additional regulatory and planning recommendations for the City of Hartford.

Specific land use regulatory and planning recommendations for Hartford include:

- Consider updating and maintaining a comprehensive online map of existing City of Hartford Inland Wetlands and Watercourses.
- Add definitions for watershed, vernal pools, and riparian buffers to the Inland Wetlands and Watercourses Regulations.
- Embrace a watershed perspective in its land use planning and/or its regulations.
- Amend the Inland Wetlands and Watercourses Regulations to promote the preservation and restoration of vegetative buffers, including recommended minimum riparian buffer widths and the preservation of natural buffers. Ensure that new development occurs with respect to regulations that protect water quality, and outline conditions to address existing development that may be damaging to water quality, especially with respect to parking areas that are less than 25 feet from the stream corridor.
- Revise the zoning regulations to strengthen stormwater management requirements and require the inclusion of Best Management Practices and Low Impact Development Design techniques in stormwater management plans. Use regulatory site plan review as a tool to ensure stormwater quality measures are implemented in new developments.
- Explore the feasibility of a stormwater utility or other stormwater program financing options, borrowing from lessons learned from the recent CTDEP stormwater utility pilot projects and the ongoing work by the CTDEP to incorporate LID into state permits and policy.
- Promote "smart growth" principles that address stormwater management through LID and green infrastructure strategies.
- Revise storm drainage design standards and regulations such that new or modified stream crossings are designed consistent with the Connecticut DEP Stream Crossing Guidelines.
- Review the municipal code and regulations for potential regulatory barriers to implementing downspout disconnection and revise the ordinances/regulations accordingly.
- Consideration of habitat fragmentation in regulations for open space, or for alternative/traditional subdivisions.
- Conduct a comprehensive review of the "Soil Erosion, Sediment Control and Storm Water Runoff" sections of the zoning regulations.
- Adopt the proposed City of Hartford Tree Ordinance. Include a comprehensive urban forest master plan that distinguishes sites and woodland ecosystems variations within parks, open spaces, and stream corridors as well as trees for streetscapes and parking lots that enhance LID and green infrastructure urban design benefits.

- Consider increasing the fine for illegal dumping (currently $100) to include cost of clean-up and restoration of environmental disturbance, which may involve a cooperative effort to update the state fines for illegal dumping.
- Develop historic landscape preservation guidelines that can inform interested property owners, and the decision-making process of the Historic Preservation Commission.
- Designate significant historic parkland and cemeteries as cultural landscape districts subject to the Historic Preservation Ordinance, and thus review by the Historic Preservation Commission.
- Review parking regulations to ensure they are consistent with smart growth & sustainability, including opportunities to reduce parking ratios, parking space size, and other factors that would reduce impervious cover.
- Adopt a City-wide complete streets roadway design policy. Employ traffic calming techniques in residential areas where appropriate, and integrate stormwater management through green streets concepts (stormwater curb extensions, roadside bioretention and water quality swales).

West Hartford

The Town of West Hartford also recently revised its Plan of Conservation and Development. West Hartford's Plan of Conservation and Development for 2009-2019 strongly emphasizes sustainability and quality of life, including preservation of remaining open space; accessible and welcoming streetscapes and public spaces; sound energy policies; and low impact development. The West Hartford Plan of Conservation and Development also contains good recommendations for improving land use practices and water quality protection, including review and revision of the Town's zoning, subdivision, and inland wetlands regulations.

Specific land use regulatory and planning recommendations for West Hartford include:

- Strengthen landscape provisions of the zoning ordinance and the subdivision regulations to require maximum tree preservation and replacement.
- Amend zoning ordinance to authorize Town Planner to refer site plan applications to the Design Review Advisory Committee and for TPZC to refer Special Use Permit applications at discretion to the Design Review Advisory Committee.
- Conduct a comprehensive review of the parking requirement standards of the zoning ordinance, in particular as it relates to number of parking spaces required by use and size of parking stalls.
- Review zoning ordinance to determine if additional ridgeline protection is necessary;
- Revise zoning ordinance to strengthen stormwater management requirements and require the inclusion of Best Management Practices and Low Impact Development Design techniques in stormwater management plans.
- Conduct a comprehensive review of the "Soil Erosion, Sediment Control and Storm Water Runoff" section of the zoning ordinance.
- Review Subdivision Regulations to determine if the street design standards effectively promote the "complete street network."
- Review Subdivision Regulations to determine if ridgelines and other natural resources are adequately protected.

- Review the Inland Wetlands and Watercourses Regulations to determine if the current regulations are adequate to continue to protect the Town's natural resources and implement the policies of the PCD, in particular as outlined in the Open Space/Conservation section. Measures such as the possible adoption of conservation overlay zones should be evaluated.
- Inclusion of a watershed-based approach in long-term planning, including adoption of the North Branch Park River Watershed Management Plan.
- Develop a "Metacomet Ridge Overlay District" to protect the natural character of the ridge, the National Historic Metacomet Monadnock Mattabesett (MMM) Trail, and to protect water quality within the MDC Reservoirs. Existing ridge protection overlay districts in Avon and Bloomfield can serve as a reference.
- Review Subdivision Regulations to determine if street design standards effectively promote best management practices for stormwater runoff and the principles of Low Impact Development.
- Consider limits on net increase in stormwater runoff volume in addition to peak flow as a result of development.
- Explore the feasibility of a stormwater utility or other stormwater program financing options, borrowing from lessons learned from the recent CTDEP stormwater utility pilot projects and the ongoing work by the CTDEP to incorporate LID into state permits and policy.
- Revise storm drainage design standards and regulations such that new or modified stream crossings are designed consistent with the Connecticut DEP Stream Crossing Guidelines.
- Review the municipal code and regulations for potential regulatory barriers to implementing downspout disconnection. Guidance provided by the West Hartford Department of Public Works recommends redirecting rain downspouts to lawn areas as one possible measure to alleviate flooding problems in areas with combined sewers. However, the municipal code and regulations related to sewers may conflict with downspout disconnection and, if so, should be revised accordingly.
- Discretion to require an E&S plan as needed for certain sites where disturbance is less than ½ acre but erosion risk is high.
- Explicit protection of steep slopes from development.
- Specific regulations concerning engineered septic systems.
- Inclusion of unique species, natural communities, habitat continuity, and ecosystem services as protection goals in regulations.
- Amend the Inland Wetlands and Watercourses Regulations to incorporate revised stormwater management standards and LID practices, including reference to the Connecticut Stormwater Quality Manual (as amended).
- Amend the Inland Wetlands and Watercourses Regulations to promote the preservation and restoration of vegetative buffers, including recommended minimum buffer widths (100 feet for the North Branch Park River) and the preservation of natural buffers similar to the Bloomfield regulations.

Greater Hartford Flood Commission

Although the Greater Hartford Flood Commission regulations address potential erosion and sedimentation due to flooding, they do not directly address water quality or related issues such as riparian zone protection, impervious cover limits, etc. Opportunities exist to incorporate additional protection of the riparian zone within the Flood Plain District, which would provide additional water quality benefits for the North Branch Park River. Potential modifications to the regulations that should be considered include:

- Acknowledge the importance of maintaining native vegetation within the riparian zone. Healthy vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The disturbance of such vegetation destabilizes the banks of channels and other surface waters, which leads to increased erosion and sedimentation that exacerbates the intensity and frequency of flooding. The loss of vegetation adjacent to surface waters also reduces filtration of stormwater runoff and thus degrades the quality of these waters. Such impacts adversely affect the health and habitat of fish and wildlife that depend upon clean surface waters and therefore disrupt the ecological balance that is necessary for life. Humans are ultimately affected by this imbalance, since clean water is essential for all life (New Jersey Department of Environmental Protection, Flood Hazard Area Control Act Rules, November 5, 2007). Invasive species removal and the restoration of native vegetation provides habitat for migratory songbirds that often connect urban residents to environmental values and an interest in natural sciences.
- Establish regulated riparian zones within the Flood Plain District.
- Establish maximum disturbance and include vegetation replacement and mitigation for various activities.
- Limit the area of vegetation that can be disturbed for various regulated activities. A permit for activity involving disturbance of the riparian zone would be issued only if specific conditions are met, such as:
    - The basic purpose of the project cannot be accomplished on site without disturbing vegetation in the riparian zone.
    - Disturbance to the riparian zone is eliminated where possible and minimized where not possible by relocating the project, reducing the size of the project, or situating the project in portions of the riparian zone where previous development or disturbance has occurred.
    - Any temporarily cleared area of vegetation must be replanted with indigenous, non-invasive vegetation.
    - Limits on the amount of disturbance allowed for specific activities.
- Limit disturbance within specified distances from the top of bank for certain activities.
- Where the standards cannot be met, providing greater than 1:1 compensation in the form of re-vegetation and placing a deed restriction on the compensation area.

Metropolitan District Commission

As part of its ongoing green infrastructure planning efforts, the MDC, working together with its member communities within the watershed, should conduct a comprehensive review of its sewer ordinance, standards, and policies to identify and remove potential regulatory barriers to green infrastructure and LID, including barriers to downspout disconnection. The MDC should also evaluate the feasibility of a stormwater utility or other financing mechanism for

green infrastructure programs, as well as incentives for downspout disconnection by private property owners.

3.1.4 Smart Growth

"Smart growth" includes a range of development and conservation strategies that help protect natural resources and make communities more attractive, economically stronger, and more socially diverse. Smart growth practices have a number of benefits including lessening the environmental impacts of development with techniques that include compact development, reduced impervious surfaces and improved water detention, safeguarding of environmentally sensitive areas, mixing of land uses, transit accessibility, and better pedestrian and bicycle amenities. Compact development and open space preservation can help protect water quality by reducing the amount of paved surfaces and by allowing natural lands to filter rainwater and runoff before it reaches water resources (EPA Website, Accessed June 25, 2010).

Smart growth practices can benefit both developed and undeveloped communities. For largely undeveloped communities with significant development potential, smart growth can shape the future development of homes, neighborhoods, and entire communities. Smart growth principles can also benefit developed areas through infill redevelopment and redevelopment of underutilized sites.

