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Monroe County, New York

Allen Creek Stormwater Assessment

February 9, 2015

ARCADIS

Brian Bandy, PE
Principal Water Resources Engineer

John Perriello, PE
Project Manager

STATE OF NEW YORK
JOHN C. PERRIELLO
No. 081662
LICENSED PROFESSIONAL ENGINEER

Allen Creek Stormwater Assessment

Prepared for:
Monroe County, New York

Prepared by:
ARCADIS of New York, Inc.
295 Woodcliff Drive
Third Floor
Suite 301
Fairport
New York 14450
Tel 585 385 0090
Fax 585 385 4198

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Tables

Figures

Appendices

A	Compiled GIS Data (Table A-1and electronic geodatabase) and GIS Methodology Summary
B	Custom Web Soil Survey Reports by Subwatersheds: Allen Creek East Branch, West Brook, Allen Creek Main Branch
C	Priority Waterbodies List (NYSDEC 2007)
D	Green Infrastructure Rapid Assessments: Allen Creek Main Branch and Allen Creek East Branch (Monroe County, NY 2013)
E	Retrofit Project Design Sheets (CWP 2007 and Pennsylvania Department of Environmental Protection 2006)
F	Potential Stormwater Retrofit Project Diagrams
G	WTM Models: Allen Creek East Branch, West Brook, and Allen Creek Main Branch

Acronyms and Abbreviations

bioretention ROW	bioretention on public highway right-of-way
BMP	best management practice
cfs	cubic feet per second
CWP	Center for Watershed Protection
MCDES	Monroe County Department of Environmental Services
Erie Canal	New York State Barge Canal
GIS	geographic information system
HOA	home owners association
HSG	Hydrologic Soil Group
HSPF	Hydrologic Simulation Program FORTRAN
ICM	Impervious Cover Model
MS4	Municipal Separate Storm Sewer System
NYSDEC	New York State Department of Environmental Conservation
PWL	Priority Waterbodies List
ROW	right-of-way
SCMC	Stormwater Coalition of Monroe County
stormwater assessment	Allen Creek Stormwater Assessment
Stormwater Master Plan	Stormwater Management Program Plan for Monroe County
SWAAP	Stormwater Assessment and Action Plan
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WTM	Watershed Treatment Model
%	percent

Executive Summary

This Allen Creek Stormwater Assessment (stormwater assessment) describes a range of potential structural stormwater retrofit projects recommended to improve water quality and reduce stormwater runoff in the Allen Creek watershed in Monroe County, New York. The projects presented in this stormwater assessment are based on a planning-level analysis and are recommended for further study prior to implementation. An overarching goal of this stormwater assessment is to help Monroe County and other municipalities in the county restore water quality to sustain designated uses as required by the federal Clean Water Act.

The approximately 29.2-square-mile Allen Creek watershed is located just south of the City of Rochester. The watershed is comprised of four subwatersheds: Buckland Creek, approximately 3.8 square miles; Allen Creek Main Branch, approximately 13.3 square miles; West Brook, approximately 2.2 square miles; and Allen Creek East Branch, approximately 9.8 square miles. Buckland Creek, Allen Creek Main Branch and Allen Creek East Branch discharge into Irondequoit Creek, which subsequently discharges into Irondequoit Bay, and ultimately into Lake Ontario. The West Brook subwatershed discharges to the Erie Canal.

Surface-water pollutants in the watershed include nutrients, salt, silt/sediment, and pathogens; sources of these pollutants consist of urban stormwater runoff, construction, sanitary discharges, agriculture, deicing, and streambank erosion. Stormwater runoff volumes and rates, flooding, and hydro-modification are additional concerns because these influence nonpoint source pollutant loads as well as stream channel geomorphology and biological habitat. This stormwater assessment recommends potential retrofit projects to reduce nonpoint source loads of stormwater pollutants, such as nutrients and sediment, and to reduce runoff volumes and rates, and attenuate peak flows.

The expedited approach used for this stormwater assessment included a baseline characterization of current watershed conditions through the collection, review, and analyses of geographic information system (GIS) datasets. Datasets used in the characterization include land cover, land use, land ownership, topography, stormwater infrastructure, roadways, surface water, hydrology, wetlands, and soil. In addition to the GIS analyses, background literature and reports (including the Allen Creek Main Branch and the Allen Creek East Branch Green Infrastructure Rapid Assessment plans [Appendix D]) were reviewed to understand the watershed characteristics. Monroe County has employed a similar streamlined approach for developing stormwater assessments and action plans for other watersheds in the county, such as Shipbuilders Creek and Buckland Creek.

This stormwater assessment identifies and ranks 51 potential retrofit projects for the Allen Creek Main Branch, West Brook and Allen Creek East Branch subwatersheds. The

Buckland Creek subwatershed is not included in the scope of this assessment because it was previously assessed. The identified projects are located on public and private lands in areas of the watershed where they are estimated to improve water quality and help control runoff volumes during flood events. The types of potential retrofits include: stormwater wet ponds, constructed wetlands, dry ponds, bioretention (green infrastructure) on public highway right-of-way (bioretention ROW), and forested riparian buffers. Potential projects are ranked by applying a scoring system adopted by Monroe County that awards project points for feasibility, watershed benefits, and cost-effectiveness criteria. Monroe County developed this approach using guidance from the Center for Watershed Protection's (CWP's) Urban Stormwater Retrofit Practices, Manual 3 in their Urban Subwatershed Restoration Series (CWP 2007). One potential forested riparian buffer on Allen Creek Main received 14 points ranked highest among the projects scored. Fourteen projects each received 13 points. These potential project types include wet and dry ponds located in the Allen Creek East Branch (nine projects) and Allen Creek Main Branch (five projects) subwatersheds. Four bioretention ROW projects, two forested riparian buffer projects, two dry ponds, and two wet ponds each received a total of 12 points and spanned all three subwatersheds.

Models were developed for the Allen Creek Main Branch, West Brook and Allen Creek East Branch subwatersheds using the CWP's Watershed Treatment Model (WTM) (Caraco 2013) to estimate baseline (without potential projects) and proposed (with potential projects) conditions. Watershed conditions for each scenario are presented in terms of average annual loads of phosphorus, nitrogen, total suspended sediment, and bacteria, as well as average annual stormwater runoff volumes. Modeling results indicate wet ponds and a constructed wetland to be the most effective project types for reducing pollutant loads of total nitrogen, total phosphorus and total suspended solids. Model results indicate a wet pond, forested riparian buffers and bioretention projects to be the most effective at reducing runoff volumes.

Model results for both scenarios for each subwatershed were evaluated in conjunction with the results of the project rankings to yield a final prioritization matrix recommended for the Allen Creek watershed. As a result of the rapid assessment ranking and the WTM modeling, 16 wet ponds, one constructed wetland, 16 forested riparian buffers, six bioretention projects within public rights-of-way and 12 dry ponds are recommended because of their potential to reduce pollutant loads and stormwater runoff volumes.

1. Introduction

Like many other communities that are experiencing growth, Monroe County, New York is faced with water resources management challenges as a result of land use and land cover associated with previous and ongoing watershed development patterns and utility infrastructure. Land uses (e.g., municipal, agricultural, and industrial), typically introduce a range of pollutants (e.g., sediment, nutrients, metals, hydrocarbons, pathogens, pesticides, organics) that have the potential to come into contact with stormwater runoff.

In urban areas, the construction of roadways and buildings typically results in increases of impervious cover and fewer opportunities for stormwater to infiltrate into the ground. Residential land uses may introduce the potential for nonpoint sources of nutrients from on-site wastewater treatment systems or sanitary sewer infrastructure, as well as pollutants related to vehicle use, chemical use, and animal waste associated with lawn care. Agricultural land uses often introduce potential stormwater pollutants such as nutrients (nitrogen and phosphorus), pesticides, and sediment from land-disturbing activities.

As a result of these practices, hydrologic, geomorphic, water quality, and biological alteration often occur within a watershed. For instance, stormwater runoff volumes and rates typically increase as a result of increases in impervious cover. Infiltration and groundwater recharge rates may decrease as a result of more impervious cover, thus causing lower baseflows and higher peak flows. High stormwater flows can cause flooding, damage property, and harm fish and wildlife habitat. As a result, stream channels may become more susceptible to erosion and excessive sediment deposition, and sediment loads in receiving waters can increase and lead to degraded biological habitats. This degradation results in poor water quality and added maintenance costs to municipalities and property owners. Increases in impervious cover can also contribute to habitat degradation by influencing increases in temperature and decreases in dissolved oxygen of the receiving surface waters. In Monroe County, stormwater pollution and associated wet weather flows have harmed virtually all urban streams, the Genesee River, and Lake Ontario's shoreline.

The Allen Creek watershed in Monroe County is an example of an area experiencing such effects from development, as exemplified through water quality and quantity issues for the entire approximately 60 miles of stream segments in the watershed as reported on the New York State Priority Waterbodies List (PWL) for Lake Ontario and tributaries (New York State Department of Environmental Conservation [NYSDEC] 2007). The PWL (NYSDEC 2007) reports nutrients as a known water quality pollutant. In addition, salt and silt/sediment are reported as suspected pollutants, and fecal coliform is reported as a possible additional pollutant for Allen Creek (NYSDEC 2007). The PWL (NYSDEC 2007) describes known sources of these pollutants as urban/ stormwater runoff, construction, other sanitary discharges (i.e., sewage), agriculture, deicing material storage and application, and streambank erosion (NYSDEC 2007).

1.1 Purpose

This Allen Creek Stormwater Assessment (stormwater assessment) provides Monroe County with a range of potential stormwater retrofit projects based on a watershed scale planning-level assessment. The recommended potential projects are expected to improve water quality and reduce stormwater runoff volumes and rates in the watershed. The analyses presented in this stormwater assessment serve to the lay the foundation for more detailed future studies, which are strongly advisable before implementation.

Developing plans to improve our impacted water resources is the objective of this stormwater assessment and other stormwater assessment and action plans being developed for Monroe County. A streamlined method was devised by Monroe County and the Stormwater Coalition of Monroe County[1] (SCMC) to quickly evaluate multiple watersheds for stormwater retrofit potential and to meet components of regulatory requirements. The main product is a list of prioritized projects based on the Monroe County Rapid Assessment methodology and associated pollutant load and stormwater runoff reductions estimated using WTM. The list represents projects that, if constructed, are expected to improve water quality and stream health, as well as provide flow attenuation to reduce erosive storm flow velocities and mitigate localized drainage problems. A second significant product is the creation of multiple electronic data files (e.g., geodatabase, maps, etc.), which are expected to lay the foundation for future, more in-depth studies.

1.1.1 Goals

This assessment presents potential stormwater retrofit projects, which if implemented, are estimated to improve the water quality of surface waters in the Allen Creek watershed. This assessment uses the Watershed Treatment Model (WTM) to estimate loads from a range of pollutant sources (point and nonpoint sources) to evaluate improvement options. The WTM approach allows for the adjustment of loads based on a projected level of stormwater best management practice (BMP) implementation, as well as evaluation of watershed management alternatives.

[1] The SCMC comprises 29 municipalities in Monroe County and was established in 2000.

1.1.2 Objectives

The results of this stormwater assessment meet some objectives of the Stormwater Management Program Plan for Monroe County (Stormwater Master Plan; SCMC 2009), such as:

- Managing stormwater from new and existing development to mimic natural systems by infiltrating runoff wherever possible, rather than creating runoff that contributes to water pollution.
- Restoring and protecting natural and critical features such as wetlands and vegetated stream corridors that reduce water pollution and stormwater runoff.

This stormwater assessment also fulfills requirements of the National Pollutant Discharge Elimination System Permit for Municipal Separate Storm Sewer System (MS4) operators, such as Monroe County and some members of the SCMC. Specifically, this stormwater assessment supports requirements for the MS4s to identify potential stormwater pollution reduction measures to restore the quality of surface waters to support their designated beneficial uses.

