

Impervious Cover TMDL Field Survey and Analysis Report



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March 4, 2010

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TABLE OF CONTENTS

Section 1. Introduction.....3
Section 2. Field Assessment and Prioritization Methodology.....3
Section 3. Field Assessment Summary.....6
Section 4. Priority Retrofit Projects.....7
Attachment A. Watershed Maps
Attachment B. Stormwater Retrofit Project Summary & Calculation Assumptions
Attachment C. Concept Sheets for High Priority Projects
Attachment D. Design Drawings for High Priority Projects
Attachment E. Retrofit Reconnaissance Inventory (RRI) Field Forms

SECTION 1. Introduction

As part of their responsibilities under the Clean Water Act, the Connecticut Department of Environmental Protection (CTDEP) has developed and issued a Total Maximum Daily Load (TMDL) analysis for Eagleville Brook. The Eagleville Brook watershed is located in Mansfield, Connecticut and includes much of the University of Connecticut (UConn) campus; the watershed is listed by the state as an impaired waterbody. The TMDL, approved by the Environmental Protection Agency (EPA) in February 2007, is the first in the nation based not on a specific pollutant(s), but on impervious cover, a landscape indicator that integrates the many impacts of urban development.

The Center for Land Use Education and Research (CLEAR) is the project lead on investigating opportunities to reduce, remove, or manage existing impervious cover to meet the TMDL by which the UConn and Mansfield communities can address the TMDL, and monitor progress toward the TMDL goals, through a watershed-based management plan. The objectives of the project are to: (1) create a specific TMDL Water Quality Management Plan for Eagleville Brook, that can be followed by the UConn and the Town of Mansfield; (2) identify opportunities for best practices that can be implemented in the near term, and; (3) document a general methodology by which other regulated communities and entities can address impervious cover-based TMDLs.

CLEAR has collaborated with the Center for Watershed Protection (CWP) and Horsley Witten Group (HW) as a part of this project to complete a field assessment of stormwater retrofit opportunities in the Eagleville Brook watershed. This report summarizes the findings from 51 sites that were surveyed, recommends a prioritization framework for the projects identified and presents schematic designs for the priority concepts.

This report is organized as follows:

Section 1. Introduction – provides an introduction to the Impervious Cover TMDL Field Survey and Analysis Report.

Section 2. Field Assessment and Prioritization Methodology - provides a summary of the protocol for the retrofit inventory field assessment, lists the criteria that were used to prioritize the identified projects and discusses the assumptions made in calculating costs, pollutant removal, runoff reduction, etc. for each practice.

Section 3. Field Assessment Summary - briefly summarizes field findings and provides a list of the high priority projects.

Section 4. Priority Retrofit Projects - provides a brief description of each of the high priority projects.

SECTION 2. Field Assessment and Prioritization Methodology

2.1 Stormwater Retrofit Inventory

Potential stormwater retrofit opportunities at 51 project sites in the Eagleville Brook watershed were assessed during the retrofit inventory (Attachment A, Map A.1.). Stormwater retrofits are structural stormwater management practices that can be used to address existing stormwater management problems within a watershed. They are an essential element of a watershed restoration program because they can help improve water quality, increase groundwater recharge, provide channel protection, and control overbank flooding. Without using stormwater retrofits to address existing problems and to help establish a stable, predictable hydrologic regime by regulating the volume, duration, frequency, and rate of stormwater runoff, the success of many other watershed restoration strategies -- such as bank stabilization, riparian reforestation, and aquatic habitat enhancement -- cannot be guaranteed. In addition to the stormwater management benefits they offer, stormwater retrofits can be used as demonstration projects, forming visual centerpieces that can be used to help educate residents and/or students while building interest in watershed restoration.

Stormwater retrofits can be broken into three general categories: offsite storage, onsite nonresidential, and onsite residential. Offsite storage retrofits, such as ponds and wetlands, generally provide the widest range of watershed restoration benefits because of their ability to treat relatively large drainage areas. However, onsite retrofit practices, such as bioretention and filtration practices, can provide a substantial benefit when applied to a large number of sites within a subwatershed.

In the Eagleville Brook watershed, candidate project areas on the UConn campus and in the City of Mansfield were identified prior to field work using aerial photography, stakeholder input, and information gathered during earlier watershed site visits prior to field work. Candidate project sites were mostly located on the UConn campus due to the high amount of impervious cover found there. The City of Mansfield is largely rural residential with little opportunity for implementing retrofits. The campus was divided into three regions that each of three teams visited throughout field work, which occurred from 7/12/09-7/16/09. A map of sites visited can be found in Attachment A.