The communities of West Hartford and Hartford have already adopted smart growth planning principles through their municipal Plans of Conservation and Development. Bloomfield is in the process of revising its Plan of Conservation and Development. Bloomfield also has the greatest potential for future new development within the North Branch Park River watershed, and much of the development potential is associated with residential and industrial-zoned properties near sensitive headwater streams. Therefore, a key opportunity exists for Bloomfield to incorporate smart growth principles into its revised Plan of Conservation and Development, which would promote resource conservation and sustainable land development in sensitive areas of the watershed. Specific recommendations related to smart growth include:

- Bloomfield should incorporate smart growth principles in its revised Plan of Conservation and Development.
- All of the watershed communities should consider modifying local land development codes and ordinances (see recommendations in *Section 6.1.3*) to promote the use of and remove common barriers to implementing smart growth principles. General recommendations include:
  - Allow or require mixed-use zones
  - Use urban dimensions in urban places to allow for more compact development
  - Revise/reduce parking requirements to reduce unnecessary impervious cover
  - Increase density and intensity in centers
  - Modernize street standards
  - Designate and support preferred growth areas and development sites
  - Use green infrastructure and LID to manage stormwater
  - Establish a water budget based on site conditions prior to development and strive to preserve pre-development site hydrology

3.1.5 Urban Watershed Forestry

What is Urban Watershed Forestry?

Urban forest research over the last several decades and new technical analysis tools have defined a wider role and value for urban trees. Urban trees and forests improve air and water quality, reduce stormwater runoff, conserve energy, and protect public health (*Table 3-3*). At the same time, the loss of trees and forests in suburban and urban watersheds continues through removal or lack of replacement. The ongoing conversion of forests to urban uses underscores the need for greater integration of forest and land use planning (USDA Forest Service, 2005).

Traditional approaches to restoring urban watersheds that have relied on structural solutions have failed to protect and restore urban streams. Through green infrastructure approaches, vegetation and natural systems are now considered a key tool in the protection and restoration of urban watersheds.

Urban watershed forestry integrates the fields of urban and community forestry and watershed planning. Urban and community forestry is the management of the urban forest for environmental, community, and economic benefits, while watershed planning promotes sound land use and resource management to improve water resources within a watershed. Therefore, urban watershed forestry sets watershed-based goals for managing the urban forest as a whole rather than managing forest resources on a site-by-site or jurisdictional basis, and provides strategies for incorporating forests into urban watershed management (USDA Forest Service, 2005).

Urban watershed forestry has three principal goals:

1. Protect undeveloped forests from human encroachment and the impacts of land development by creating and applying various planning techniques, regulatory tools, and incentives.
2. Enhance the health, condition, and function of urban forest fragments.
3. Reforest open land through active replanting or natural regeneration to regain some of the functions and benefits of a forest and to increase overall watershed forest cover, tree canopy, and forest connectivity along stream corridors.

Urban Tree Canopy

Urban Tree Canopy (UTC) is defined as the layer of tree leaves, branches, and stems that cover the ground when viewed from above. Tree canopy is a useful parameter because it provides such benefits as rainfall interception, pollutant removal, and reduced temperatures due to shading of streams and impervious surfaces, and can be measured using remote sensing and/or field techniques.

Many communities have assessed the tree canopy in their community and developed urban tree canopy goals as numerical targets to guide urban watershed forestry planning efforts.

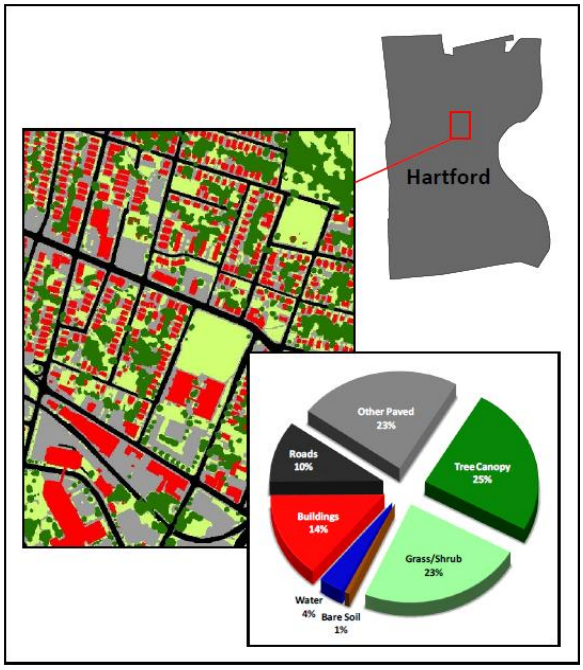
Table 3-3. Watershed Benefits of Forest Cover

Benefit	Description
Reduce storm water runoff and flooding	• Trees intercept rainfall in their canopy, reducing the amount of rain that reaches the ground. A portion of this intercepted rainwater evaporates from tree surfaces. This effect is greater in low rainfall events. • Trees take up water from the soil through their roots during transpiration, which increases soil water storage potential and lengthens the amount of time before rainfall becomes runoff • Trees promote infiltration by attenuating runoff and by increasing soil drainage due to the creation of macropores by tree roots. The addition of organic matter (e.g., leaf litter) also increases storage of water in the soil, further reducing runoff. • Reduced runoff from forested land reduces the frequency and volume of downstream flood events.
Improve regional air quality	• Trees absorb nitrogen dioxide, carbon monoxide, ozone, and particulate matter from the atmosphere. • Trees reduce air temperature which reduces formation of pollutants that are temperature dependent, such as ozone • Trees indirectly improve air quality by cooling the air, storing carbon, and reducing energy use, which reduces power plant emissions
Reduce stream channel erosion	• Trees growing along a stream bank prevent erosion by stabilizing the soil with root systems and the addition of organic matter, and by substantially dispersing raindrop energy • Reduced runoff volume due to forests upstream can reduce downstream flood flows that erode the stream channel
Improve soil and water quality	• Trees prevent erosion of sediment by stabilizing soil with root systems and the addition of organic matter, and by substantially dispersing raindrop energy • Trees take up nutrients such as nitrogen from soil and groundwater • Forested areas can filter sediment and associated pollutants from runoff • Certain tree species break down pollutants commonly found in urban soils, groundwater, and runoff, such as metals, pesticides and solvents
Provide habitat for terrestrial and aquatic wildlife	• Forests (and even single trees) provide habitat for wildlife in the form of food supply, interior breeding areas, and migratory corridors • Streamside forests provide habitat in the form of leaf litter and large woody debris, for fish and other aquatic species • Forest litter, such as branches, leaves, fruits, and flowers, form the basis of the food web for stream organisms
Reduce summer air and water temperatures	• Riparian forests shade the stream and regulate summer air and water temperatures, which is critical for many aquatic species • Trees and forests shade impervious surfaces, reducing temperature of storm water runoff, which can ameliorate the thermal shocks normally transmitted to receiving waters during storms.

Source: Adapted from USDA Forest Service, 2005.

Based on a recommendation of American Forests (2009), 40% forest cover is a reasonable overall threshold goal for urban areas, and many communities have adopted this or similar canopy goals as existing tree canopy is typically significantly lower. As indicated in the baseline watershed assessment (*Appendix A*), forest cover in the North Branch Park River watershed is estimated at approximately 35%, with some areas having forest cover between 10% and 20%. The overall North Branch Park River watershed and many of its subwatersheds are below the recommended goals for urban areas.

The City of Hartford has begun to assess the existing tree canopy within the city limits and establish a city-wide tree canopy goal. The City of Hartford, Knox Parks Foundation, the USDA Forest Service and the Department of Environmental Protection's Division of Forestry conducted a tree canopy survey in the summer of 2007 (Knox Parks Foundation, undated). The study estimated the existing tree canopy in Hartford at 26%, which compares favorably with other major cities in the Northeast, including Boston (22%), New York (21%) and Washington DC (29%).



City of Hartford 2010 tree canopy assessment.

The City of Hartford, in conjunction with the USDA Forest Service and the University of Vermont, also recently performed a city-wide tree canopy assessment using high-resolution aerial imagery (O'Neil-Dunne, 2010). The assessment estimated existing tree canopy within the City of Hartford at 26%, and within the Hartford portion of the North Branch Park River watershed between 24% and 36%. The assessment suggested a potential tree canopy goal for the watershed of between 40% and 50%.

The City of Hartford has also proposed a city-wide tree ordinance that recommends the establishment of a Tree Master Plan for Parks, Open Space and Streets. The proposed ordinance also recognizes the need to protect legacy trees of unique value, such as heirs to seeds collected from the Connecticut Charter Oak tree, and large "champion" trees. Many of these legacy trees have been already been identified and mapped by Ed Richardson.

Plan Recommendations

A key objective of this watershed management plan is to protect and enhance forests and urban tree canopy and restore understory vegetation within the North Branch Park River watershed. Specific recommendations include:

- Conduct a watershed-wide tree canopy analysis, building on the previous urban forest canopy assessments performed by the City of Hartford, Knox Parks Foundation, USDA Forest Service, CTDEP Division of Forestry, and University of Vermont. The watershed tree canopy analysis will help target priority areas, identify ownership, and establish a baseline for the watershed. The analysis should use high-resolution aerial

imagery and analysis techniques similar to those used in the University of Vermont study.

- Review the conditions of understory vegetation for invasive species and appropriate habitat for migratory songbirds. This process, will involve bringing together foresters, invasive species specialists, and ornithologists to review restoration strategies.
- Adopt the proposed City of Hartford Tree Ordinance. The City should also develop a comprehensive urban forest master plan that distinguishes sites and woodland ecosystem variations within parks, open spaces, and stream corridors as well as trees for streetscapes and parking lots to enhance LID and green infrastructure benefits.
- Quantify the value of urban forestry and tree programs for improving the City's appearance, improving energy efficiency and air quality, providing wildlife habitat, recreational opportunities, real estate values, and most importantly job opportunities. Tools to quantify such benefits are available online (http://www.itreetools.org/). Undertake efforts to monitor, maintain and enhance these resources through tree improvement programs as part of the City's maintenance and capital planning programs
- Establish Town-based UTC goals for other municipalities in the watershed and develop a plan to achieve those goals. Potential recommendations include:
  - Land acquisition and conservation easements
  - Amend site development regulations and zoning to encourage tree retention and maintenance, restrict tree removal, and require landscaping and parking lot shading
  - Reforest public lands, beginning with priority sites
  - Encourage large trees wherever possible
  - Encourage reforestation of private land by developing education, stewardship and incentive programs. For larger parcels, contact a CTDEP Service Forester or private consulting forester to developing specific goals and objectives for that property.
  - Consider tree ordinances similar to the proposed Hartford ordinance
- Identify priority parcels for reforestation based on watershed field inventories and detailed tree canopy analysis results.
- Engage the tree wardens in the watershed municipalities regarding tree health, tree retention, and canopy cover goals.
- Use demonstration projects to demonstrate the importance of trees and vegetation as green infrastructure to help manage water quality and temperatures in the vicinity of the North Branch Park River.
- Promote urban agriculture within the watershed through community gardens, backyard gardens, and schoolyard edible efforts. Promote and establish community gardens in denser population areas of the watershed, in addition to those maintained by the Town of Bloomfield at the Tunxis Flood Control Reservoir and private community gardens maintained at the Seabury Retirement Community and the Duncaster Heartcare Facility in Bloomfield.
- Promote low-maintenance seasonal mowing schedules for municipal open space with respect to bird nest patterns within native meadows. This program can be developed with area landscape businesses and the Connecticut Northeast Organic Farming Association.