1.2 Scope

The scope of this stormwater assessment is a desktop planning analysis of the Allen Creek East Branch, West Brook, and Allen Creek Main Branch subwatersheds. The results include a prioritized list of 51 potential stormwater retrofit projects, such as wet ponds, dry ponds, constructed wetlands, forested riparian buffers, and bioretention on public highway right-of-way (bioretention ROW) projects, which are expected to improve water quality and attenuate stormwater runoff if implemented. The 51 potential projects comprise some projects (34) that are identified in the Allen Creek Main Branch and the Allen Creek East Branch Green Infrastructure Rapid Assessment plans completed by Monroe County in 2013 (Appendix D), and some new projects (17) identified in this stormwater assessment.

The desktop planning analysis helped to develop an understanding of the Allen Creek watershed. Previously completed scientific studies reported for Allen Creek were collected and reviewed to understand historical and current watershed conditions. One particularly noteworthy study was conducted by the United States Geological Survey (USGS [2005]) in cooperation with the Irondequoit Creek Watershed Collaborative.

In the USGS (2005) study, the Hydrologic Simulation Program FORTRAN (HSPF) model was developed for Irondequoit Creek and Irondequoit Bay, including Allen Creek, to continuously simulate watershed pollutant loading (from point and nonpoint sources), pollutant fate and transport, and hydrometerological processes. The model simulated contributions from the New York State Barge Canal (Erie Canal) point source discharges, such as those in the Allen Creek Main and East branches (Figure 2). Results of the HSPF modeling study concluded that continuing urbanization within the 150-square-mile Irondequoit Creek basin has increased flooding and impaired stream-water quality in the northern (downstream) half of the watershed. The model provides a management tool to support decisions regarding future development in the watershed. The model is designed to permit creation of scenarios that represent planned or hypothetical development, and assessment of associated flooding and chemical loads. Storm flow detention basins were simulated and alternative scenarios can be simulated to assess their effect on flooding and chemical loads.

In addition, geographic information system (GIS) datasets, such as aerial photography, parcels, land use/land cover, imperviousness, hydrology, soil, wetlands, and roadways were reviewed to identify locations of potential stormwater retrofit projects in the Allen Creek East Branch, West Brook, and Allen Creek Main Branch subwatersheds. After potential projects were identified, projects were assessed according to the Assessment Methodology developed by Monroe County to guide project evaluation. Following this approach, potential projects were scored based on criteria for feasibility, watershed benefits, and cost effectiveness. Scores for each criterion were summed for each project to obtain a total score, which was used to develop a prioritized list of potential projects. Finally, each potential project was evaluated using watershed models developed to help estimate each project's influence on pollutant loads and stormwater runoff.

This stormwater assessment does not include the Buckland Creek subwatershed of Allen Creek because a Stormwater Assessment and Action Plan was developed for this area in 2012 (SCMC 2012). In addition, this stormwater assessment does not include a field reconnaissance, which is critically important to validate the feasibility of each potential project. Therefore, a recommendation of this work is to perform a field reconnaissance of each potential site for validation prior to potential project implementation.

2. Setting

The Allen Creek watershed is located just south-southeast of the City of Rochester, New York (Figure 1). The approximately 29-square-mile watershed is part of the larger Irondequoit-Ninemile River Basin (Hydrologic Unit Code 04140101). Average annual rainfall in the watershed is 32 to 34 inches (United States Department of Agriculture, Natural Resources Conservation Service [USDA] 2010).

The Allen Creek Main Branch begins at the southern end of the Town of Henrietta and flows north into the Towns of Brighton, Pittsford, and Penfield. Allen Creek consists of four subwatersheds with varying characteristics: Allen Creek East Branch, West Brook, Allen Creek Main Branch, and Buckland Creek. After merging with the Allen Creek East Branch in the Town of Pittsford, the Allen Creek Main Branch flows through the Town of Brighton and then discharges into Irondequoit Creek in Panorama Valley (Town of Penfield). Due to size variability and diversity, each of these subwatersheds was modeled independently using WTM. The Buckland Creek subwatershed was previously modeled in WTM and a Draft stormwater assessment and action plan (SWAAP) was previously developed for this area (SCMC 2012). For this reason, Buckland Creek is not included in the scope of this stormwater assessment.

A middle branch of Allen Creek, known as the West Brook subwatershed (approximately 1,000 acres), discharges into the Erie Canal at Lock No. 32 near Clover Street. Two potential retrofit projects for this subwatershed are included in the scope of this stormwater assessment.

2.1 Watershed Characteristics

The Allen Creek watershed (18,661 acres) comprises four subwatersheds: Allen Creek East Branch (6,303 acres), West Brook (1,422 acres), Allen Creek Main Branch (8,486 acres), and Buckland Creek (2,450 acres) (Table 1 and Figure 2).

2.1.1 Streamflow

Allen Creek East Branch flows south to north for approximately 21 miles. A USGS gage (USGS 0423204920 East Branch Allen Creek at Pittsford) operates on the Allen Creek East Branch downstream of the Erie Canal point source discharge into the creek (approximately 2 cubic feet per second [cfs] on average). The drainage area to the gage is approximately 6,100 acres and mean daily discharge recorded for the gage is approximately 9 cfs, as reported from October 1, 1989 through September 30, 2002. Monthly mean discharge from May 1, 1990 through September 20, 2002 ranged from 4.3 cfs in September to 18 cfs in March. Annual mean discharge reported from 1991 through 2002 ranges from

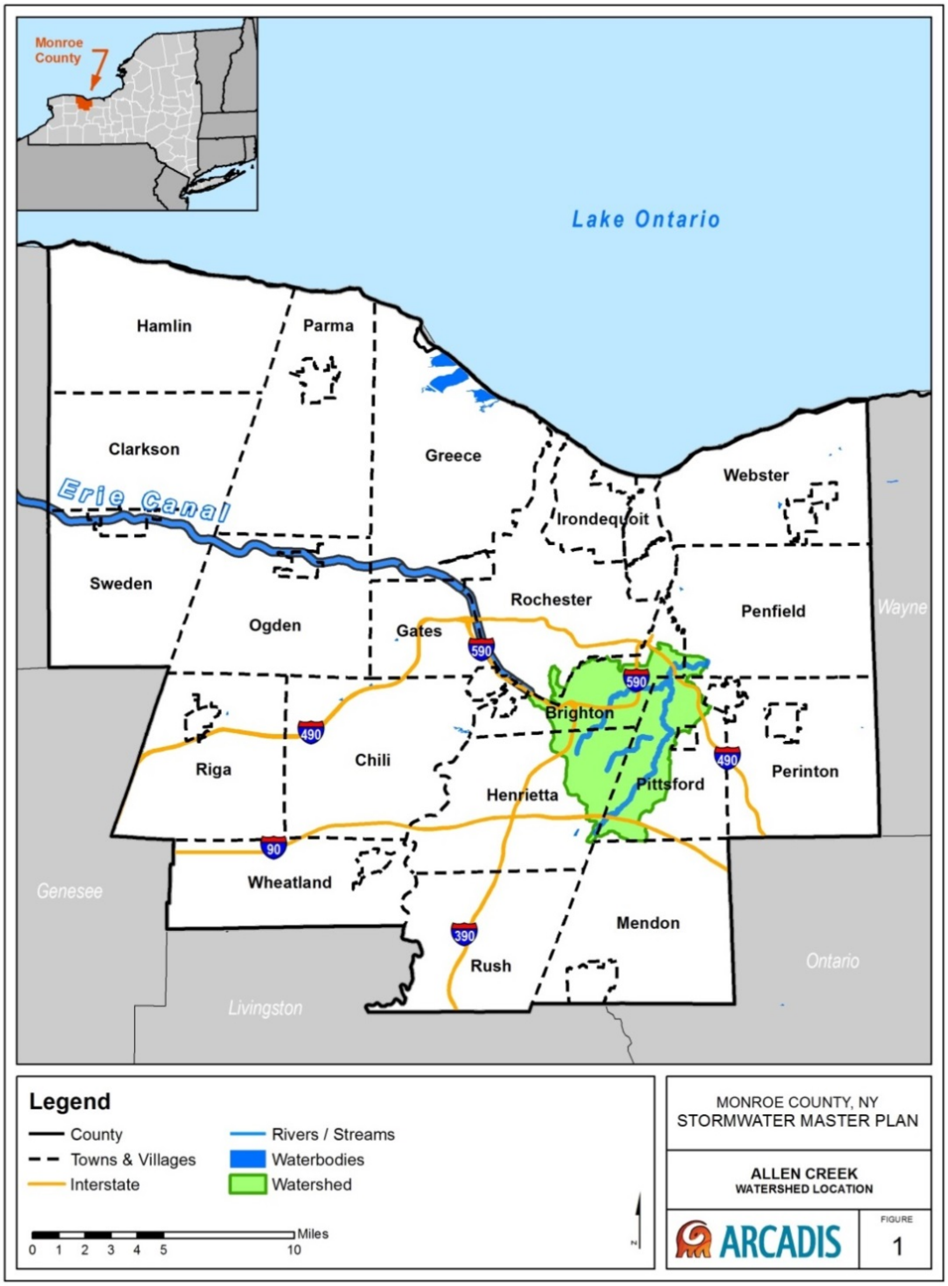

Figure 1 Location of Allen Creek Watershed, Monroe County, New York

Table 1 Watershed Data

Metric	Subwatershed		
	Allen Creek East Branch	West Brook	Allen Creek Main Branch[2]
Area (acres)	6,303[1]	1,422	10,939
Mapped Stream Length (miles)	21[1]	3.7	26
Percent (%) of Stream Channelized	7[1]	33[3]	
Primary/Secondary Land Use[4]	Residential/wild, forested, conservation lands, and public parks[1]	Residential/vacant land	Residential/vacant land
Land Use (% of watershed)[3,4]			
Agricultural (%)	19[1]	2	1
Residential (%)	29[1]	41	35
Vacant Land (%)	9[1]	16	14
Commercial (%)	3[1]	2	14
Recreational and Entertainment (%)	2[1]	15	4
Community Service	12[1]	13	27
Industrial (%)	1[1]	1	2
Public Services (%)	1[1]	7	2
Wild, Forested, Conservation Lands, and Public Parks (%)	25[1]	2	0
Number of Stormwater Treatment Ponds (count)	39[1]	43[3]	
Number of Stormwater Outfalls (count)	175[1]	548[3]	
Current Impervious Cover (%)	24[1]	33	34
Estimated Future Impervious Cover (%)	30[1]	37[3]	
Wetlands (acres, %)	450[1], 7	1382, 12[3]	
Municipal Jurisdictions (%)			
City of Rochester	0	0	3
Town of Brighton	<1	8	58
Town of Henrietta	3	52	33
Town of Mendon	<1	0	0
Town of Penfield	0	0	3

Table 1 Watershed Data

Metric	Subwatershed		
	Allen Creek East Branch	West Brook	Allen Creek Main Branch[2]
Town of Pittsford	95	40	4
Village of Pittsford	1	0	0

Notes:

1. Source: Green Infrastructure Rapid Assessment Allen Creek Watershed – East Branch, 2013. Appendix D.
2. 1% of land use in Allen Creek Main Branch is unclassified.
3. Source: Green Infrastructure Rapid Assessment Allen Creek Watershed – Main Branch, 2013. Appendix D.
4. Land use classes were determined using the New York State Office of Real Property Services' Assessor's Manual. Data Collection and Maintenance of Property Inventories – RFV. Section APP-B (New York State Office of Real Property Services 2006).