Using the Retrofit Reconnaissance Inventory (RRI) field form developed by CWP, the stormwater retrofit potential of each site was evaluated by analyzing existing drainage patterns, drainage areas, impervious cover, available space, and other site constraints (e.g. conflicts with existing utilities and land uses, site access, and potential impacts to natural areas). Unless there were obvious site constraints and/or evidence that a particular stormwater retrofit would offer few or no watershed benefits, a stormwater retrofit concept was developed. More detail on conducting the RRI protocol can be obtained directly from Schueler et al. (2007). The scanned RRI field forms can be found in Attachment E.

Each proposed stormwater retrofit was based on the size of the project site, the particular constraints and characteristics of the project site, the size of the drainage area to be treated, the current use of the land by the University, and the amount of impervious cover within the drainage

area. During the field investigation, observed impervious areas that were already disconnected were noted and recorded. Additionally, several discrepancies in the original watershed boundary provided by CT Department of Environmental Protection were identified during the field assessments. The watershed boundary was revised based on these findings. The original and revised boundaries can be found in Attachment A, Map A.2.

2.2 Project Prioritization Framework

A variety of stormwater management practices were proposed on the UConn campus, including rain gardens, bioretention, downspout disconnection, green roofs, swale enhancement, soil amendments, dry swales, porous pavement, cisterns, sand filters, constructed wetlands, floodplain reconnection, impervious cover removal, tree plantings, pervious area restoration and stormwater planters. CWP & HW used professional judgment to rank the preliminary concepts from high to low priority for further investigation based on the following factors:

- Impervious area treated
- Pollutant removal capability
- Runoff reduction
- Feasibility
- Cost
- Demonstration / education
- Maintenance

The water quality volume for each practice was calculated using the following equation based on criteria established in CT's stormwater design manual:

$$WQ_v = [(P)(R_v)(A)] / 12$$

Where:

WQ_v = water quality volume (acre-feet),

P = target rainfall depth (inches)

$R_v = 0.05 + 0.009(I)$, where (I) is the percent impervious cover of the site, and

A = site drainage area (acres)

This calculation is based on 1" of rainfall multiplied by the contributing impervious area to the practice. Runoff reduction refers to annual reduction in stormwater runoff. Pollutant removal estimates were calculated from drainage area, impervious cover, practice proposed, annual precipitation of 46" per year and removal estimates per practice based on Schueler et al. (2007). Retrofit concepts for projects at the "top 10" retrofit sites have been developed into 25% detailed concepts. A brief description of each project can be found in Section 4, project concept sheets for the high priority sites can be found in Attachment C and design drawings for the high priority projects can be found in Attachment D.

2.3 Project Assumptions

Disconnection from impervious surfaces was defined prior to field work as a length of drainage to a pervious area with the same length as the impervious surface itself. Disconnected areas are shown in Attachment A, Map A.1.

Practice cost assumptions were derived from Schueler et al (2007) and are summarized in Attachment B, Table B.3. Cost data are estimates only and reflect the cost of construction and not design and engineering. For a complete list of assumptions associated with these retrofit cost estimates, see Schueler et al (2007), Appendix E.

Runoff reduction and event mean concentration pollutant removal efficiencies were derived primarily from the Runoff Reduction Technical Memo (CWP and CSN, 2008) and Virginia Department of Conservation and Recreation Best Management Practice Clearinghouse (<http://www.vwrrc.vt.edu/swc/NonProprietaryBMPs.html>). A summary table of these efficiencies can be found in Attachment B, Table B.4. Runoff reductions were amended in some cases due to soil permeability.

SECTION 3. Field Assessment Summary

A total of 51 sites were visited by three teams during the field inventory. 110 projects were identified at those sites and priority projects were selected via the criteria stated above. GIS measurements and the field assessment resulted in adjustments to the drainage area and impervious cover calculations. These adjustments are summarized in Table 1. A summary of the impervious cover acres to be managed to meet the TMDL requirements can be found in Table 2. A summary of project benefits for high priority and all projects is displayed in Table 3.

Implementation of the high priority projects at the “top 10” watershed sites would result in the treatment of approximately 31 acres of impervious cover and approximately 2.5% of the watershed. These high priority projects are estimated to remove approximately 33 lbs of total phosphorus and would also reduce the annual runoff volume by 797,600 cubic feet of stormwater (Table 4). A complete list of the expected benefits for all of the 110 project sites can be found in Attachment B. Implementation of all 110 identified projects would result in the treatment of approximately 61 acres of impervious cover and approximately 5.1% of the watershed.