3.1.6 Illicit Discharge Detection and Elimination

Illicit discharges are non-stormwater flows that discharge into the stormwater drainage system or directly into surface waters. Failing septic systems, wastewater connections to the storm drain system, and illegal dumping are among the types of illicit discharges that can occur in residential and commercial areas. Depending on the source, an illicit discharge may contain a variety of pollutants that can impact both human health and the aquatic environment. A number of potential illicit discharges were identified throughout the watershed during the stream inventories. Identifying and eliminating these discharges is an important means of pollution source control for the watershed.

All of the watershed municipalities are subject to the requirements of the NPDES Phase II stormwater program, which is regulated under the CTDEP General Permit for the Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (MS4 General Permit). The MS4 General Permit regulates the quality of discharges from municipal storm drainage systems. The program requires municipalities to implement an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the municipal storm drainage system, as well as sanctions to ensure compliance. This includes developing an Illicit Discharge Detection and Elimination (IDDE) Plan to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.

The MS4 General Permit is scheduled for re-issuance by January 2011, which represents an opportunity for the watershed municipalities to review their municipal stormwater management plans relative to the MS4 General Permit requirements, including the illicit discharge detection and elimination component.

The following recommendations apply to each of the watershed municipalities:

- Review and update municipal stormwater management plans to ensure that IDDE efforts of the watershed municipalities (required by the MS4 General Permit) include their respective areas of the North Branch Park River watershed.
- Review and update municipal stormwater management plans to ensure that the watershed municipalities implement IDDE programs as required by the existing and future MS4 General Permit, including an ordinance or other regulatory mechanism to effectively prohibit non-stormwater discharges into the regulated municipal separate storm sewer system and an IDDE Plan to detect and eliminate existing and future non-stormwater discharges, including illegal dumping.
- Conduct follow-up illicit discharge investigations at priority outfall locations identified during the watershed inventories (see Targeted Recommendations).
- Implement priority stream cleanup projects identified during the watershed field inventories (see Targeted Recommendations).

3.1.7 Downspout Disconnection

Residential and commercial areas in the watershed contribute significant quantities of rooftop runoff to the storm drainage system. Opportunities exist to disconnect residential rooftop runoff from the storm drainage system or surface waters directly, and reduce the quantity of runoff by redirecting the runoff to pervious areas or through the use of rain barrels or rain gardens.

Rain barrel used to capture and re-use rooftop runoff (Source: CWP, 2007).

Downspout disconnection (also referred to as "roof leader disconnection") is a cost-effective on-site option for reducing the volume and cost of stormwater that requires public management. Runoff from residential rooftops is collected by eaves troughs, which are installed along the edge of the roofline. Water collected in the eaves trough is conveyed to ground level by one or more downspouts. Downspouts may then connect directly into the storm sewer system or discharge to driveways, which in turn convey the water to the street and storm drainage system. Similarly, building roof drainage in older commercial developments is typically tied directly to the on-site storm drainage system.

Downspout disconnection has a number of economic and environmental benefits to the municipality and the property owner. The major benefits include:

- Reduces volumes of flows conveyed and resulting loads to watercourses,
- Reduces the volume of flow to the municipal storm drainage system,
- Increases infiltration and groundwater recharge,
- Provides options to "recycle" rainwater.

Downspout disconnection is ideal in neighborhoods where roof leaders are directly connected to the storm drainage system and in medium density residential areas with lot sizes in the 0.25 to 1.0 acre range (CWP, 2007). However, most residential areas that contribute rooftop runoff to the storm drainage system are potential retrofit candidates for some form of rooftop disconnection.

Runoff from commercial rooftops can be directed to bioretention planting beds (Source: CWP, 2007).

A variety of alternatives are available for residential and non-residential rooftop disconnections, ranging from simple disconnections to more complex delivery systems. Residential rooftop disconnection options include (*Figure 3-3*):

- Simple disconnection
- Rain barrels and rain gardens
- French drain or dry wells

Non-residential rooftop disconnection options include (*Figure 3-3*):

- Simple disconnection
- Rain gardens
- Stormwater planters and cisterns
- Green rooftops

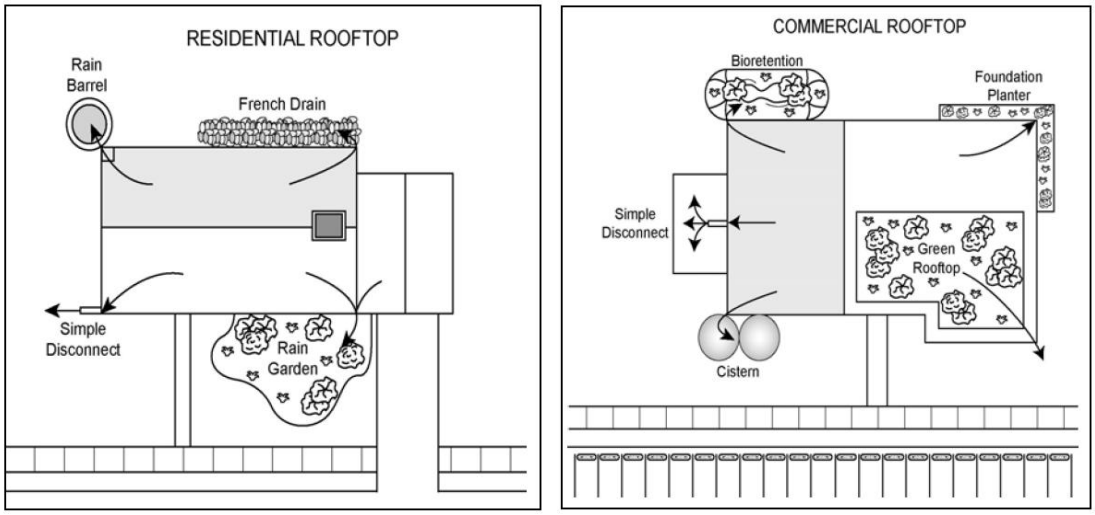


Figure 3-3. Residential and Commercial Rooftop Disconnection Retrofit Strategies (Source: CWP, 2007)

The watershed municipalities should encourage disconnection of rooftop runoff from the storm drainage system by redirecting the runoff to pervious areas or through the use of rain barrels or rain gardens. Municipalities should demonstrate the use of rain barrels and other forms of downspout disconnection at public facilities and parks, as well as offer incentives for downspout disconnection on private property through rain barrel rebates and similar programs. Municipalities should also review their municipal code and regulations for potential regulatory barriers to implementing downspout disconnection and revise the ordinances/regulations accordingly. Local municipal stormwater standards and design guidance should include specific criteria regarding the suitability and design of various rooftop disconnection practices.

Individual rooftop retrofits target a small area, requiring the participation of many homeowners and businesses to make a measurable difference across a watershed. As a result, a coordinated effort is required for widespread participation in such a program, which typically includes a combination of targeted education, technical assistance, and financial subsidies to homeowners or the business community. Examples of effective local downspout disconnection programs are presented in *Urban Stormwater Retrofit Practices* (CWP, 2007).

3.1.8 Education and Outreach

Often, the public is not aware of the critical role they have in protecting water resources. Public education is critical to the long-term success of watershed management, especially in urban areas, because it raises awareness of both personal responsibilities and the responsibilities

of others relative to environmental protection and teaches people what individual actions they can take to protect and improve water resource conditions in their watershed. This increased understanding has the additional benefit of fostering support for watershed management efforts and cultivating a long-term urban-environmental watershed stewardship ethic, particularly with respect to the benefits of green infrastructure.

The public education and stewardship recommendations of this plan are an extension of the education and outreach efforts that were conducted during the plan development process. Four primary target audiences were identified as having the greatest potential to affect long-term change and improve water resource conditions in the North Branch Park River watershed:

- Students (K-12)
- Campus facility managers and large property owners
- Homeowners and residential land use
- Municipalities and businesses

Education and outreach recommendations that are tailored to each of these audiences are described in the following sections. Watershed public outreach and educational programs will coordinate with existing CTDEP, MDC, municipal, and local non-profit educational programming. The watershed management plan website for the North Branch Park River (www.northparkplan.net) will continue to serve as a clearinghouse for watershed information, watershed-based education and outreach materials, past and upcoming events, and opportunities for public involvement.

Students

A key objective of this watershed management plan is the creation of a formal comprehensive K-12/higher education and stewardship network along the North Branch Park River by capitalizing on the numerous educational institutions within the watershed. Specific recommendations include:

- Develop a framework for watershed place-based K-12 education that strengthens comprehensive relationships between local, regional and global natural science as well as guidelines for local environmental stewardship. This Park Watershed Educational Stewardship Network, which could serve as a state-wide model, will develop a sequence of K-12 field research, classroom experiences and regional networking into learning activities that build shared scientific knowledge and stewardship experiences.
- Work with K-12 educators within the Park River watershed as well as with area higher-education teacher training programs to build a place-based educational "toolkit" along with a school stewardship network. The toolkit will include recommendations for field research and documentation (photographs and GIS mapping) that can link into an online network, allowing for both internal and external (public) postings. Guidelines for learning activities will conform to state curriculum standards.
- Encourage watershed colleges and universities to participate in the educational stewardship network and through relevant research.
- Develop career path exerience towards new green jobs.

Campus Facility Managers and Large Property Owners

The institutional facilities within the North Branch Park River watershed (University of Hartford, UConn Law School, other schools, corporate campus facilities, hospitals, golf courses, etc.) are major land owners that can have a significant impact on the water quality of the North Branch Park River through land development and grounds management activities. The large institutional land owners, like residential and municipal land owners in the watershed, will therefore play an important collective role in the success of the watershed management plan.

An objective of this watershed management plan is to conduct outreach to campus facility managers and large property owners about the water quality and nonpoint impacts of campus management practices. Education and outreach programs should emphasize the importance of LID and green infrastructure approaches such as the use of pervious pavement, rain gardens, and green roofs. Grounds management issues include operation and maintenance activities with potential for water quality impacts, which are common to these large, institutional land owners.
Specific recommendations include:

- Host a series of hands-on workshops to demonstrate best practices and local resources regarding LID and green infrastructure approaches, as well as operation and maintenance activities with potential for water quality impacts:
    - Integrated pest management
    - Turf management and low fertilizer usage
    - Grass clippings management
    - Leaf/brush waste management
    - Parking lot and road maintenance (deicing, snow management)
    - Drainage system maintenance (catch basins, storm drains, LID and traditional structural stormwater BMPs,)
    - Water quantity and flooding issues

  Provide funding and/or project assistance incentives for facility managers who complete the program.
- Encourage awareness and involvement of students and faculty in campus (and golf course) management decisions, including annual or bi-annual volunteer service events.
- Conduct a comprehensive, integrated evaluation of the institutional properties along the North Branch Park River north of Albany Avenue (University of Hartford, University High School, Weaver High School, Annie Fisher Magnet School, and Watkinson School) relative to riparian corridor restoration and maintenance, including definition of the stream corridor edges and landscape features, and invasive species removal.