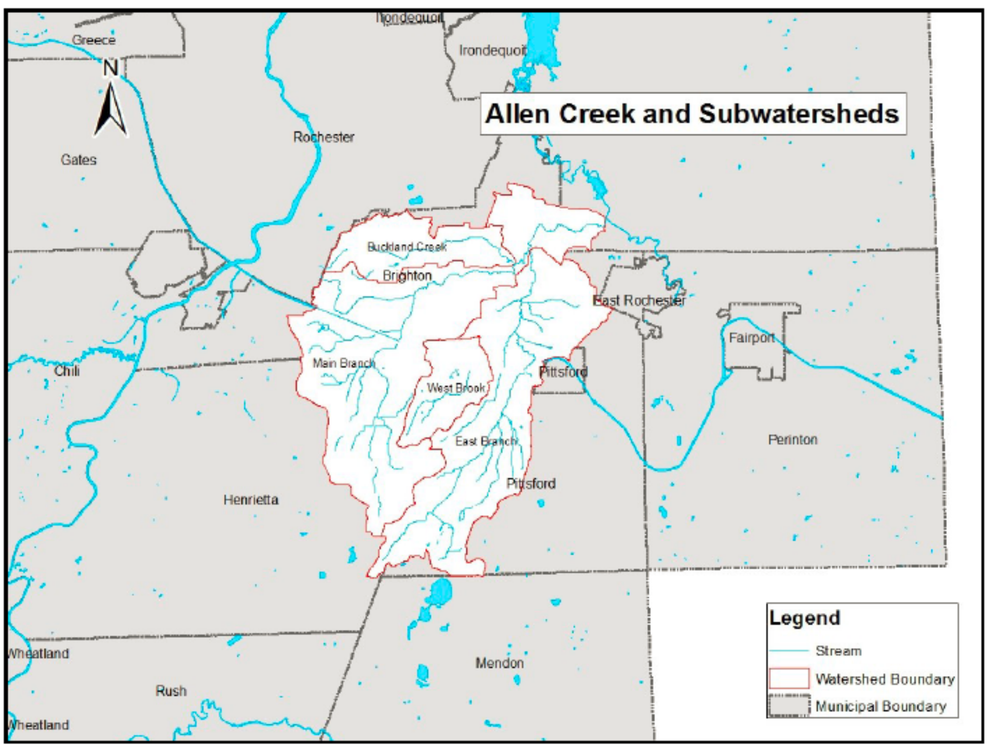

Figure 2 Allen Creek Subwatersheds, Monroe County, New York

approximately 5 cfs in 1995 to 11 cfs in 1998, with a median of approximately 9 cfs. Annual peak stream flow ranged from a high of 459 cfs in 1999 (which is reported as being “affected to unknown degree by regulation or diversion”), to a low of 110 cfs in 2002 (which is reported as being “affected to unknown degree by regulation or diversion”) (USGS 2014).

The Allen Creek Main Branch flows for approximately 26 miles. A USGS gage (USGS 04232050 Allen Creek near Rochester, New York) is located on the Allen Creek Main Branch, downstream of the confluences with Buckland Creek and the Allen Creek East Branch. Monthly mean discharge reported from December 1959 through December 2013 ranges from a low of 23 cfs in July, August, and September to a high of 56 cfs in March. Reported annual mean discharge ranged from 16 cfs in 1961 to 50 cfs in 1978, with a median of approximately 30 cfs. Peak annual stream flow ranged from approximately 320 cfs in 1965 to 3,280 cfs in 1974.

The Allen Creek Main Branch flows northeast from the Town of Henrietta through the Towns of Brighton, Pittsford, and Penfield. The Allen Creek Main Branch is joined by Buckland Creek and the Allen Creek East Branch in the Town of Pittsford, upstream of its confluence with Irondequoit Creek. From this confluence, Irondequoit Creek flows northward to Irondequoit Bay and ultimately discharges into Lake Ontario, northeast of the City of Rochester.

In the Town of Brighton, the Allen Creek Main Branch is intersected by the Erie Canal. At this location, the Erie Canal discharges intermittently, as part of controlled canal management, to the Allen Creek Main Branch. Further east, the Erie Canal intersects West Brook; at this location, the West Brook flow is discharged into the Erie Canal through managed control. Further east, the Erie Canal intersects and discharges intermittently to the Allen Creek East Branch in the Town of Pittsford.

The west- to east-flowing Erie Canal intersects many north-flowing streams in Monroe County, with most being conveyed underneath the Erie Canal via aqueducts. As discussed above, the Erie Canal has siphon discharges to the Allen Creek Main and East branches. Because Erie Canal water quality is generally poor, these discharges contribute significant pollutant loads to the receiving streams. Samples collected from Allen Creek above the Erie Canal, from the siphon, and below the Erie Canal for approximately 15 years have shown that concentrations of suspended material (e.g., turbidity, suspended solids, and phosphorus) were higher in water from the siphon than above the siphon and generally resulted in elevated concentrations and overall higher pollutant loads in the receiving streams.

Unlike Buckland Creek and the Allen Creek East and Main branches, the West Brook subwatershed, a drainage area of approximately 1,000 acres, does not discharge to

Irondequoit Creek, but rather to the Erie Canal at Lock No. 32 near Clover Street (Appendix D).

2.1.2 Land Use

The Allen Creek watershed is currently characterized by residential and agricultural land uses in the southern and upstream reaches of basin according to the property class descriptions provided in Assessor's Manual (New York State Office of Real Property Services 2006). The central part of the watershed is predominantly commercial and residential and the downstream and northern portion is a mix of residential, commercial, and recreation and entertainment land uses.

The predominant land uses in the Allen Creek East Branch are residential and agricultural, with pockets of commercial areas in the lower one-third of the sub-basin (Figure 3). The West Brook subwatershed is characterized by a mix of residential, community services, and recreation and entertainment land uses, with a concentration of commercial and public services near the location where the Erie Canal intersects and receives discharge from West Brook (Figure 4). The Allen Creek Main Branch is mostly residential land use in the southern (uppermost one-third) and northern (downstream most one-third) portions of the sub-basin (Figure 5). However, the middle portion of the Allen Creek Main Branch sub-basin is dominated by commercial land use, and to a lesser extent, industrial and public services.

2.1.3 Impervious Cover

The Allen Creek East Branch is approximately 21% impervious cover (Appendix D). Impervious surfaces make up approximately 33% and 34% of the West Brook and Allen Creek Main Branch, respectively, according to GIS analyses completed as part of this stormwater assessment. Impervious cover GIS data processing and analyses are described in the GIS methodology summary included in Appendix A.

Impervious cover is concentrated in the northern and downstream portions of the Allen Creek East Branch subwatershed in the Village and Town of Pittsford (Figure 6). In the West Brook subwatershed, impervious cover is most prevalent at the downstream end of the drainage basin near the intersection of Jefferson Road and further downstream near the subwatershed outlet to the Erie Canal (Figure 7). In the Allen Creek Main Branch, impervious cover is concentrated in the central portion of the subwatershed in the Town of Brighton and in line with the denser commercial, industrial, and transportation land uses of the basin (Figure 8). Potential retrofit projects are located, to the extent possible, downstream of or within concentrated areas of impervious cover to improve stormwater infiltration and reduce surface runoff.