If implemented, these stormwater retrofits will improve stormwater runoff quality and recharge, mitigate some of the effects of existing impervious cover, and serve as demonstration and education sites for staff, students and visitors on the UConn campus. It should be duly noted that some stormwater pollutants particularly chloride in road salts are not significantly removed by stormwater treatment practices and may negatively affect biological communities and water quality – source control is the best way to reduce the concentration of these pollutants in urban watersheds.

Table 1. Impervious Cover and Drainage Area Adjustments			
Eagleville Brook Watershed	Existing Conditions		
	TMDL Estimated	GIS Measured	Field Adjusted
Watershed DA (acres)	1225	1225	1199
Watershed IC (acres)	145	216	165
% Watershed IC	12%	18%	14%
11% IC TMDL target (acres)	135	135	132
Remaining IC to manage (acres)	10	81	33
^a IC estimated using land use coefficients and 2002 ISAT data ^b IC measured from GIS mapping of 2008 high resolution imagery ^c Field assessment revealed 26 acres did not drain to Eagleville Brook ^d Field assessment identified 51 acres of watershed IC was already disconnected and should not be considered "effective."			

Table 2. Impervious Cover Management Summary			
Eagleville Brook Watershed	Existing Conditions*	Future IC with Retrofit Implementation	
		"Top 10" Projects	All Projects
Watershed IC (acres)	165	134.46	104.15
% Watershed IC	14%	11%	8.7%
11% IC TMDL target (acres)	132	Target met	Target exceeded
Remaining IC to manage (acres)	33		
[*] Using field adjusted watershed DA and IC values ^{**} Projects manage a total of 31 acres IC (subtract from 165 acres) ^{***} Projects manage a total of 61 acres IC (subtract from 165 acres). Assumes B7g option 1; and discounts double treatment by A2.			

Table 3. Project Benefit Summary							
	DA IC (acres)	% of Watershed*	Cost	TP Removed (lb/yr)	TN Removed (lb/yr)	TSS Removed (lb/yr)	Runoff Reduction (cf)
High Priority Projects	30.54	2.5%	\$1,350,600	32.5	207.5	6433	797,600
All projects	60.85	5.1%	\$5,797,500	72.4	521.5	15030	2,494,150
* Using Field Adjusted Watershed DA							

Table 4. High Priority Projects

Site ID	Location	Retrofit	DA IC (acres)	Cost ¹	TP Removed (lb/yr)	TN Removed (lb/yr)	TSS Removed (lb/yr)	Runoff Reduction (%)	Annual Runoff Reduction (cf/yr)
A3	F Lot	Terraced bioretention	1.64	\$89,000	2.3	20.0	500	20%	51,950
A4	F Lot	Bioretention	1.13	\$41,000	1.6	13.8	346	40%	25,350
A5a	Motor Pool	Sand filter	1.33	\$56,000	1.3	4.6	213	0%	0
A5b	Central Warehouse	Green roof	0.93	\$545,400	1.1	8.0	285	45%	66,400
A8a	Hurley Hall	Bioretention	0.47	\$4,800	0.2	1.6	41	40%	8,450
A8b	Hurley Hall	Rain gardens	0.20	\$15,900	0.2	1.9	47	40%	8,400
A8c	Hurley Hall	Rain gardens	0.18	\$22,800	0.3	2.7	67	40%	11,400
A11a-d	Lot 9	Bioretention & grass swale	1.39	\$51,600	1.9	16.0	410	10% (grass swale) 40% (bioretention)	0
B3	Baseball Field Batting Cage	Gravel Wetland	15.11	\$250,100	13.3	49.2	2263	0%	0
B5a	Parking Lot Y	Swale to Bioretention	1.32	\$43,500	1.7	14.6	367	60%	113,250
B5b	Parking Lot Y	Swale to Bioretention	0.50	\$18,300	0.7	6.1	155	60%	47,300
B11a	Parking Lot W	Bioretention	0.86	\$27,200	1.1	9.1	230	60%	70,900
B11b	Parking Lot W	Bioretention	1.38	\$32,600	1.3	11.0	275	60%	82,000
B11c	Parking Lot W	Swale to Bioretention	1.02	\$33,800	1.3	11.4	286	60%	87,250
B11d	Parking Lot W	Bioretention	0.92	\$33,500	1.3	11.3	283	60%	87,250

¹ Cost reflects an estimate of construction costs only and does not include further design and engineering.