Homeowners and Residential Land Use

Another objective of the watershed management plan is to build awareness of land stewardship and management practices and reduce nonpoint source impacts in residential areas, which comprise approximately one-third of the watershed land area. Specific recommendations include:

- Foster a "block-by-block" approach for the restoration and conservation of stream reaches and ponds. This urban stewardship approach encourages neighbors to "self-organize" around shared interests. Neighbors living along the North Branch Park River have expressed an interest in professional support in removing invasive species so as to restore native vegetation that serves as habitat for migratory birds. Homeowners are often willing to undertake environmental improvement projects – and assist with the labor – yet recognize the need for technical guidance.

- Increase watershed stewardship signage (watershed, stream, stormwater pollution prevention, and storm drain markings). Stewardship signage can be an effective way of educating the public on the importance of preserving natural resources and common ways in which they may be impacting these resources. The general public is often unaware of the cumulative effects of their every-day activities. Signage can play an important role in making the connection between every-day activities and their sometimes harmful results. Educational signage can take the form of kiosks in public areas, storm drain markers or stencils, anti-dumping signs, proper pet waste management signs, and roadside/stream side signage (examples include "adopt a stream/roadway" programs).

  The watershed field inventories identified very little evidence of storm drain stenciling or watershed stewardship signage. Stormwater and pollution prevention signage is generally lacking in most residential areas of the watershed. The watershed municipalities, together with other local stakeholders and volunteers, should consider additional storm drain marking in residential neighborhoods, heavy pedestrian areas served by storm sewers, and municipal facilities (schools, town offices, parks, libraries, etc.).

- Tailor education efforts to the types of pollution producing behaviors observed in residential neighborhoods throughout the watershed (buffer encroachments, yard waste, piped discharges, septic system maintenance for unsewered areas, etc.).

- Encourage the creation of backyard habitat in residential areas that abut the North Branch Park River and its tributaries and recognize efforts of the public.

- Encourage disconnection of rooftop runoff from the storm drainage system to reduce the quantity of runoff by redirecting the runoff to pervious areas or through the use of rain barrels or rain gardens (see *Section 6.1.7*).

Municipalities and Businesses

Municipal and businesses in the watershed can also impact water quality. An objective of this watershed management plan is to advance local government and community business awareness of the North Branch Park River through pollution prevention education and watershed restoration outreach activities

- The municipal facilities and businesses that were observed during the field inventories exhibited examples of both good pollution prevention practices and opportunities for improvement. The watershed municipalities should review the current compliance of

their respective facilities (public works/maintenance facilities, parks, schools, public safety facilities, etc.) in the watershed with pollution prevention best management practices and applicable regulatory requirements. "Good housekeeping" at municipal facilities should serve as demonstration sites for comparable private operations, many of which are also subject to stormwater pollution prevention and other similar state and federal regulatory programs (oil pollution prevention, hazardous waste, air emissions). Examples of good practices should be recognized and modeled. The proposed watershed organization should provide guidance (e.g., visits, group training, and/or printed materials) and develop incentives to encourage local businesses to adopt these model practices.

- Watershed municipalities should create incentives (such as fast-track permits/approvals) for projects that utilize Low Impact Development or green infrastructure, incorporating state-wide guidance currently being developed by the CTDEP.

- With the pending re-issuance of the CTDEP MS4 General Permit, the watershed municipalities have an opportunity to re-evaluate and improve upon the effectiveness of their municipal stormwater management programs. This includes the municipal good housekeeping minimum measure contained in the General Permit. The towns should review and modify as necessary their stormwater management plans to include audits of pollution prevention and good housekeeping practices at their respective municipal facilities, as well as re-evaluate their municipal street sweeping, catch basin cleaning, and drainage system maintenance efforts. At a minimum, all streets in the watershed should be swept at least twice per year, with more frequent sweeping of targeted areas, as necessary and as equipment and funding allow. Vacuum-assisted sweeping has been shown to be more effective than conventional mechanical broom sweeping for removing finer particulates.

- Conduct compliance assistance outreach (e.g., visits, group training, and/or printed materials) for specific types of businesses in the watershed (e.g., light industry, offices, commercial retail centers, golf courses, restaurants).

- Promote private investment and participation in green infrastructure improvements through "Institutional Stewardship" workshops for large private property owners (see recommendations for Campus Facility Managers and Large Property Owners), networking with area business research divisions to explore green technologies, and arranging training workshops for small landscape business owners

- Increase watershed stewardship signage (watershed, stream, stormwater pollution prevention, and storm drain markings) and create educational displays in highly visible, strategic locations throughout the watershed to highlight water quality and habitat amenities, and to reinforce the watershed protection efforts in the watershed. Increased educational signage explaining the linkage between recreational centers in the watershed and the North Branch Park River is also recommended within parks, greenways, and other recreational areas throughout the watershed.

- Improve maps, online resources, and signage to educate citizens about the environment of the Metacomet Ridge within the MDC Reservoir area.

3.1.9 Water Quality Monitoring Program

Long-Term Monitoring Program

A long-term water quality (chemical and biological) monitoring program should be established for the Park River, including both the North and South Branches, to refine the understanding of water quality impacts from potential point and non-point pollution sources in the watershed, to continue developing a water quality database for the watershed to guide environmental decision-making, and to measure the progress toward meeting watershed management goals. The monitoring program could build upon the ongoing water quality monitoring program led by Dr. Jonathan Gourley of the Trinity College Environmental Science Program, as well as the state-wide RBV citizen volunteer monitoring. Additional funding sources should be sought to finance future monitoring efforts.

Recommended enhancements to the previous and ongoing water quality monitoring efforts include:

- Monitoring should be coordinated with wet and dry weather conditions to assist in assessing potential causes and sources of water quality impacts.
- Continue RBV bioassessment and CTDEP ambient water quality monitoring programs in the North Branch Park River watershed. Bioassessments should be performed at common chemical monitoring locations, where feasible. Biological monitoring should be expanded to the major North Branch tributaries, including Wash Brook, Tumbledown Brook, and Beamans Brook.
- *Escherichia coli* is the preferred indicator bacteria for chemical monitoring for consistency with the Connecticut Water Quality Standards.

Stormwater Retrofit Demonstration Monitoring

Water quality monitoring (runoff volumes and pollutant concentrations) is recommended in conjunction with the potential LID and green infrastructure retrofit demonstration projects that are described in the Targeted and Site-Specific Recommendations sections of this plan. Monitoring of the retrofit site(s) is recommended before and after the installation of the retrofit. Such a monitoring program could help quantify the benefits of innovative LID and green infrastructure techniques within the North Branch Park River watershed, but would require a significant funding source for a comprehensive and statistically-valid "before and after" study design.

3.2 Targeted Recommendations

Targeted recommendations are tailored to address issues within specific subwatersheds or areas, rather than watershed-wide. Targeted recommendations also include actions to address common types of problems that were identified at representative locations throughout the watershed, but where additional studies or evaluations are required to develop site-specific recommendations. Targeted recommendations can have both short and long-term benefits.

3.2.1 Stormwater Retrofits

Stormwater retrofits are structural practices installed in upland areas to capture, treat, and store or infiltrate stormwater runoff before it is discharged to a water body or wetlands. Stormwater retrofits include end-of-pipe treatment measures installed in the downgradient portion of a storm drainage system to treat flows prior to discharge, as well as structural practices that can be added to existing, developed sites including LID and green infrastructure approaches.

End-of-pipe stormwater retrofits tend to be larger and more expensive, but they generally provide treatment for a larger area and can be more cost-effective when installed as a retrofit (although recent research, including the Jordan Cove Urban Watershed Project in Waterford, Connecticut, has shown them to be less cost-effective than LID measures when installed as part of new construction). In contrast, LID and green infrastructure retrofits are distributed practices that can often be integrated into the existing landscape with minor infrastructure modifications. LID practices typically place maintenance responsibilities on individual property owners.

Opportunities for stormwater retrofits at municipal, state, and private outfalls and/or sites in the North Branch Park River watershed include:

- Parking lot upgrades (bioretention, pervious pavement, vegetated buffers, water quality swales)
- Athletic fields at parks and educational institutions (water quality swales, vegetated buffers, infiltration, bioretention, stormwater reuse for irrigation)
- Road repair/upgrades (green streets – bioretention, water quality swales, tree planters, below-ground infiltration chambers)
- Roadway stormwater outfalls, particularly at or near roadway stream crossings
- New stormwater outfalls resulting from separation of combined sewers (distributed LID practices, end-of-pipe stormwater wetlands)

Table 3-4 lists priority outfall retrofit sites that were identified during the watershed field inventories. This list is not intended to be all-inclusive, as only several representative subwatersheds and target areas were included in the field inventories. Rather, the identified outfall retrofit sites are representative of the types of retrofit opportunities that exist throughout the watershed. The outfall retrofit locations are also shown on the watershed mapping in *Appendix D*. The feasibility of retrofits at these locations should be further evaluated based on consideration of site-specific factors including hydraulic head, available space, soil conditions, and easements. Several example stormwater retrofit concepts for specific sites are presented in the Site-Specific Recommendations section of this plan.

Table 3-4. Priority Outfall Retrofit Sites

Watershed	Stream Reach	ID	Description
Blue Hills Reservoir	BHR-01	OT-A	Open channel outfall with observed trickle flow and oily deposits; bank erosion at this location.
Blue Hills Reservoir	BHR-02	OT-A	12" concrete pipe; bank erosion.
Filley Brook	FYB-01	OT-C	Several (approx 7) outfalls along grass swales with unknown source; discharge investigation and possible retrofit candidate.
Filley Brook	FYB-02	OT-A	Open earthen channel drainage from parking lot; poor design, good retrofit candidate.
Filley Brook	FYB-02	OT-B	Various outfalls behind apartment and senior center buildings with evidence of scour and erosion; retrofit candidate and discharge investigation recommended.
Filley Brook	FYB-03	OT-A	There are a few open channel outfalls and approx 21 closed pipe outfalls along this reach. No unusual observations, although restoration to divert some stormwater inputs may be possible.
North Branch Park River	NBP-04	OT-B	16" concrete closed pipe; Discharge investigation recommended.
North Branch Park River	NBP-04	OT-C	16" concrete closed pipe; Discharge investigation recommended due to scum on and near pipe.
North Branch Park River	NBP-13	OT-A	Local stream repair/stabilization recommended.
North Branch Park River	NBP-14	OT-A	18" concrete closed pipe behind 10-story building with orange, cloudy discharge; Local stream repair/stabilization recommended.
North Branch Park River	NBP-14	OT-B	24" concrete closed pipe; no dry-weather discharge; concrete pieces around outfall require restoration.
North Branch Park River	NBP-14	OT-D	Approx 10 ft downstream of sewer manholes along bank; smelled like sewage; no discharge from outfalls. Discharge investigation recommended.
North Branch Park River	NBP-15	OT-F	Open channel on left bank with steep grade and evidence of scour; stormwater retrofit candidate.
North Branch Park River	NBP-16	OT-E	36" metal pipe; investigate source, possible combined sewer overflow location.
Tumbledown Brook	TDB-14	OT-A	Discharge investigation for open earthen channel; potential nutrient loading source.
Wash Brook South	WBS-11	OT-A	Open channel outfall with clear dry weather flow, smell of sewage.
Wintonbury Reservoir	WTR-01	OT-A	Earthen channel impacted by erosion from impervious surfaces and steep slope. Major erosion in stream channel; Discharge investigation and retrofit candidate.