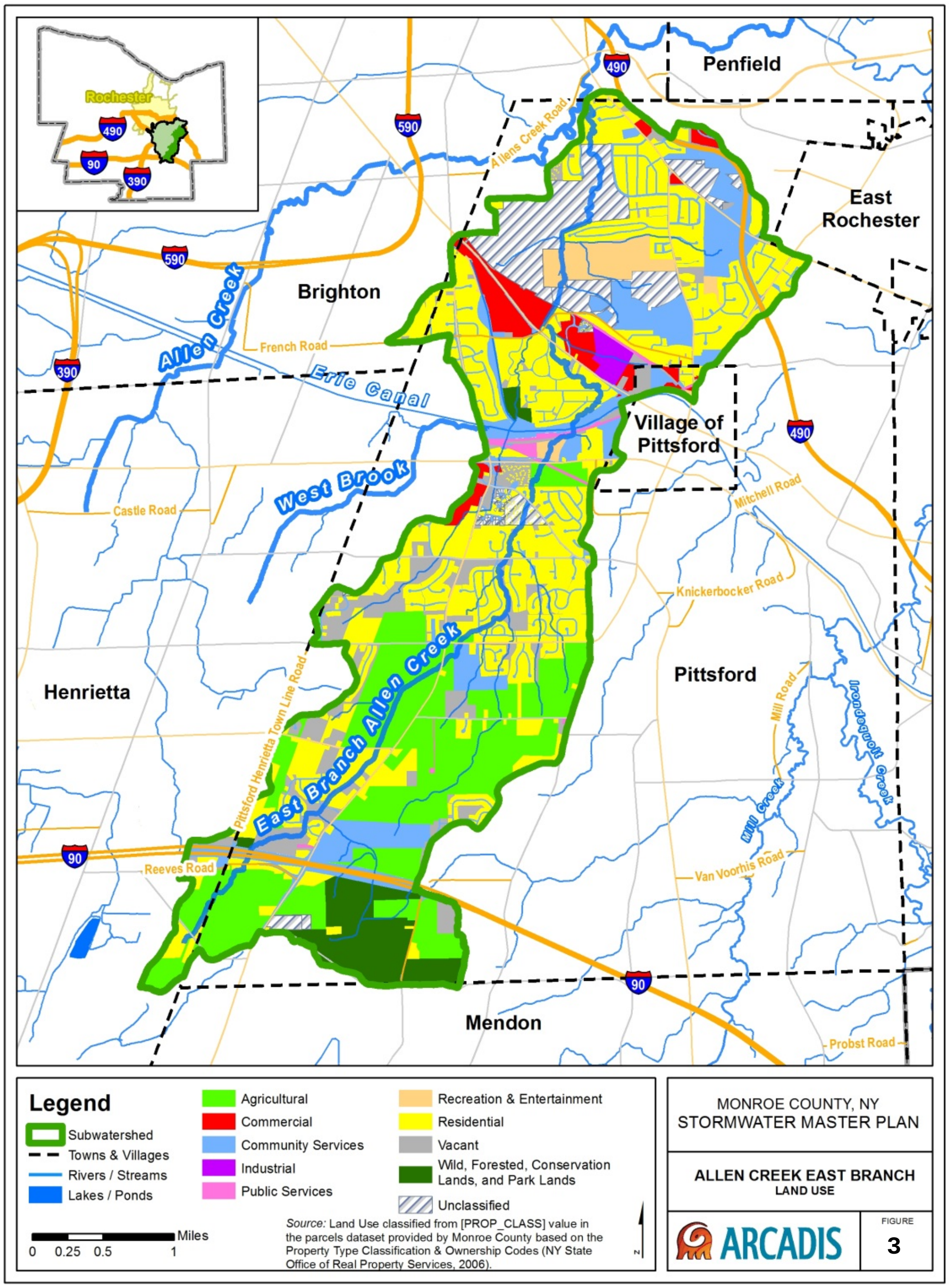

Figure 3 Current Land Use in Allen Creek East Branch Subwatershed

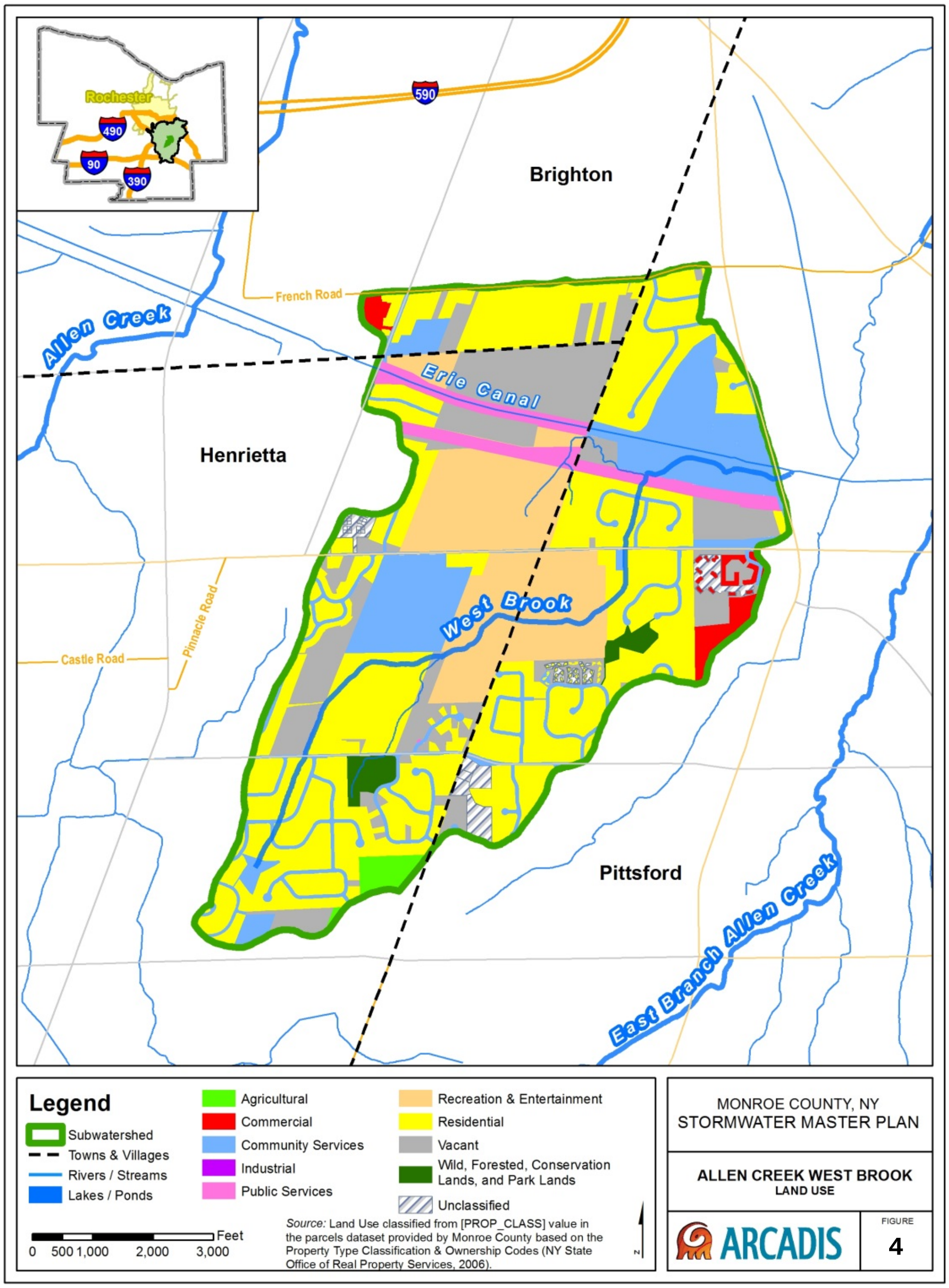

Figure 4 Current Land Use in West Brook Subwatershed

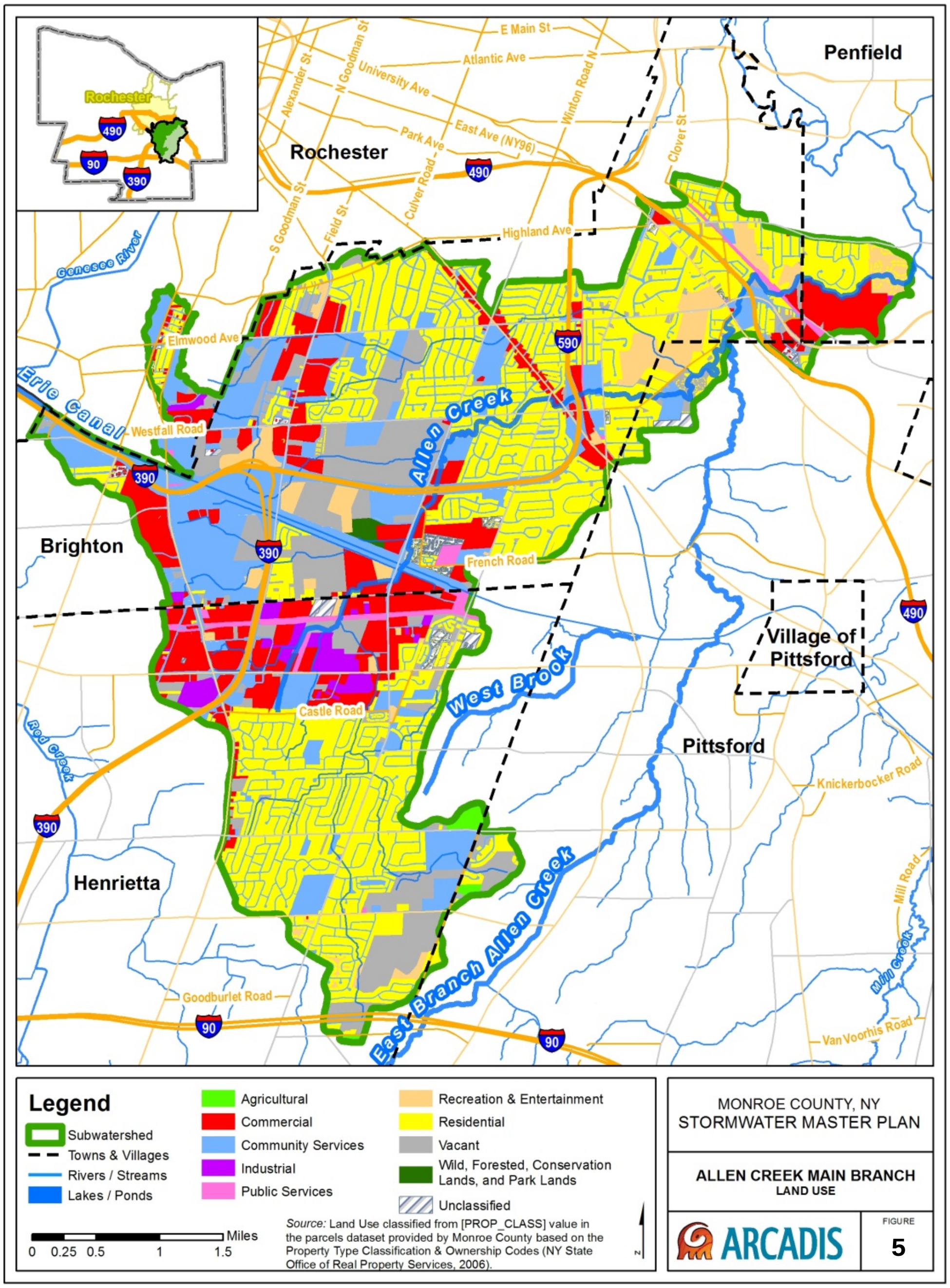

Figure 5 Current Land Use in Allen Creek Main Branch Subwatershed

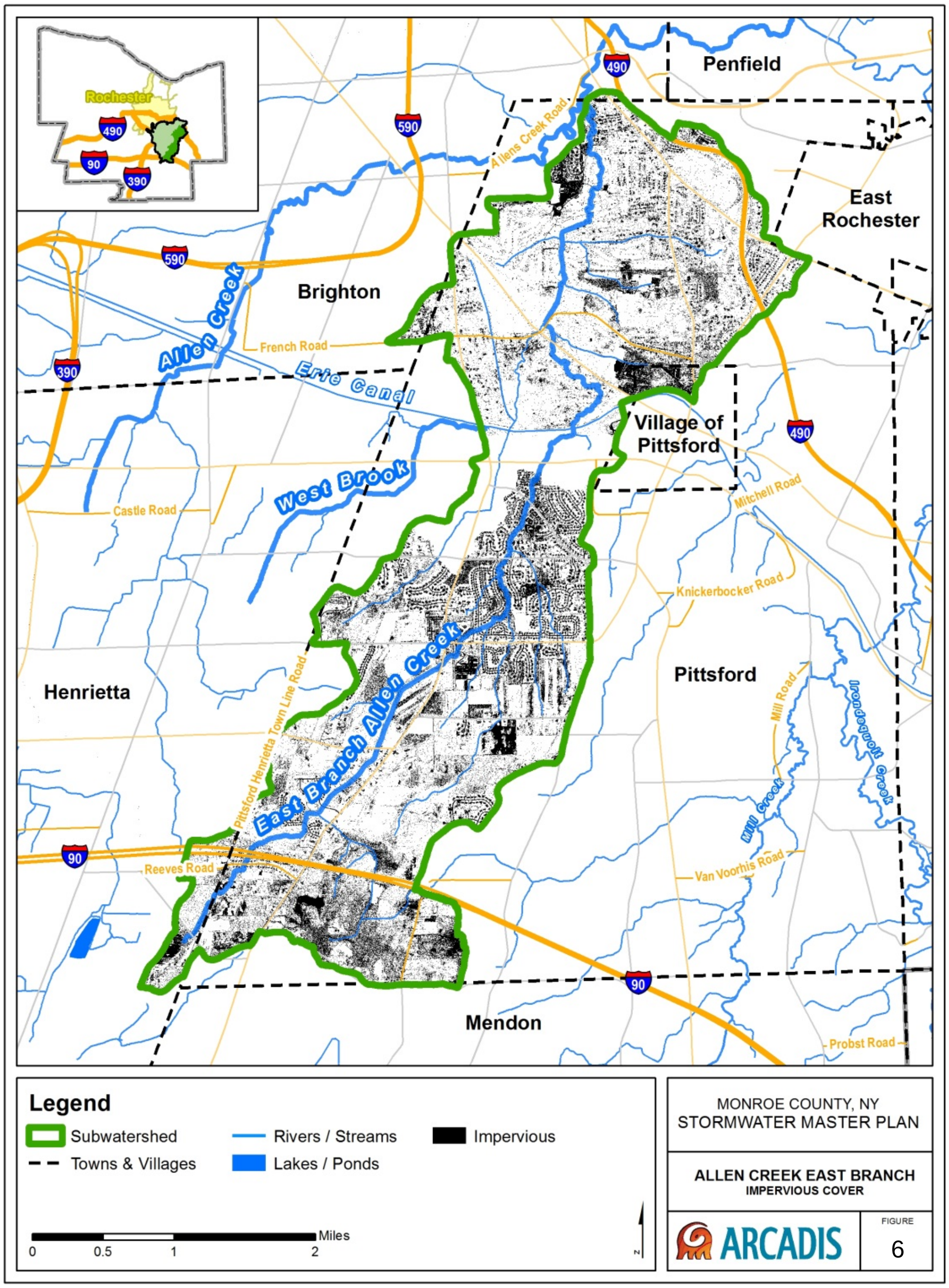

Figure 6 Current Impervious Cover in Allen Creek East Branch Subwatershed

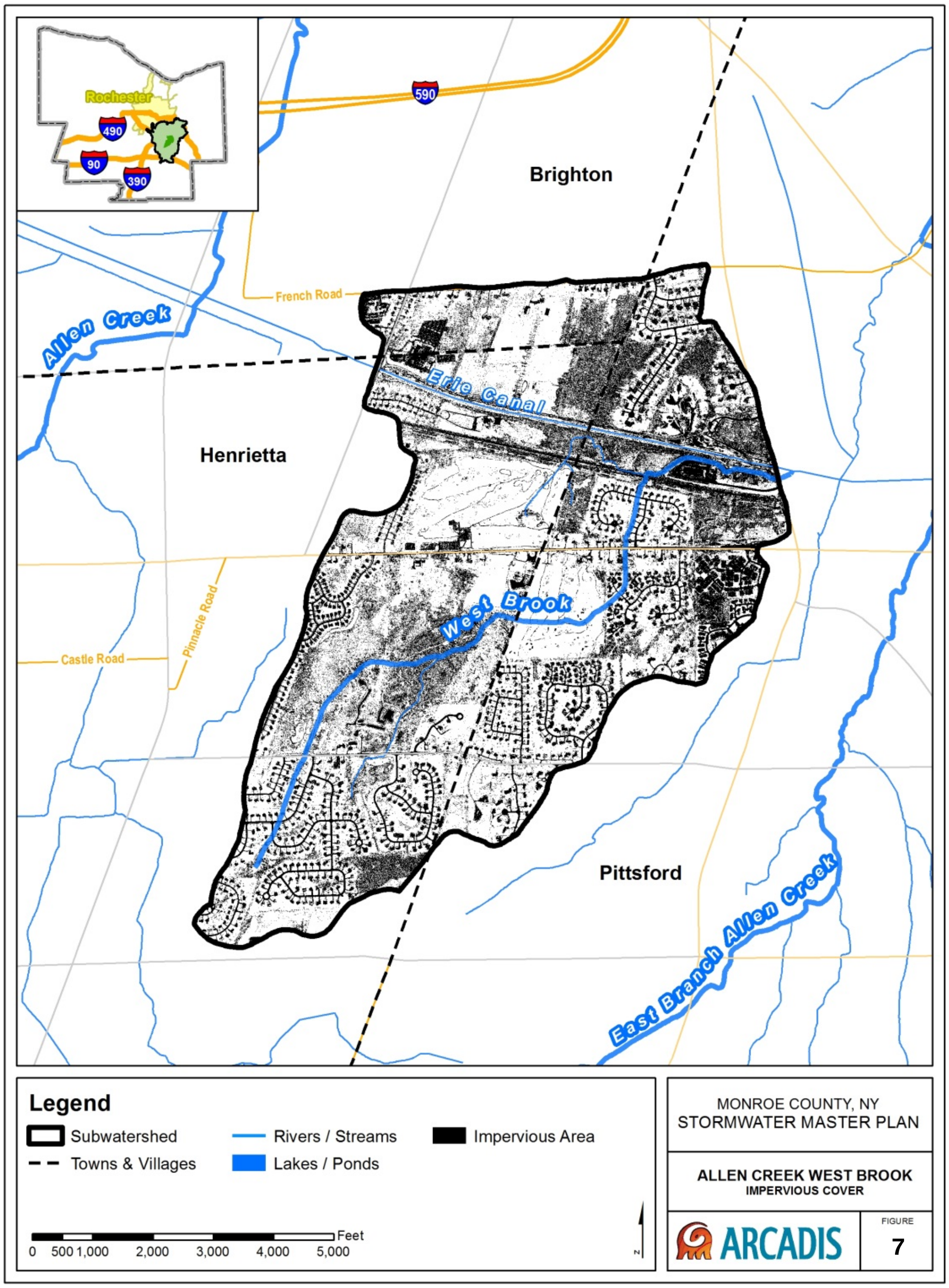

Figure 7 Current Impervious Cover in West Brook Subwatershed

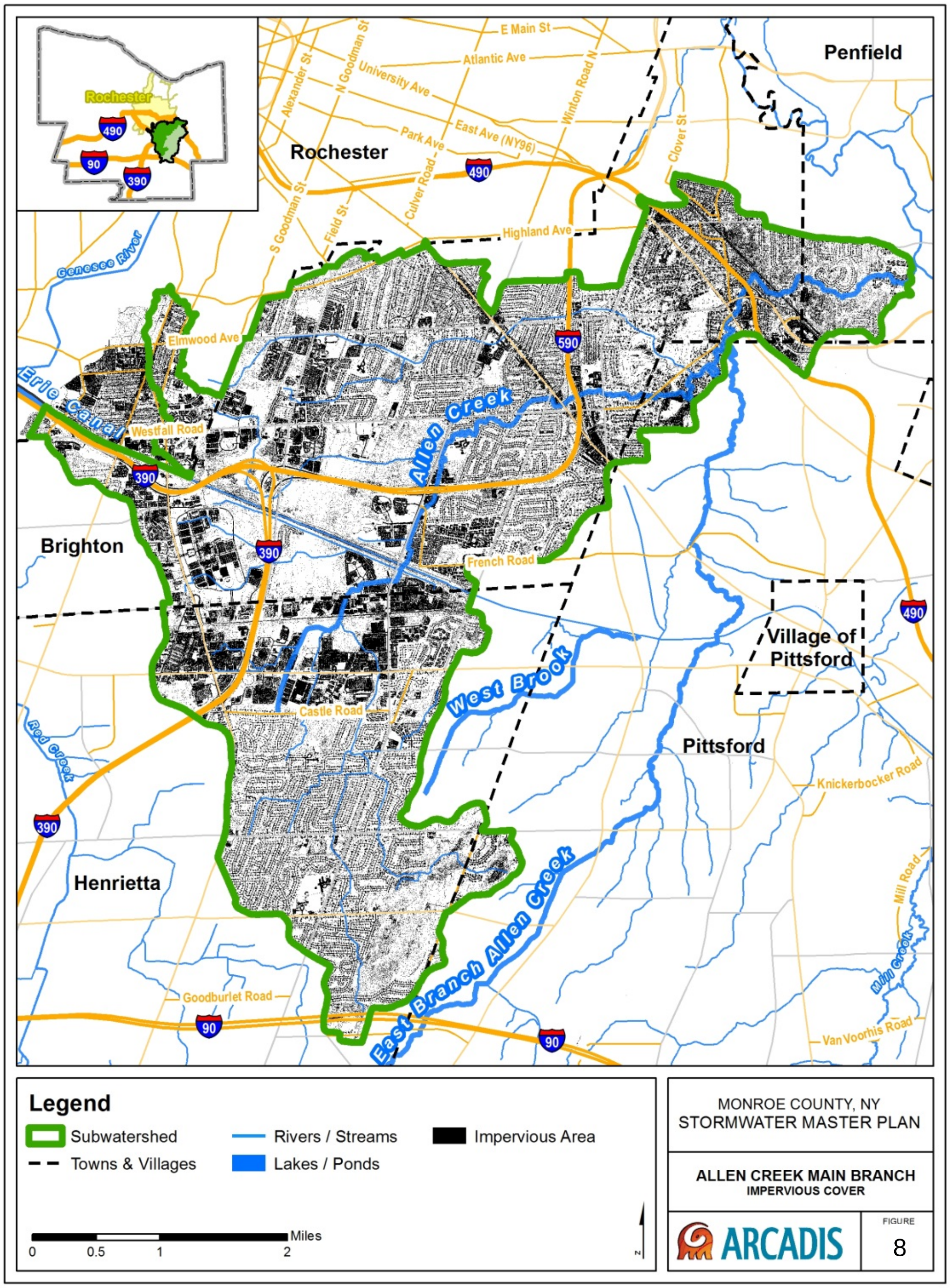

Figure 8 Current Impervious Cover in Allen Creek Main Branch Subwatershed

The Center for Watershed Protection (CWP) developed an Impervious Cover Model (ICM) to predict the degree of impairment associated with varying proportions of watershed impervious cover (Figure 9). Applying the total percent impervious surface for Allen Creek East Branch (24%), West Brook (33%), and