Table 4. High Priority Projects									
Site ID	Location	Retrofit	DA IC (acres)	Cost¹	TP Removed (lb/yr)	TN Removed (lb/yr)	TSS Removed (lb/yr)	Runoff Reduction (%)	Annual Runoff Reduction (cf/yr)
C4e	School of Education	Bioretention	0.34	\$12,400	0.5	4.2	105	40%	21,350
C4/5a	GENT	Stormwater planters	0.12	\$10,500	0.2	1.4	36	40%	7,400
C4/5d	GENT	Bioretention	0.07	\$2,600	0.1	0.9	22	40%	4,650
C16	Torrey Life Sciences	Bioretention	0.28	\$10,300	0.4	3.5	87	40%	17,950
C17	Quad in front of chemistry bldg	Bioretention	0.51	\$18,600	0.7	6.2	157	40%	32,400
C18	Eagleville Rd	Bioretention	0.85	\$30,700	1.2	10.3	259	40%	53,950
Total			30.5	\$1,350,600	32.5	207.5	6433	--	797,600

SECTION 4. Priority Retrofit Projects

A brief description of each high priority project can be found below. Detailed information concerning each of these projects can be found in Appendices C & D and locations can be found in Attachment A, Map A.1.

Site A3/A4

The site, Lot F, is two parking areas separated by a grassed slope, and is located over a former landfill with an impervious cap. Currently, runoff is captured in a storm drain system that discharges directly to Eagleville Brook. The proposed concept calls for the installation of two bioretention facilities. Runoff would be conveyed to each practice using paved flumes and overflow would be overland flow to the Brook.

Site A5a/b

The site is the motor pool and warehouse east of the facilities building; indications of oil spillage on the completely impervious lot are evident. Currently no stormwater treatment exists on the site despite the potential for automotive contaminants. The concept at this site is a perimeter sand filter around the motor pool parking lot and a green roof on the warehouse.

Site A8

This site is a quad area of the Hurley Hall Student Residences. Erosion is pervasive at the site as indicated by gullies in the turf area, sand and gravel on the walkways and yard inlets full of sediment. Bioretention is proposed in three locations to capture walkway runoff. An underdrain will be required due to the compacted conditions at the site; soil amendments are also recommended.

Site A11a-d

This is a highly visible site across from the campus visitor center. The parking lot is in poor condition and untreated runoff is conveyed directly to the storm drain system. The proposed concept calls for the installation of two linear bioretention areas in the medians and two small bioretention cells in existing landscaped areas.

Site B3

The site is located near the baseball fields in the SE portion of the campus. The drainage area is large (55 acres) and the practice has the potential to manage significant volumes of runoff and impervious surfaces. The concept proposes using a diversion manhole to direct flows into a pretreatment forebay that discharges to a gravel based wetland system. Flows are then forced upward through gravel filters to a vegetated wetland surface.

Site B5a/b

The site, nested within drainage area of site B3, is located along the edge of Parking Lot Y. Currently, runoff is conveyed to an underground detention pipe system, however, some drainage appears to bypass the inlets and contribute to damage of a reinforced slope at the low end of the lot. The proposed concept calls for the installation of paved flumes from two lots at strategic locations into bioretention cells.

Site B11a-d

This site, a large, underused lot that is showing signs of decay, is located near the reservoir and Greek housing area. A portion of the site drains out of the Eagleville Brook watershed and the remaining portions of the lot are divided into four catchments that capture untreated stormwater runoff. Four bioretentions are proposed at the site. Some pavement removal and lot restriping would be required. Overflow ties back into the existing drainage.

Site C4/5

The Education and Gentry buildings are located in the center of campus and are separated by a Sundial Garden quad area. Soils in the garden and in adjacent areas are very compacted; roof leaders from the buildings are directly connected to the stormdrain system. Multiple projects are proposed for the site, including directing front roof leaders to stormwater planter beds; capturing rooftop runoff in cisterns near the main entrance of the building; soil amendments in the Sundial Garden; tree plantings to reduce runoff; and direction of two downspouts near a side entrance into a bioretention facility in the Sundial Garden.

Site C16/17

This site is located between the Chemistry building and Pharmacy/Biology building; soils are very compacted and little landscaping exists. Rooftop runoff from the Chemistry building connects directly to the storm drain system. The quad area and parking lot convey untreated stormwater directly to the Brook, which has been piped deep underneath the quad area. The proposed concept calls for the installation of three bioretention areas to capture rooftop and impervious area runoff.

Site C18

Eagleville Road runs through the center of campus and receives a significant amount of pedestrian use. The road is very wide in locations and runoff is directed to catch basins along the edge of the street. The proposed concept calls for removal of impervious cover along the road edge and installation street planter areas. The stormwater treatment facilities will also help to calm traffic and improve pedestrian safety on this busy road.

Literature Cited

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Schueler, T., D. Hirschman, M. Novotney and J. Zielinsky. 2007. Urban Subwatershed Manual No. 3: Urban Stormwater Retrofit Practices. Center for Watershed Protection.