3.2.2 Illicit Discharge Investigations

Outfalls were observed from virtually all of the land uses encountered during the stream assessments. Some appear to be associated with sources having low potential for water quality impacts (i.e., residential foundation drains), while others were of unknown origin and should be the focus of future investigation. Priority outfalls that were identified for follow-up illicit discharge investigations are depicted on the watershed mapping in *Appendix D* and summarized in *Table 3-4*. The watershed municipalities should continue to implement illicit discharge detection and elimination (IDDE) programs as required by the CTDEP MS4 General Permit.

Methods for identifying illicit discharges can vary widely in the level of effort and cost required for implementation. The following field-based methods are typically used to identify illicit discharges:

- *Testing of Dry Weather Discharges* – Flows from stormwater outfalls during dry weather may indicate an illicit discharge. A combination of visual inspection and chemical analysis of dry weather discharges can aid in identifying potential discharge sources.
- *Visual Inspection* – Examination of piping connections by either physical examination or closed-circuit camera can be used to identify possible illicit connections.
- *Review of Piping Schematics* – Examination of architectural plans and plumbing details can reveal potential sites of improper connections.
- *Smoke Testing* – Injection of a non-toxic vapor (smoke) into the facility plumbing system and following its path of travel can be used to locate connections.
- *Dye Testing* – In this method, appropriate colored dyes are added into the drain water of suspect piping. Appearance of the dyed water in the storm drainage system indicates an illicit discharge. As mentioned in the discussion of septic system discharges, testing for optical brighteners can provide an indication of the presence of domestic wastewater flows.
- *Infrared, Aerial, and Thermal Photography* – Use of aerial, infrared, and thermal photography to locate patterns of stream temperature, land surface moisture, and vegetative growth are emerging techniques to identify potential illicit discharges to stormwater systems.

Other sources of information on performing illicit discharge investigations include:

- *Illicit Discharge Detection and Elimination Manual - A Handbook for Municipalities,* New England Interstate Water Pollution Control Commission (2003) http://www.neiwpcc.org/neiwpcc_docs/iddmanual.pdf
- *Illicit Discharge Detection and Elimination - A Guidance Manual for Program Development and Technical Assessments*, Center for Watershed Protection (2004)

3.2.3 Riparian Buffer Restoration

A healthy riparian buffer along Wash Brook.

Riparian buffers are naturally vegetated areas adjacent to streams, ponds, and wetlands. Vegetative buffers help encourage infiltration of rainfall and runoff, and provide absorption for high stream flows, which helps reduce flooding and drought. The vegetative community of riparian buffers provides habitat for plants and animals, many of which are dependent on riparian habitat features for survival. Since, in many areas, riparian buffers are becoming reduced in size and impacted by roadways and development, many species of plants and animals that are dependent on the unique blend of characteristics that buffers provide are threatened or endangered species. The buffer area provides a living cushion between upland land use and water, protecting water quality, the hydrologic regime of the waterway and stream structure. The naturally vegetated buffer filters out pollutants, captures sediment, regulates stream water temperature and processes many contaminants through

vegetative uptake. Riparian buffers should be kept intact or restored wherever possible (Delaware Riverkeeper Network, undated).

Stream buffer encroachments are present throughout the North Branch Park River watershed along stream corridors in or near areas of residential and commercial development. In many areas, residential lawns and institutional grounds extend down to the banks of the stream. Yard and grounds keeping waste such as grass clippings, leaves, and brush, as well as trash, are common in and near areas where easy access exists to streams. Parking lots and buildings are also common along the banks of the North Branch Park River within the City of Hartford. There are also many instances where riparian buffers are impacted as streams, especially Tumbledown Brook, flow through or adjacent to golf courses in the western portion of the watershed.

Table 3-5 lists potential buffer restoration candidates that were identified during the watershed field inventories. These locations are also shown on the watershed mapping in *Appendix D*. In general, riparian buffers are most effective along smaller, headwater streams, although larger streams including the main stem of the North Branch Park River could also benefit significantly from riparian corridor enhancements. Potential riparian buffer restoration approaches for the watershed include:

- Installation of new riparian buffers
- Widening existing riparian buffers
- Invasive species removal/management
- Tree planting/reforestation

The feasibility of riparian buffer restoration at these sites should be further evaluated based on consideration of site-specific factors including site access, available land area, land ownership, soil conditions, appropriate buffer width, and native plant species.

Table 3-5. Priority Riparian Buffer Restoration Sites

Watershed	Stream Reach	ID	Description
Beamans Brook West	BBW-02	IB-A	Impacted buffer from park; good restoration candidate since plenty of staging area and good access.
Beamans Brook West	BBW-02	IB-B	Yard waste piled on right bank, homeowner draining pool to stream.
Filley Brook	FYB-01	IB-A	Railroad tracks and rip-rap along both banks.
Filley Brook	FYB-01	IB-B	Stormwater outfalls without canopy cover; vegetation and topsoil cleared from left bank and replaced with straw; mowed lawns to bank without vegetation in riparian zone; approx. 30% canopy cover.
Filley Brook	FYB-03	IB-A	Rip-rap on banks to stabilize along many sections of the reach. Not likely restoration candidate unless bioengineered alternative to rip-rap.
North Branch Park River	NBP-04	IB-A	Yard to top of bank, short grass, yard waste dumping.
North Branch Park River	NBP-04	IB-B	Outflow pipe approx. 5 feet upstream from erosion.
North Branch Park River	NBP-09	IB-A	Thin forested, open lawn on other side of Univ. Hartford campus. Impacted buffer from 8-bay culvert to student overpass bridge.
North Branch Park River	NBP-09	IB-B	Maintained lawn, yard waste at edge of river, bedrock cliff river bank.
North Branch Park River	NBP-10	IB-A	Rip-rap, chunks of concrete, exposed concrete, parking lot and lawn.

Table 3-5. Priority Riparian Buffer Restoration Sites

Watershed	Stream Reach	ID	Description
North Branch Park River	NBP-14	IB-A	Minor bank erosion.
North Branch Park River	NBP-15	IB-A	Maintained lawns, parking lots, invasive plants, concrete retaining wall and trash.
North Branch Park River	NBP-16	IB-A	Good restoration candidate; bank failure on right bank, residential lawn and parking lots on left bank side with leaf and waste dumping.
North Branch Park River	NBP-16	IB-B	Rip-rap with wire mesh and minor bank erosion.
North Branch Park River	NBP-16	IB-C	Rip-rap along left bank; leaf dumping and possible winter snow piling from parking lot.
North Branch Park River	NBP-16	IB-D	Rip-rap on both banks and minor bank erosion.
North Branch Park River	NBP-16	IB-E	Rip-rap on banks, parking lot and lawn encroachment, and minor erosion on both banks.
Tumbledown Brook	TDB-06	IB-A	Approx. 600 feet impacted buffer with turf up to stream bank.
Tumbledown Brook	TDB-08	IB-A	Rip-rap on both banks and lawn encroachment on right bank.
Tumbledown Brook	TDB-12	IB-A	Rip-rap on left bank.
Tumbledown Brook	TDB-14	IB-A	Rip-rap on bank; near golf course turf.
Wash Brook North	WBN-06	IB-A1	Train track encroachment, not a restoration candidate.
Wash Brook North	WBN-06	IB-A2	Erosion due to yard encroachment and yard waste dumping within channel.
Wash Brook South	WBS-01	IB-A	Lawn encroachment on both banks.
Wash Brook South	WBS-03	IB-A	Concrete patio to bank of stream.
Wash Brook South	WBS-04	IB-B	Stream encroachment from farmland.
Wash Brook South	WBS-06	IB-A	Lawn encroachment on both banks.
Wash Brook South	WBS-06	IB-B	Residential lawn impacting buffer; invasive species covering much of the banks.
Wash Brook South	WBS-11	IB-A	Impacted buffer along entire reach, including rip-rap, gabion walls, sever erosion due to lawn encroachment from residences and golf course.

The following sections describe additional riparian corridor recommendations for targeted institutional and other large property owners in the watershed.

Institutional and Large Property Owners

- Golf courses in the watershed should work to increase riparian buffers by establishing buffers of native trees and shrubs in out-of-play areas and working to establish low-growing native plants along stream reaches along in-play areas.

- A comprehensive, integrated evaluation of the institutional properties along the North Branch Park River north of Albany Avenue (University of Hartford, University High School, Weaver High School, Annie Fisher Magnet School, and Watkinson School) is recommended relative to riparian corridor restoration and maintenance, including definition of the stream corridor edges and landscape features and invasive species

removal. The University of Hartford is encouraged to take a leadership role in this effort, including an evaluation of potential corridor enhancement opportunities associated with 1) several campus parking lots that abut the North Branch Park River, 2) future repair, replacement, or removal of the University of Hartford dam, and 3) a proposed on-campus greenway trail along the North Branch Park River.

3.2.4 Fish Passage Assessment

The North Branch Park River and its tributaries support a variety of resident fish and migratory eel. A dam on the University of Hartford campus serves as the first significant obstruction to fish passage upstream of the North Branch Park River conduit entrance. According to the CTDEP Fisheries Division, the dam prevents passage of resident (non-migratory) fish, including trout that are present, as well as migratory eel that can pass through the flood control conduit from the Connecticut River.

A number of existing or potential barriers to fish passage were identified during the stream inventories. A more comprehensive fish passage assessment is recommended to refine the understanding of fish passage barriers throughout the watershed and opportunities for restoring fish passage and aquatic habitat for various parts of the river system. The assessment should investigate the feasibility of removal or modification of the dam at the University of Hartford campus (see Site-Specific Recommendations) to provide passage of resident fish and migratory eel. The need for a fish/eel ladder at the North branch Park River conduit entrance north of Farmington Avenue should also be evaluated because of a reported 8 to 12 foot drop/water fall into the conduit.