Allen Creek Main Branch (34%) subwatersheds (calculated as part of this stormwater assessment), the ICM yields a stream quality prediction of "impacted" for the Allen Creek East Branch and "non-supporting" for West Brook and the Allen Creek Main Branch.

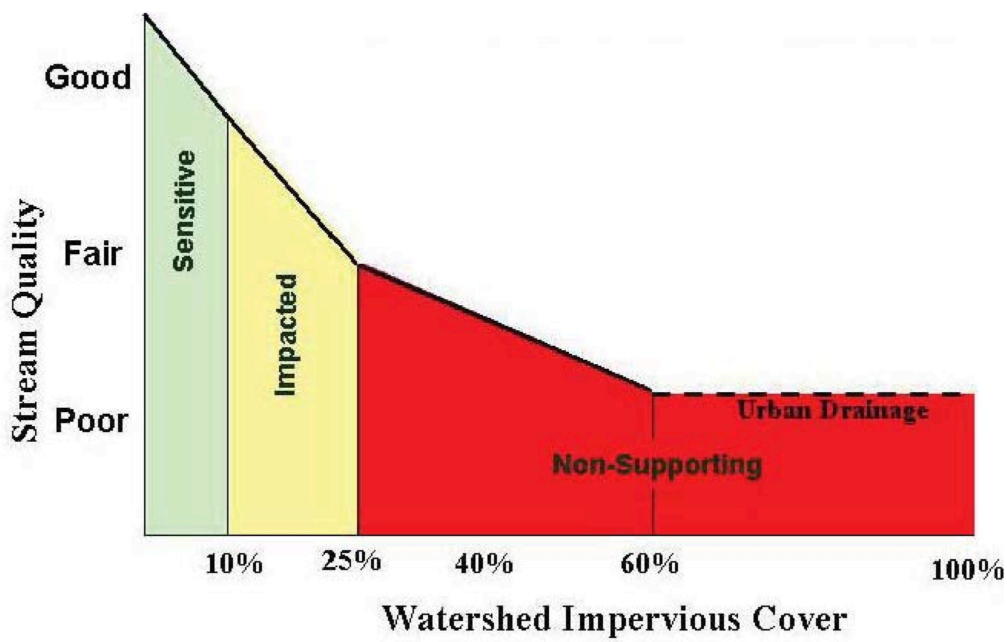

Figure 9 Impervious Cover Model (CWP 2003)

2.1.4 Soil

The predominant Hydrologic Soil Group (HSG) in the Allen Creek East Branch is Group B, which is well drained, facilitates stormwater infiltration, and is a desired characteristic for many retrofit project types (Figure 10). Group C soil, which is somewhat poorly drained soil, comprises 18%; Group D soil, which is poorly drained soil, comprises approximately 14% of the Allen Creek East Branch subwatershed. In the West Brook subwatershed, soil is primarily HSG Group B. In the Allen Creek Main Branch subwatershed, soil is predominately HSG Group C (USDA 2013a through 2013d) (Figures 11 and 12).

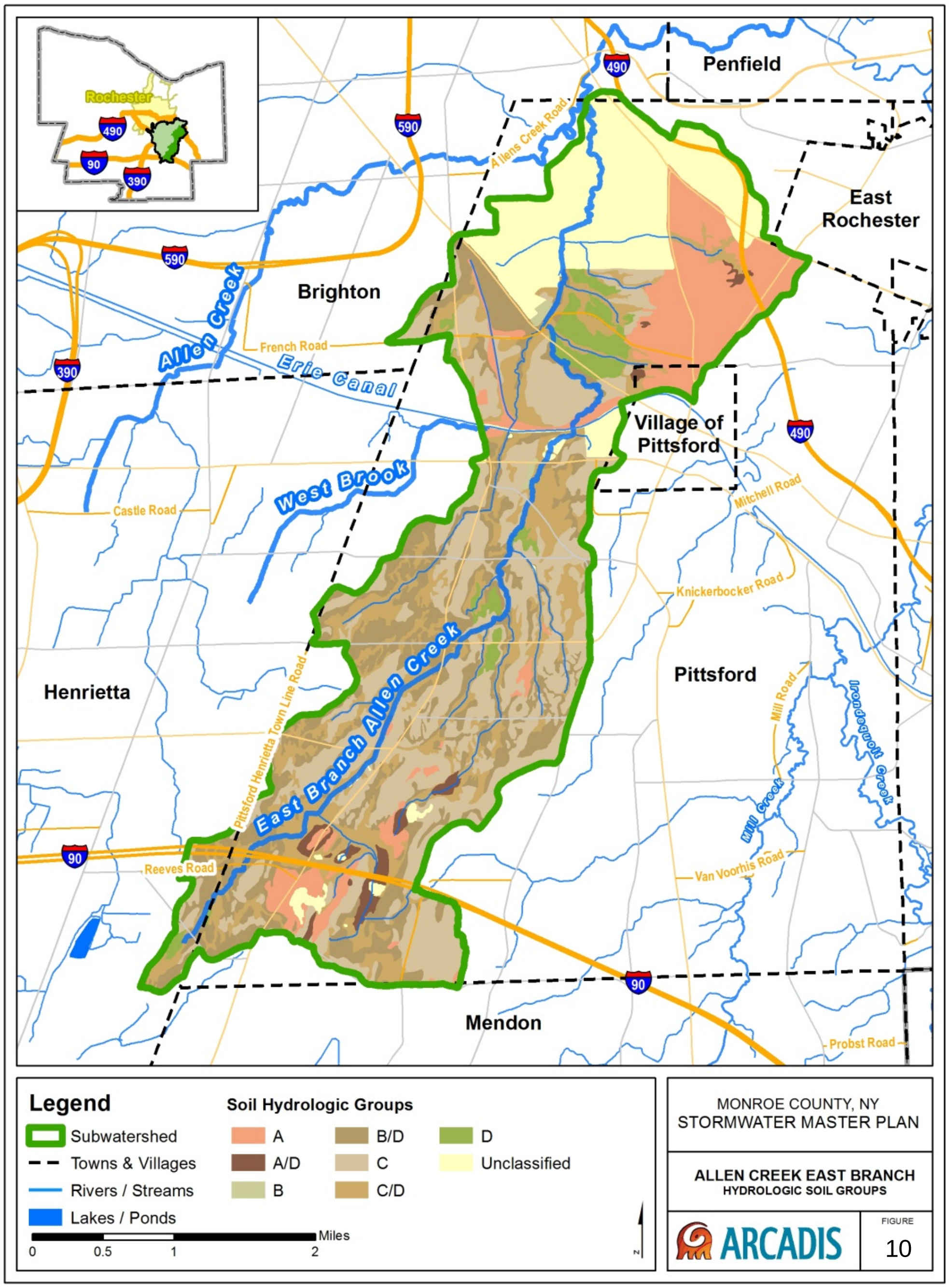

Figure 10 Hydrologic Soil Groups in Allen Creek East Branch Subwatershed

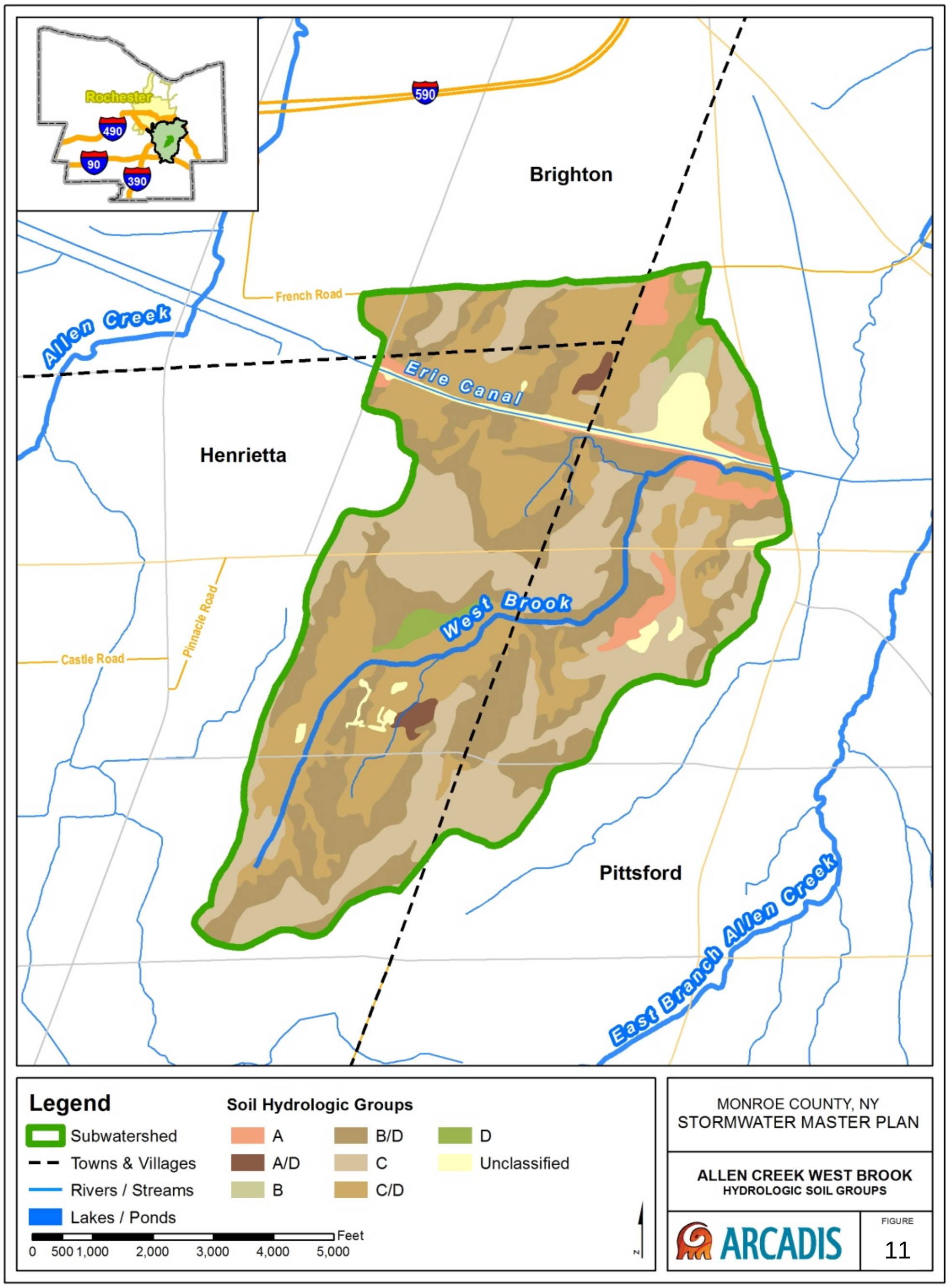

Figure 11 Hydrologic Soil Groups in West Brook Subwatershed

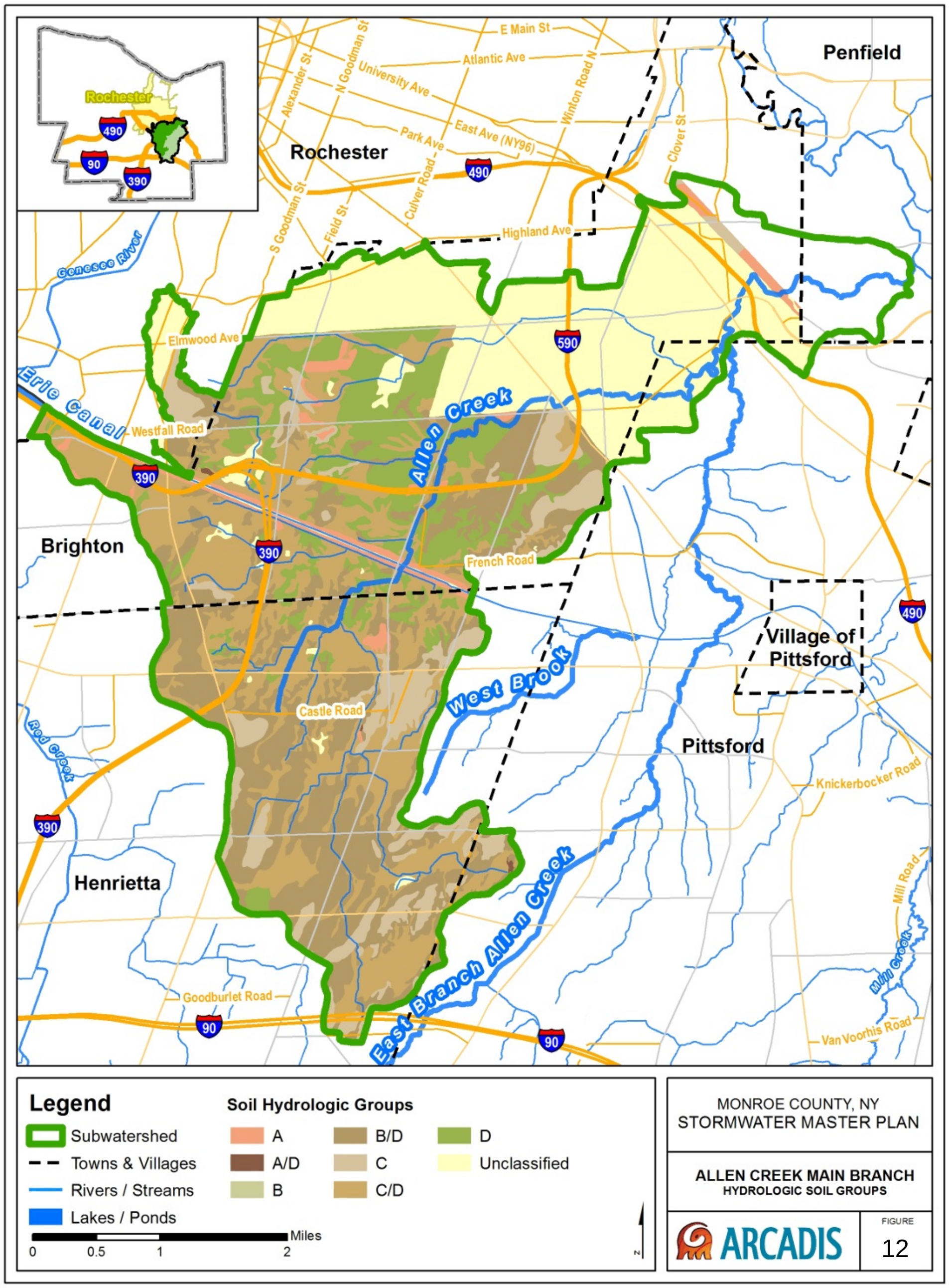

Figure 12 Hydrologic Soil Groups in Allen Creek Main Branch Subwatershed

Soil survey reports were generated for each subwatershed (Allen Creek East Branch, West Brook, and Allen Creek Main Branch) using the USDA's Web Soil Survey application (Appendix B). Reports were reviewed to determine dominant soil types in each subwatershed, which are summarized below.

- Allen Creek East Branch:
  - OnB: Ontario loam, 3 to 8% slopes, 1,064 acres or 6.6% of subwatershed
  - Ub: Urban land, 1,002 acres or 15.6% of subwatershed
  - HlB: Hilton loam, 3 to 8% slopes, 761 acres or 11.9% of subwatershed
- West Brook:
  - OnB: Ontario loam, 3 to 8% slopes, 316 acres or 22.2% of subwatershed
  - HlB: Hilton loam, 3 to 8% slopes, 308 acres or 21.7% of subwatershed
  - OnC: Ontario loam, 8 to 15% slopes or 112 acres or 7.8% of subwatershed
- Allen Creek Main Branch:
  - HlB: Hilton loam, 3 to 8% slopes, 1,727 acres or 20.3% of subwatershed
  - Ub: Urban land 1,193 acres or 14.1% of subwatershed
  - OnB: Ontario loam, 3 to 8% slopes, 664 acres or 7.8% of subwatershed

2.1.5 Water Quality

Allen Creek and its tributaries, which total 59.8 miles, are listed as having "minor impacts" according to the PWL (NYSDEC 2007) (Appendix C), as summarized below:

- *Pollutants of concern in the watershed*. Nutrients, salt, silt/sediment, and pathogens.
- *Sources of pollutants*. Urban stormwater runoff, construction, sanitary sewer discharges, Erie Canal discharges, agricultural nonpoint sources, and deicing material runoff. Streambank erosion is a major concern.

- *Challenges*. Complicated hydrology (Erie Canal, combined sewer overflow tunnels), large amount of impervious surfaces, major transportation routes, and aquatic habitat degradation.

- *Positives*. Modeling has shown stormwater detention ponds to be effective in improving some water quality and flooding concerns. Some vacant land is prevalent in the middle portion of the watershed and provides opportunities for siting BMPs and stormwater retrofit projects.