Local storm drainage design standards and regulations should also be revised to require that new or modified stream crossings be designed consistent with the CTDEP Stream Crossing Guidelines to promote improved stream continuity.

3.2.5 Stream Restoration

Areas of moderate to severe stream bank erosion were observed in many areas of the assessed portions of the watershed. *Table 3-6* lists stream reaches with moderate to severe bank erosion that were identified during the watershed field inventories. These reaches are potential stream restoration candidates, and their locations are shown on the watershed mapping in *Appendix D*. Typical stream restoration techniques that could be implemented in the watershed include:

- Slope Stabilization Techniques
- Redirective or Flow Changing Techniques
- Toe Protection Techniques
- Bioengineering Techniques
- Grade Control Techniques
- Riparian Buffer Improvement

Several proposed stream restoration concepts are also presented in the Site-Specific Recommendations section of this plan.

Access to many of the potential stream restoration sites is limited; therefore, potential candidate sites should be evaluated further for overall feasibility including land ownership, erosion severity, upstream and downstream conditions, infrastructure constraints, and construction access to the stream.

Table 3-6. Priority Stream Restoration Sites

Watershed	Stream Reach	Description
Filley Brook	FYB-02	Minor slope failure at confluence with Wash Brook South. Adjacent to senior living facility, good access.
Filley Brook	FYB-03	Minor bank erosion and slope failure throughout the reach, area behind Wesleyan Terrace neighborhood.
North Branch Park River	NBP-10	Bank erosion at bend in stream south of Univ. of Hartford campus.
Wash Brook South	WBS-06	Minor bank erosion behind residences; lower priority restoration candidate.

3.2.6 Stream Cleanups

The watershed field inventories identified areas of trash and debris dumping along many of the assessed streams. Stream clean-ups and trash removal are often cosmetic and temporary. However, they are an effective tool for involving and educating the public about stream degradation. In addition, some trash and debris accumulation may present risks to infrastructure and increased flooding, such as when outfalls and culverts become clogged with trash.

Table 3-7 lists stream reaches where significant trash and debris were observed. These locations, which are shown on the watershed mapping in *Appendix D,* are recommended candidates for targeted stream cleanups.

Table 3-7. Priority Stream Cleanup Sites

Watershed	Stream Reach	ID	Description
Beamans Brook East	BBE-02	TR-A	Old abandoned car on right bank, may require heavy equipment.
Blue Hills Reservoir	BHR-01	TR-A	Plastic, tires, appliances (washing machine & A/C units), automotive, construction (concrete debris, metal piping, telephone poles) and yard waste. Good restoration candidate.
Blue Hills Reservoir	BHR-01	TR-B	Car dumped in stream.
Blue Hills Reservoir	BHR-01	TR-C	Sediment washout and trash, tires, and concrete from construction activities; wetland restoration.
Blue Hills Reservoir	BHR-01	TR-D	Yard waste and metal scraps.
Blue Hills Reservoir	BHR-02	TR-A	Automotive parts, possible oil drums, and garbage cans; access may be difficult.
Filley Brook	FYB-01	TR-A	Dumping throughout reach, including oil bottles, plastic bottles, shopping carts, and tires. Various car parts near Park Avenue.
Filley Brook	FYB-02	TR-A	Plastic and paper debris dumping near senior living center and apartment building.

Table 3-7. Priority Stream Cleanup Sites

Watershed	Stream Reach	ID	Description
North Branch Park River	NBP-11	TR-A	Dumping of shopping cart, crates, tires, railroad ties, plastic bottles, broken glass, etc.
North Branch Park River	NBP-11	TR-B	Notable litter problem at this site. Dumping of plastic bottles and crates washed up against fallen trees.
Tumbledown Brook	TDB-05	TR-A	Heating oil tank on left bank, automobile oil drums, tires, stove, sink, toilet, etc. on right bank. Note invasive species growing along bank.
Wash Brook North	WBN-04	TR-A	Dump on banks and in channel includes old car, stove, foundation, piping, possible oil tank, and garbage.
Wash Brook South	WBS-04	IB-A	Dumping of AC unit, pots, bricks, bottles, insulation, parts of above-ground swimming pool.
Wash Brook South	WBS-04	TR-A	Stone slabs, old tractor tires, landscaping stones placed in stream.
Wash Brook South	WBS-11	TR-A	Behind medical center, dumping including wheelchair, AC unit, plastic bottles, yard waste. Many golf balls in stream adjacent to golf course.
Wintonbury Reservoir	WTR-01	TR-A	Trash & dumping problem along entire reach; auto parts, plastic buckets, cups, etc.)
Wintonbury Reservoir	WTR-02	TR-A	Broken glass, tires, toilet, & miscellaneous debris.

3.2.7 Invasive Plant Species Management

Invasive plant species (Multiflora Rose, Barberry, Japanese Knotweed, Garlic Mustard, Phragmites, Cattails, Reed Canary Grass, etc.) were observed in stream corridors in many areas of the watershed during the field inventories. Invasive species removal efforts should focus on site-specific and targeted stream corridor improvements. Key recommendations include:

- Implement priority invasive species management projects identified during the watershed field inventories.
- Develop an invasive species management plan for targeted areas of the watershed, including prevention and education efforts to preempt arrivals, early detection and citizen monitoring efforts, rapid response measures for successful eradication, and when a species cannot be eradicated, continued control efforts that are necessary to minimize ecological and economic impacts. The plan could identify prevention and education efforts to preempt arrivals, early detection and citizen monitoring efforts, response measures for successful eradication, and when a species cannot be eradicated, continued control efforts that are necessary to minimize ecological and economic impacts. Information on invasive plant species planning and management can be obtained from:
    - U.S. Fish and Wildlife Service: (http://www.fws.gov/invasives/staffTrainingModule/planning/introduction.html),
    - The Connecticut Department of Environmental Protection,
    - The Nature Conservancy (TNC),
    - Connecticut Invasive Plant Working Group (CIPWG).
- Educate residents, facility maintenance personnel, landscapers, and land use commissions about the negative effects of non-native invasive species.

- Involve individuals and neighborhood block associations in invasive species removal and stream corridor improvements.

3.2.8 Open Space Protection

Conservation of open space is critical in protecting and preserving the health of a watershed by limiting development and impervious cover, preserving natural pollutant attenuation characteristics, and supporting other planning objectives such as farmland preservation, community preservation, and passive recreation.

There are several common ways that undeveloped land can be preserved and protected as open space. These include outright purchase (fee simple), conservation easements, purchase of development rights, and land donations. Regardless of the mechanism, critical to the success of protecting open space land is having a source of funding that can be readily accessed when windows of opportunity to acquire significant parcels arise.

The watershed communities have identified open space protection goals and priorities within the watershed primarily through their Plans of Conservation and Development. Private groups, such as the Wintonbury Land Trust in Bloomfield, also maintain open space throughout the watershed with plans to preserve additional areas.

The watershed towns, working closely with local land trusts and other stakeholders including local land owners, should:

- Continue efforts to protect and/or acquire unprotected open space as recommended in this watershed management plan and by municipal Plans of Conservation and Development and related planning efforts.
- Implement existing municipal open space plans and update the plans at least once every 5 years. Endorse the remaining priority open space in the watershed as high priority open space conservation areas in the municipal open space plans and Plans of Conservation and Development.
- Continue ongoing efforts by the Bloomfield Conservation, Energy & Environment Committee to identify and protect priority farmland.
- Seek alternative funding sources and approaches for open space acquisition such as state grants, limited market rate development on a parcel to help fund the acquisition of the remainder of the parcel as open space, and transferring development rights from sensitive locations to locations better suited for development.
- Create a watershed-wide "green" map of environmental features and recreational amenities, including existing protected open space (through land ownership or conservation restrictions) in the watershed. Promote awareness and appropriate use of existing open space by publicizing parks, trails, community gardens, and historic landscapes as well as educational events, (such as a bio-blitz) on open space parcels.

Priority for open space protection should be given to properties that meet one or more of the following general criteria:

- *Size*: Larger parcels provide greater opportunity for contiguous undeveloped areas to benefit wildlife, water quality and provide recreation.

- *Water Resources*: Parcels that provide buffers for larger rivers and streams and associated riparian communities, and/or headwater streams.

- *Wetlands and Wildlife Habitat*: Parcels that provide upland buffers around high quality wetlands and habitat areas that supports, enhances or protects biodiversity.

- *Floodplain Protection*: Parcels in floodplain areas to provide habitat, protect or improve water quality, and preserve natural flood storage or function (to the 500-year flood level).

- *Streamflow Protection*: Parcels that provide protection of groundwater recharge areas and headwater streams, protect large areas or parcels of unfragmented forest or parcels whose protection would prevent fragmentation of a large protected forest tract.

- *Recreation*: Parcels that provide water and land-based recreational opportunities including swimming, fishing, boating, hunting, other water-access, or could accommodate multi-use trails as part of an existing or planned greenway, trail or linear park or provide connectivity of existing trail systems.

Undeveloped and underdeveloped parcels in the watershed were assessed based upon the above factors to help identify open space protection priorities. Two types of protection were considered – acquisition or protection through a conservation easement or restriction. Parcels that are currently undeveloped were given higher priority for acquisition, while those parcels that are partially developed but have potential for future development are assigned higher priority for a conservation restriction. *Figure 3-4* summarizes the results of the screening-level assessment, identifying parcels in the watershed that are recommended for acquisition or a conservation restriction and their relative priorities. Details of the assessment method and results are provided in *Appendix E* of this watershed management plan.

Several of these parcels, which are among the highest priorities for open space protection in the watershed, are also described below.

Kelly Farm

Kelly Farm is an approximately 45-acre parcel located between Duncaster Road and Arnold Drive in the western portion of Bloomfield (identified as Parcel 9 in *Figure 3-4*). The Kelly Farm parcel consists of cultivated fields, forest, and wetlands. The parcel is located near the headwaters of Cold Spring Reservoir and Wash Brook, is contiguous with other existing protected open space, and is the site of the proposed LaSalette Trail. Kelly Farm is currently proposed for acquisition by the Wintonbury Land Trust for permanent preservation. The Kelly Farm parcel is also an example of a priority acquisition parcel in a sensitive headwater area of Bloomfield, where a significant portion of the remaining undeveloped land exists within the watershed.