The designated uses of aquatic life and recreation are reported as “known to be stressed” and public bathing is “suspected to be stressed” from nutrients in sources of “urban/storm runoff” (Appendix C).

Potential stormwater hotspots were identified and summarized in the Green Infrastructure Rapid Assessments for Allen Creek Main Branch and Allen Creek East Branch completed by Monroe County in 2013 (Appendix D). These stormwater hotspots are defined as commercial, municipal, industrial, institutional, or transport-related operations that produce higher levels of stormwater pollutants and may present a higher than normal risk for spills, leaks, or illicit discharges. To the extent possible and practical, potential stormwater retrofit projects identified and evaluated in this stormwater assessment are located in areas, in part, to help mitigate water quality and stormwater runoff concerns from these areas. Property uses in these areas include trucking, gas stations, auto washing, storage, repair and recyclers, mini-marts, and fast food restaurants. These areas should be visited to evaluate and to determine if and how stormwater pollutants are being generated and exported from the site and to define the specific type of retrofit project to mitigate the pollutants.

2.1.6 Water Quantity

The effective floodplain maps and rapid assessments for the Allen Creek watershed were reviewed to identify existing flood-prone areas and retrofit projects that could provide flood storage benefits. Drainage and flooding concerns exist in the Town of Pittsford in low lying topographic areas downstream of the Erie Canal and above French Road (Appendix D). Commercial areas south of Brighton Henrietta Town Line Road and residential neighborhoods south of Castle Road along Allen Creek and its tributaries are also prone to flooding. Drainage concerns in the Town of Brighton include flooding of yards in the Evans Farm Subdivision along Idlewood Road (east of Winton Road and South of Westfall Road).

Streambank erosion problems have been reported by the Monroe County Soil and Water Conservation District for areas on the Allen Creek East Branch upstream of Jefferson Road. The downstream portion of the Allen Creek East Branch, which flows through the Oak Hill

Country Club golf course, has been heavily armored to help prevent streambank erosion. The lack of forested riparian buffers in this area is evident and suspected to allow pollutant loading to the stream channel.

ARCADIS

3. Retrofit Assessment

A total of 51 potential stormwater retrofit projects located in the Allen Creek East Branch, West Brook, and Allen Creek Main Branch subwatersheds were selected for evaluation and ranking as part of this stormwater assessment (Table 2). Project types identified include bioretention areas (within public highway right-of-ways and areas of current impervious cover), constructed/enhanced wetlands, forested riparian buffers, and stormwater wet and dry ponds (Figure 13). The potential stormwater retrofit projects selected for evaluation in this stormwater assessment are listed in Table 2. Design sheets for these stormwater retrofit projects from the Urban Subwatershed Restoration Manual No. 3 (CWP 2007) are included in Appendix E.

Table 2 Potential Stormwater Retrofit Projects Selected for Evaluation

Project ID	Subwatershed	Project Type	Source
D1-E	Allen Creek East Branch	Dry pond	Monroe County
D6-E	Allen Creek East Branch	Dry pond	Monroe County
D8-E	Allen Creek East Branch	Dry pond	Monroe County
P12-E	Allen Creek East Branch	Wet pond	Monroe County
P13-E	Allen Creek East Branch	Wet pond	Monroe County
P1-E	Allen Creek East Branch	New pond	Monroe County
P2-E	Allen Creek East Branch	Bioretention ROW	Monroe County
P3-E	Allen Creek East Branch	Bioretention ROW	Monroe County
P4-E	Allen Creek East Branch	Bioretention ROW	Monroe County
P5-E	Allen Creek East Branch	Bioretention ROW	Monroe County
Rip-10-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-11-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-12-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-1-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-2-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-3-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-4-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-5-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-6-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-7-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
Rip-8-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS

Table 2 Potential Stormwater Retrofit Projects Selected for Evaluation

Project ID	Subwatershed	Project Type	Source
Rip-9-E	Allen Creek East Branch	Forested riparian buffer	ARCADIS
W2-E	Allen Creek East Branch	Wet pond	Monroe County
W4-E	Allen Creek East Branch	Wet pond	Monroe County
W5-E	Allen Creek East Branch	Wet pond	Monroe County
D13-M	Allen Creek Main Branch	Dry pond	Monroe County
D2-M	Allen Creek Main Branch	Dry pond	Monroe County
D3-M	Allen Creek Main Branch	Dry pond	Monroe County
D4-M	Allen Creek Main Branch	Dry pond	Monroe County
D5-M	Allen Creek Main Branch	Dry pond	Monroe County
D6-M	Allen Creek Main Branch	Dry pond	Monroe County
D8-M	Allen Creek Main Branch	Dry pond	Monroe County
D9-M	Allen Creek Main Branch	Dry pond	Monroe County
O1-M	Allen Creek Main Branch	Bioretention Right-of-Way	Monroe County
O3-M	Allen Creek Main Branch	Bioretention Right-of-Way	Monroe County
P1-M	Allen Creek Main Branch	New pond	Monroe County
P2-M	Allen Creek Main Branch	New pond	Monroe County
P3-M	Allen Creek Main Branch	New pond	Monroe County
P5-M	Allen Creek Main Branch	New pond	Monroe County
Rip-13-M	Allen Creek Main Branch	Forested riparian buffer	ARCADIS
Rip-14-M	Allen Creek Main Branch	Forested riparian buffer	ARCADIS
Rip-15-M	Allen Creek Main Branch	Forested riparian buffer	ARCADIS
Rip-16-M	Allen Creek Main Branch	Forested riparian buffer	ARCADIS
W13-M	Allen Creek Main Branch	Wet pond	Monroe County
W1-M	Allen Creek Main Branch	Wet pond	Monroe County
W20-M	Allen Creek Main Branch	Wet pond	Monroe County
W2-M	Allen Creek Main Branch	Wet pond	Monroe County
W8-M	Allen Creek Main Branch	Wet pond	Monroe County
Wtlnd-1-M	Allen Creek Main Branch	Constructed/enhanced wetland	ARCADIS
D7-W	West Brook	Dry pond	Monroe County
W12-W	West Brook	Wet pond	Monroe County

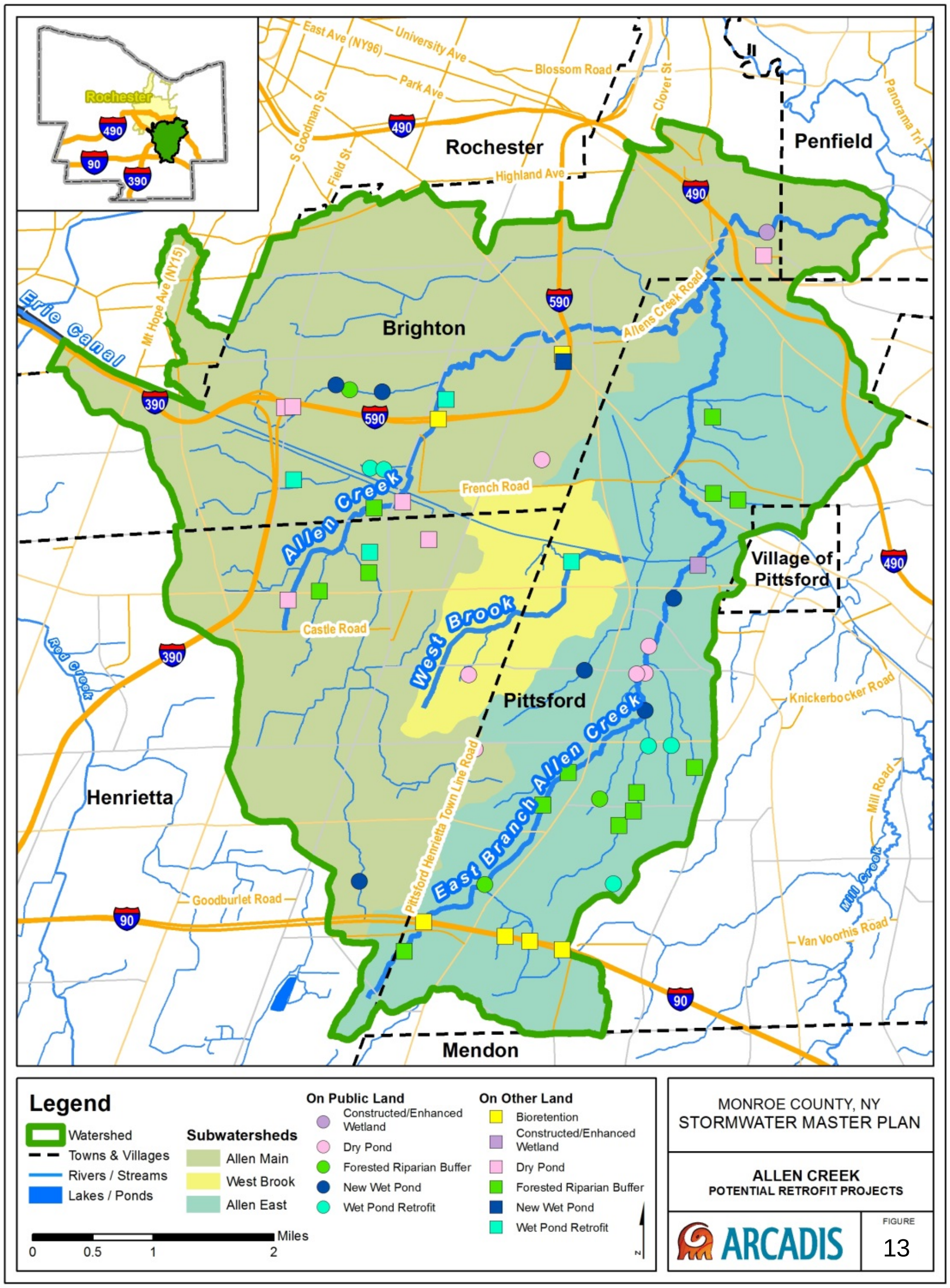

Figure 13 Potential Stormwater Retrofit Projects in the Allen Creek Watershed

ARCADIS

3.1 Approach

Potential stormwater retrofit projects selected for WTM modeling were derived from previous assessments and GIS reconnaissance. Potential projects identified in the Green Infrastructure Rapid Assessments previously completed for Allen Creek East and Main Branches (Appendix D) were reviewed. The highest ranked 20 projects from each rapid assessment (40 total projects) were selected for evaluation in this stormwater assessment. In addition to these selected projects, 11 other potential stormwater retrofit projects were identified by GIS reconnaissance for evaluation in this stormwater assessment. Thus, a total of 51 potential retrofit projects are evaluated in the subsequent watershed modeling task using WTM.

The newly identified projects were assessed according to scores calculated for each individual project based on metrics for feasibility, watershed benefits, and cost-effectiveness criteria as explained in the Retrofit Assessment Methodology, Project Type Descriptions, and Retrofit Ranking Criteria (Monroe County 2013), which serves as a reference document for the Stormwater Management Program Plan (SCMC 2009). These ranking criteria and their associated metrics are summarized below and in Table 3:

- *Feasibility*. A maximum of 5 points is awarded to potential projects for feasibility. Points were awarded to projects based on whether the potential project is located mostly on publicly owned land, commercial land, or residential land with Homeowners Associations, and whether the land is undeveloped, zoned for commercial land use, and easily accessed (i.e., easement or within a public right-of-way).

- *Watershed Benefits*. Each project is assigned points for watershed benefits based on calculations of the project's available flood storage capacity, channel protection volume, and water quality volume targets. If the available flood storage of a project was greater than the computed water quality volume, the channel protection volume, or the sum of the computed channel protection and water quality volumes, then the project is awarded 1 point for flood storage. The target channel protection storage volume is approximately 60% of the 1-year, 24-hour storm rainfall depth. The target for water quality volume is to store and treat the runoff from 90% of the 1-year, 24-hour storm rainfall depth (CWP 2007). In addition, points are awarded to projects located in areas of expected infiltration (HSG Groups A and/or B) and whether the projects are considered a potential opportunity for public education and/or community revitalization.