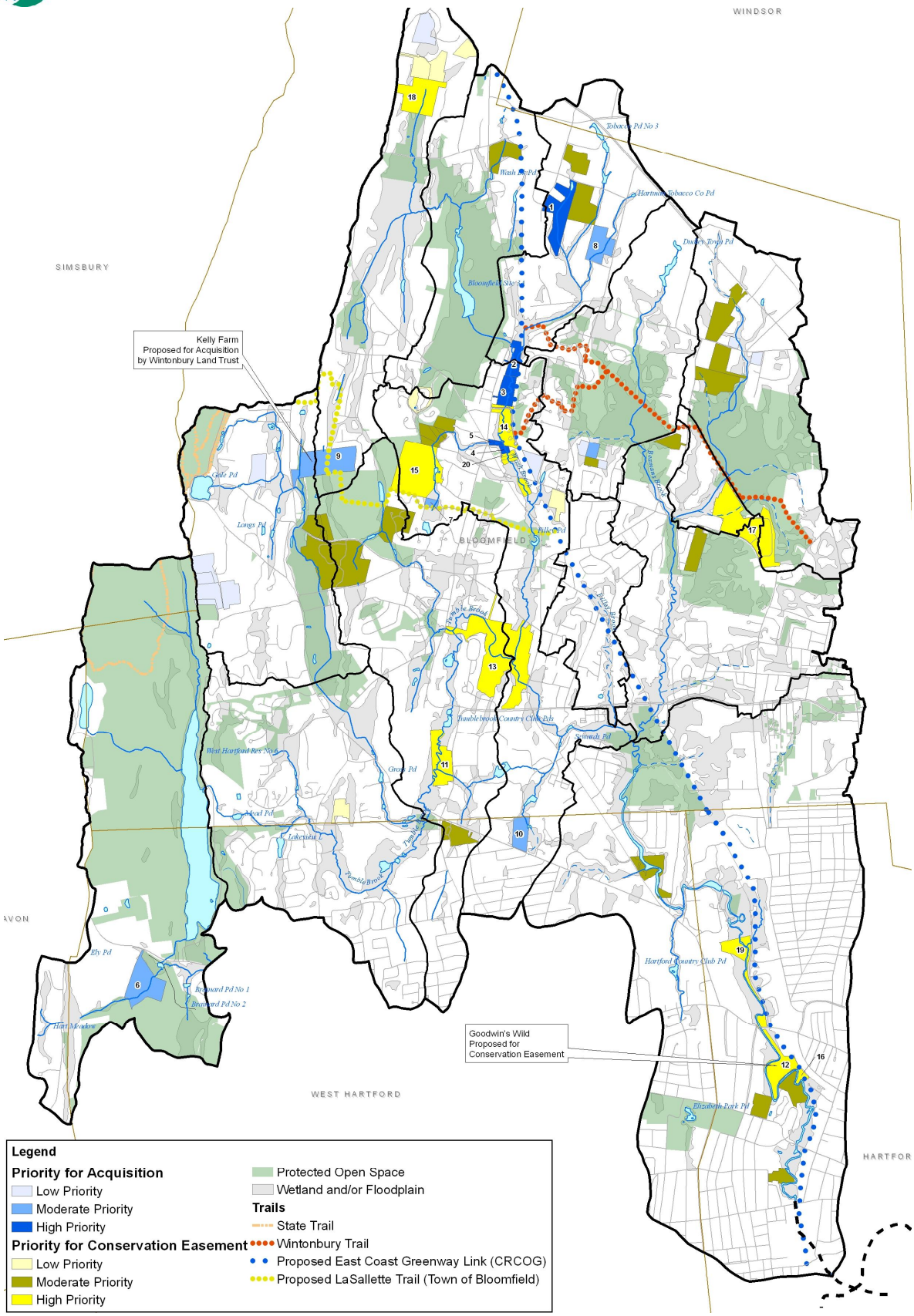


Figure 3-4. Open Space Priority Parcels

Goodwin's Wild

This area of largely forested open space is situated on the east side of the North Branch Park River in the West End and Asylum Hill neighborhoods of Hartford. The area, known as Goodwin's Wild for its "urban wild" forestland and river, includes approximately 30 acres of land and is generally bounded by Asylum and Albany Avenues, the North Branch Park River, and Woodland and Homestead Avenues. This land and section of the river have historically been protected as part of Goodwin's larger estate. Goodwin's Wild currently consists of two adjacent parcels. The larger parcel (identified as Parcel 12 in *Figure 3-4*) is owned by the Greater Hartford Flood Commission and is largely forested riparian area and floodplain. The smaller parcel situated to the south (identified as Parcel 16 in *Figure 3-4*) is owned by the City of Hartford and is associated with the Woodland Drive public housing complex. A portion of this parcel is developed as part of the adjacent housing complex and is in poor condition, with an abandoned building, trash dumping, construction and demolition debris, and landscaping debris.

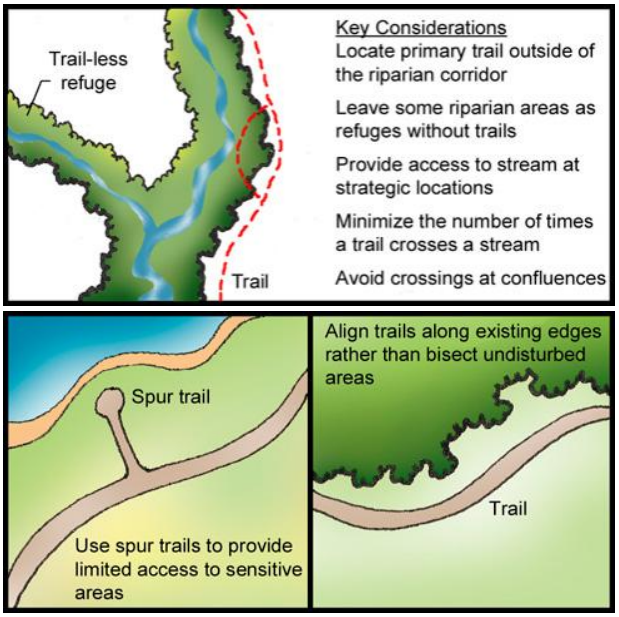
Through the efforts of the neighborhood residents, the Goodwin's Wild area has been recognized in the City of Hartford Plan of Conservation and Development as protected open space. It is recommended that the City of Hartford and the Greater Hartford Flood Commission approve and grant a conservation easement to permanently protect the existing wooded areas of Goodwin's Wild from development, recognizing the land's high ecological value and important role in protecting the water quality of the North Branch Park River. As described in the Site-Specific Recommendations section of this plan, the developed, underutilized portions of the smaller parcel also have the potential for reuse as regional stormwater retrofit site to treat existing and future stormwater discharges associated with the MDC combined sewer separation efforts.

3.2.9 Low-Impact, Context-Sensitive Greenway Development

A number of existing and planned recreational trails are located within the North Branch Park River watershed. The planned recreational trails include completion of key links in the East Coast Greenway Project, including the Park River Greenway along portions of the North and South Branches of the Park River and connections between Bloomfield and the existing trails in Simsbury and Granby (*Figure 3-4*). The Town of Bloomfield is also proposing a trail (LaSalette Trail) that would provide a westerly connection to the greenway system through existing and proposed open space areas.

The proposed Park River Greenway has been identified in state, regional, and municipal planning documents. Construction of the South Branch Trail of the Park River Greenway is underway. One segment of this project along the South Branch is expected to be completed in 2011. The North Branch segment, as depicted schematically in *Figure 3-4*, is identified in the Capitol Region Council of Governments (CRCOG) Regional Pedestrian and Bicycle Plan (April 2008), the City of Hartford Plan of Conservation and Development "One City, One Plan," and the Town of Bloomfield "Proposed Trails" mapping (March 2010). The Park River Greenway is envisioned as a recreational pathway and a commuter route, and has the potential to connect to the regional East Coast Greenway system.

Greenways and recreational trails along river systems can impact riparian vegetation, water quality, wildlife, and other important ecological functions provided by the riparian corridor. Careful design of greenways and recreational trails within the river corridor and wetlands is critical to avoiding or minimizing impacts on these sensitive natural resources. Locating recreational trails in urban settings can also be challenging due to potential conflicts between the needs of local residents and regional recreation interests.



Examples of Low-Impact Trail Design Considerations (Bentrup, 2008).

A goal of this watershed management plan is to promote the development of a greenway network within the watershed and the region without adversely impacting water quality and natural resources and taking into consideration the concerns and needs of local residents along the proposed trail routes. Specific recommendations include:

- Develop a Greenway between Bloomfield and Hartford that protects the stream corridor, and links the East Coast Greenway recreational trail to neighborhood cultural points of interest. Study alignments and feasibility of connecting north Bloomfield with the existing pathway systems in Simsbury and Granby, as well as the feasibility of locating a path in the North Branch corridor in Hartford consistent with regional and City planning initiatives.
- With respect to block-by-block urban contextual differences, improve and protect the stream corridor within the City of Hartford and other highly urban areas of the watershed. Distinguish between the needs of residents, and the interests of regional recreational projects as well as water quality and habitat values. Concerns of local residents and abutters on both sides of the trail should be accommodated in the trail alignment and design.
- The greenway recreational trail should be routed to avoid disturbing ecologically sensitive areas of the river corridor including wetlands, floodplains, sensitive wildlife areas and existing or planned open space.
- Incorporate LID and other sensitive design elements into greenway trail designs including maintaining and/or restoring native riparian vegetation along the stream banks, appropriate setbacks/buffers for wetlands and streams, designated access points to the river to maintain as much natural riparian habitat as possible, use of permeable pavement or other materials to reduce runoff, and use of other LID techniques. Incorporate these recommendations into local and facility master planning documents.

3.2.10 Public Access to the River

An objective of this watershed management plan is to increase public access to the North Branch Park River and its tributaries to enhance public appreciation and stewardship of the river. Recommendations to achieve this objective include:

- Where appropriate, enhance river access at existing public open spaces.
- Develop a public access area inventory (existing and potential) for the North Branch Park River and its tributaries. The inventory should include a list and map of the areas with location, size of area, ownership, and potential active and passive uses.
- Public access areas should not adversely affect sensitive areas.
- Incorporate LID and other sensitive design elements into access area designs. Incorporate these recommendations into local and facility master planning documents.
- Introduce signage, interpretive stations and online resources to tell the story of the North Branch Park River's history and natural environment.
- Provide linkages between the North Branch Park River and the cultural institutions within the lower NBPR watershed building upon planning principles from the "iQuilt" project, which is a vision for the City of Hartford that aims to weave together Hartford's key cultural sites and institutions around the theme of cultural innovation to promote economic growth and the redevelopment of the Capitol district (http://www.hartfordiquilt.org/).

3.2.11 Additional Subwatershed Field Assessments

Due to limited project funding, not all stream segments in the priority subwatersheds were assessed, and other subwatersheds were not assessed as they were determined to be less vulnerable to future development impacts. The remaining subwatersheds and stream reaches (*Table 3-8*) should be assessed over the next two years, pending the availability of funding, to identify additional site-specific issues and potential watershed restoration opportunities.

Table 3-8. Additional Subwatersheds and Stream Reaches to be Assessed

Subwatershed	Stream Reach	Proposed Schedule
Wash Brook North	WBN-01, WBN-02, WBN-03, WBN-05, WBN-07	2011
Wash Brook South	WBS-02, WBS-05, WBS-07 through WBS-10, WBS-12 through WBS-19	2011
Beamans Brook West	BBW-01, BBW-03 through BBW-06	2011
Tumbledown Brook	TDB-01 through TDB-04, TDB-7, TDB-09, TDB-10, TDB-11, TDB- TDB-13, TDB-15, TDB-16, TDB-17	2011
North Branch Park River	NBP-01 through NBP-03, NBP-05, NBP-06, NBP-07, NBP-08, NBP-12, NBP-17, NBP-18	2011
Wintonbury Reservoir	WTR-03, WTR-04, WTR-05	2012
Blue Hills Reservoir	BHR-03 through BHR-09	2012
Beamans Brook East	BBE-03	2012
Wash Brook West	All reaches	2012
Tunxis Reservoir	All reaches	2012
Cold Spring Reservoir	All reaches	2012
Tumbledown Brook South	All reaches	2012
West Hartford Reservoir	All reaches	2012

3.2.12 Estimated Costs

Planning-level costs were estimated for the targeted recommendations in this plan, where sufficiently detailed information was available. The cost estimates assist watershed stakeholders to evaluate the financial resources and funding sources that may be required to implement the plan. Planning-level cost estimates for site-specific project recommendations are presented for each site-specific restoration concept (*Section 3.3*).

Table 3-9 summarizes typical ranges of planning-level unit costs for the targeted recommendations that are identified in this plan. Additional information is required to develop more detailed cost estimates for these recommendations.

Table 3-9. Typical Costs for Targeted Plan Recommendations

Recommendation	Planning-Level Cost (2010 Dollars)	Typical Range	Source
Invasive Species Management Plan	$25,000	$15,000 - $35,000	Professional engineering experience
Targeted Stormwater Retrofits			Center for Watershed Protection Urban Stormwater Retrofit Practices (2007)
Constructed Wetlands (ac. treated)	$3,400	$2,400 - $11,110	
Extended Detention (ac. treated)	$4,400	$2,600 - $8,700	
Wet Ponds (ac. treated)	$9,700	$3,600 - $33,000	
Water Quality Swale (ac. treated)	$20,900	$12,500 - $42,000	
Bioretention/infiltration (ac. treated)	$29,300	$23,000 - $48,000	
Stormwater Curb Extensions - per 1000 sf IC treated	$195,000	$140,000 - $290,000	City of Portland (2005)
Pervious Pavement (square foot)	$10	$5 to $15	R.S. Means - includes limited subgrade modifications
Fish Passage Assessment			
Lower North Branch Park River	$15,000	$10,000 - $20,000	Varies depending on volunteer involvement
Entire Watershed	$20,000	$15,000 - $30,000	
Illicit Discharge Investigation	Varies significantly based on methods used		NEIWPCC IDDE Manual (2003), CWP IDDE Manual (2003)
Additional Subwatershed Field Assessments (per stream mile)	$1,000	$200 - $2,000	Varies depending on volunteer involvement, summary reports prepared, difficulty of terrain
Reforestation and Riparian Buffer Restoration			
Herbaceous buffer in grassed area (ac.)	$2,000	$1,000 - $3,000	R.S. Means, depends on existing condition
Trees and Shrubs (ac.)	$15,000	$5,000 - $20,000	U.S. Forest Service Urban Watershed Forestry Manual (2006), R.S. Means
Reforestation of Paved Areas (ac.)	$75,000	$50,000 - $100,000	R.S. Means
Streambank Restoration			
Bank Stabilization (linear ft of bank)	$40	$10 - $100	Derrick (1997), NOAA (2000)
Redirective Techniques (each)	$4,000	$3,000 - $10,000	Professional engineering experience
Channel Rehab. (linear ft of channel)	$30	$11 - $37	NOAA (2000)
Stream Daylighting (linear ft of channel)	$1,100	$300 - $3000	Small streams at less constrained sites
Priority Stream Cleanups	Varies significantly based on amount of donated supplies and services		
Fish Passage Enhancement	Varies significantly based on methods used		

3.3 Site-Specific Recommendations

Site-specific recommendations are tailored to address issues at selected sites that were identified during the watershed field inventories. The site-specific recommendations presented in this section are intended to serve as concepts for further refinement and to provide examples of the types of projects that could be implemented at similar sites throughout the watershed, including other priority sites identified in the Targeted Recommendations section of this management plan.

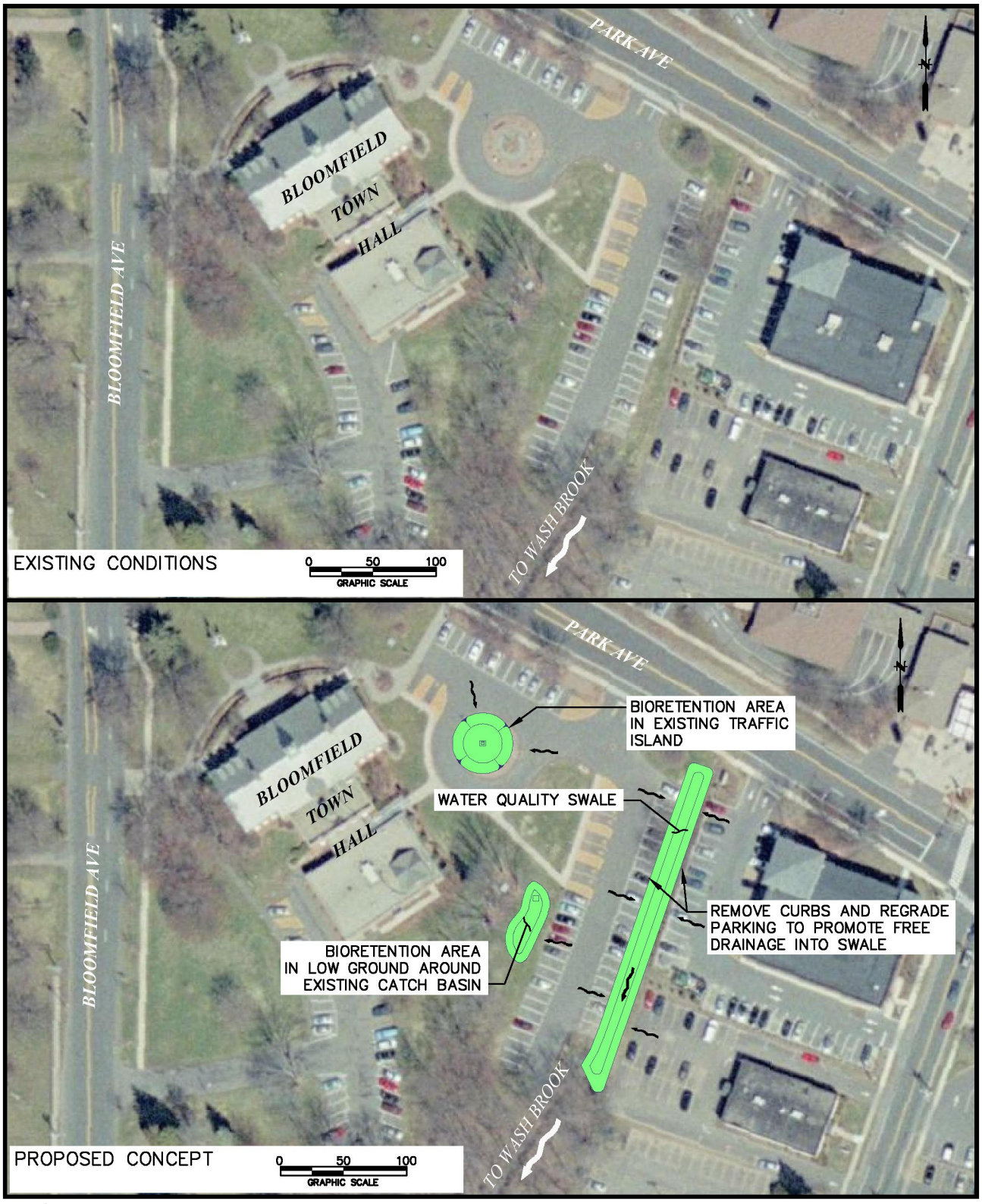
Preliminary, planning-level costs were estimated for the site-specific restoration concepts presented in this section. These estimates are based upon unit costs derived from published sources and the proposed concept designs. Capital (construction, design, permitting, and contingency) and operation and maintenance costs were included in the estimates, and total annualized costs are presented in 2010 dollars based on the anticipated design life of each restoration concept. A range of likely costs is presented for each concept, reflecting the inherent uncertainty in these planning-level cost estimates. A more detailed breakdown of the cost estimates is included in *Appendix F*.

3.3.1 Bloomfield Town Hall LID Retrofits

Bloomfield Town Hall LID Retrofits	
Objectives:	Runoff reduction Pollutant reduction Public outreach
Estimated Cost:	$200,000 - $300,000
Responsible Entity:	Town of Bloomfield
Timeline:	2 to 3 years

The Bloomfield Town Hall on Bloomfield Avenue is surrounded by landscaped grounds, driveways, and parking areas that provide a good opportunity for a high-profile LID retrofit project. Currently, some of the stormwater from parking areas at the site flows overland and discharges directly to a tributary of Wash Brook. Other areas, which consist primarily of grass and a driveway that surrounds a circular traffic island, are served by catch basins and storm drains. Many permeable areas of the grounds lie at a lower elevation than paved areas, but water is directed away from these areas by curbing around the pavement. On the eastern portion of the site, a grass swale is located between an on-site parking lot and an adjacent commercial parking lot.

Existing landscaped areas of the site could be converted to bioretention areas to treat and potentially infiltrate stormwater from the parking lots. Curbing at the parking lot edges could be replaced with a wheel stop at each parking stall, spaced to allow water to flow off the pavement and onto the grass areas. The grass areas could be regraded to retain water and promote infiltration into the underlying soils, or an underdrain could be installed to receive treated stormwater below a filtration layer that would serve as the growing media for landscape plants. Existing stormwater infrastructure could be used to provide overflow drainage for larger storms and receive discharges from underdrains. *Figure 3-5* presents a bioretention retrofit concept for the Bloomfield Town Hall site.



(Photo Source: U.S. Geological Survey, 2008)

Figure 3-5. Bloomfield Town Hall LID Retrofit Concept