- *Cost Effectiveness*. Projects are assigned points for cost effectiveness based on planning-level cost estimates that consider retrofit project type and drainage area to the project. Unit costs described in the Urban Subwatershed Restoration Manual No. 3 (CWP 2007) for all project types (except forested riparian buffers) are applied to estimate the planning-level construction cost. Forested riparian buffer planning-level construction costs are estimated using unit costs developed based on recent analysis conducted by Virginia Polytechnic Institute and State University, Forest Resources and Environmental Conservation Department, and presented in the current version of the peer-reviewed Journal of Ecological Restoration (Guillozet et al. 2014).

Cost estimates did not consider the cost of land acquisition or ongoing maintenance. Projects with an estimated low cost and high degree of watershed or community benefits (see Table 3) receive the highest number of points, while projects estimated to be a high cost with a low benefit are assigned the lowest points.

For each new project selected for evaluation in this stormwater assessment (those not selected in the Allen Creek East Branch and Allen Creek Main Branch Rapid Assessments [Appendix D]), scores were computed for feasibility, watershed benefits, and cost effectiveness to yield a total score for each project. For the projects previously identified by Monroe County, project scores for feasibility and cost effectiveness were taken directly from "Final Rank" tables reported in the rapid assessments (Appendix D). Numerical project scores for watershed benefits were not presented in the rapid assessments; therefore, ARCADIS calculated scores from the letter abbreviations for watershed benefits noted for each project and using the scoring system presented in Table 3. After computing the watershed benefit scores for the existing projects, these scores were added to scores for feasibility and cost effectiveness to give a total score for each existing project. Some of the total scores for existing projects differed from the total scores for projects reported in the Allen Creek East Branch and Allen Creek Main Branch Rapid Assessments (Appendix D). The differences in total scores appear to stem from differences in points calculated for the "watershed benefits" criteria.

After computing total scores for the potential projects selected for evaluation in this stormwater assessment, projects were ranked based on:

1. Total overall score (highest to lowest)
2. Project type
3. Project ID
4. Subwatershed.

Table 3 Ranking Protocol (Monroe County 2013)

Project Type	Feasibility	Watershed Benefits	Cost Effectiveness	Maximum Possible Score
New or Retrofit Stormwater Management Ponds	**New projects:** Vacant public lands = 4 points Other public lands = 3 points Projects on commercial property or HOA = 2 points Ease of access = 1 additional point ***5 possible points*** *(Or)* **Upgrades to existing stormwater facilities** On public land = 4 points On private land with easement = 2 points Ease of access = 1 additional point ***5 possible points***	Infiltration = 2 points Flood storage = 1 point Water quality = 1 point Channel protection = 1 point Education = 1 point ***6 possible points***	3 points = $1 to $11 2 points = $12 to $25 1 point = >$26 Note: new ponds = new storage ***3 possible points***	14
Green Infrastructure on Public Highways	1. Planned road reconstruction = 5 points 2. Area within ROW is: • Vacant/unused paved = 3 points • Lawn = 2 points • In use by adjacent business = 1 point 3. Average number of property owners: • One property owner per 125 or more linear feet = 2 points • Greater than one property owner per 125 feet = 1 point ***5 possible points***	Infiltration = 2 points A or B soil types = 1 point Water quality = 1 point Channel protection = 1 point Education = 1 point Source control = 1 point ***8 possible points***	3 points = $1 to $11 2 points = $12 to $25 1 point = >$26 based on table ***3 possible points***	16
Neighborhood Green	Neighborhoods considered meet these criteria and	Community revitalization =	Neighborhood green infrastructure	8

Table 3 Ranking Protocol (Monroe County 2013)

Project Type	Feasibility	Watershed Benefits	Cost Effectiveness	Maximum Possible Score
Infrastructure	receive 1 point each: • Neighborhood was built in 1975 or before whose stormwater is not being treated with any management practice. • Average property size is 10,000 square feet or larger, but less than 1 acre. • A, B, or C soil type ***2 points***	1 point Water quality = 1 point Education = 1 point Source control = 1 point ***4 points***	practices vary in cost effectiveness from a score of 3 to 1; therefore, average with 2 points each ***2 points***	
Other Green Infrastructure Retrofits	Vacant public lands = 4 points Other public lands = 3 points Projects on commercial property or HOA = 2 points Ease of access = 1 additional point ***5 possible points***	Same as green infrastructure on public highways ***8 possible points***	Same as above ***3 possible points***	16

3.2 Results

Potential retrofit projects received total scores ranging from 4 to 14 (Table 4). One potential forested riparian buffer on Allen Creek Main received 14 points and is the highest ranked project. Fourteen projects each received 13 points. These potential project types include wet and dry ponds located in the Allen Creek East Branch (nine projects) and Allen Creek Main Branch (five projects) subwatersheds. Four bioretention ROW projects, two forested riparian buffer projects, two dry ponds, and two wet ponds each received a total of 12 points and spanned all three subwatersheds.

One noteworthy project is an enhanced/constructed wetland located on the Allen Creek Main Branch downstream of its confluence with the Allen Creek East Branch. Although this potential project did not receive a high total score, a wetland in this area would be strategic to infiltrate stormwater and mitigate pollutant loads prior to Allen Creek's discharge into Irondequoit Creek.

3.3 Retrofit Project Diagrams

Potential retrofit projects are shown individually on diagrams included in Appendix E. Each diagram includes the project name, project identification number, summary of the watershed benefits (per Monroe County Assessment Methodology), project footprint, parcel boundaries, hydrology, stormwater infrastructure, and surrounding roadways.

Table 4 Ranked Potential Projects

Project ID	Category	Subwatershed	Feasibility	Watershed Benefits	Cost Effectiveness	Total Score
Rip-16-M	Forested Riparian Buffer	Allen Creek Main Branch	5	6	3	14
D1-E	Dry Pond	Allen Creek East Branch	5	5	3	13
D2-M	Dry Pond	Allen Creek Main Branch	5	5	3	13
D3-M	Dry Pond	Allen Creek Main Branch	5	5	3	13
D6-E	Dry Pond	Allen Creek East Branch	5	5	3	13
D8-E	Dry Pond	Allen Creek East Branch	5	5	3	13
P12-E	Wet Pond	Allen Creek East Branch	5	5	3	13
P13-E	Wet Pond	Allen Creek East Branch	5	5	3	13
P1-E	New Pond	Allen Creek East Branch	5	5	3	13
P2-M	New Pond	Allen Creek Main Branch	5	5	3	13
P3-M	New Pond	Allen Creek Main Branch	5	5	3	13
W20-M	Wet Pond	Allen Creek Main Branch	5	5	3	13
W2-E	Wet Pond	Allen Creek East Branch	5	5	3	13
W4-E	Wet Pond	Allen Creek East Branch	5	5	3	13
W5-E	Wet Pond	Allen Creek East Branch	5	5	3	13
D6-M	Dry Pond	Allen Creek Main Branch	4	5	3	12
D7-W	Dry Pond	West Brook	5	4	3	12
P1-M	New Pond	Allen Creek Main Branch	4	5	3	12
P2-E	Bioretention Right-Of-Way	Allen Creek East Branch	5	4	3	12
P3-E	Bioretention Right-Of-Way	Allen Creek East Branch	5	4	3	12

Table 4 Ranked Potential Projects

Project ID	Category	Subwatershed	Feasibility	Watershed Benefits	Cost Effectiveness	Total Score
P4-E	Bioretention Right-Of-Way	Allen Creek East Branch	5	4	3	12
P5-E	Bioretention Right-Of-Way	Allen Creek East Branch	5	4	3	12
Rip-2-E	Forested Riparian Buffer	Allen Creek East Branch	5	4	3	12
Rip-3-E	Forested Riparian Buffer	Allen Creek East Branch	5	4	3	12
W8-M	Wet Pond	Allen Creek Main Branch	4	5	3	12
D13-M	Dry Pond	Allen Creek Main Branch	3	5	3	11
D4-M	Dry Pond	Allen Creek Main Branch	4	4	3	11
D5-M	Dry Pond	Allen Creek Main Branch	3	5	3	11
D8-M	Dry Pond	Allen Creek Main Branch	3	5	3	11
D9-M	Dry Pond	Allen Creek Main Branch	3	5	3	11
O3-M	Bioretention Right-Of-Way	Allen Creek Main Branch	4	5	2	11
P5-M	New Pond	Allen Creek Main Branch	4	4	3	11
W13-M	Wet Pond	Allen Creek Main Branch	3	5	3	11
W1-M	Wet Pond	Allen Creek Main Branch	5	3	3	11
W2-M	Wet Pond	Allen Creek Main Branch	5	3	3	11
O1-M	Bioretention Right-Of-Way	Allen Creek Main Branch	4	4	2	10
Rip-5-E	Forested Riparian Buffer	Allen Creek East Branch	1	6	3	10
Rip-4-E	Forested Riparian Buffer	Allen Creek East Branch	1	5	3	9
Rip-6-E	Forested Riparian Buffer	Allen Creek East Branch	3	3	3	9
Rip-9-E	Forested Riparian Buffer	Allen Creek East Branch	1	5	3	9
W12-W	Wet Pond	West Brook	3	3	3	9

Table 4 Ranked Potential Projects

Project ID	Category	Subwatershed	Feasibility	Watershed Benefits	Cost Effectiveness	Total Score
Rip-11-E	Forested Riparian Buffer	Allen Creek East Branch	0	5	3	8
Rip-12-E	Forested Riparian Buffer	Allen Creek East Branch	1	4	3	8
Rip-15-M	Forested Riparian Buffer	Allen Creek Main Branch	3	2	3	8
Rip-7-E	Forested Riparian Buffer	Allen Creek East Branch	1	3	3	7
Rip-8-E	Forested Riparian Buffer	Allen Creek East Branch	1	3	3	7
Rip-10-E	Forested Riparian Buffer	Allen Creek East Branch	0	3	3	6
Rip-14-M	Forested Riparian Buffer	Allen Creek Main Branch	3	0	3	6
Rip-1-E	Forested Riparian Buffer	Allen Creek East Branch	0	3	3	6
Wtlnd-1-M	Constructed/Enhanced Wetland	Allen Creek Main Branch	1	2	3	6
Rip-13-M	Forested Riparian Buffer	Allen Creek Main Branch	1	0	3	4

4. Watershed Treatment Model

A WTM (Caraco 2013) was developed for three subwatersheds (Allen Creek Main Branch, West Brook and Allen Creek East Branch) within the Allen Creek watershed to estimate baseline and proposed loads to surface waters, WTM results were used in conjunction with the results from the retrofit project ranking discussed in Section 3 to prioritize recommended stormwater retrofits.

WTM is a spatially lumped, event-based watershed model that estimates average annual loads and runoff volume in a watershed using the “simple-method” (Schueler 1987). WTM does not simulate hydrologic/hydraulic routing or flow attenuation. Model inputs include land use, soil, rainfall, management practices, and stormwater structural controls. Loads estimated by the model include average annual values of total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), fecal coliform, and runoff volume. The model simplifies complex watershed processes such as rainfall-runoff and effects of structural and programmatic management measures. WTM is intended to be used as a screening level tool to broadly estimate load and runoff to assist in the development of watershed-scale planning. The model is not intended for site-specific analysis to support engineering design; therefore, projects recommended based on model results should be evaluated in greater detail prior to implementation.

4.1 Watershed Treatment Model Development

Primary model input data were developed using GIS analyses for each of the three assessed subwatersheds: Allen Creek Main Branch, West Brook and Allen Creek East Branch using source datasets (Monroe County et al. 2009-2014). Table A-1 in Appendix A presents the GIS source datasets collected and analyzed to develop WTM inputs. These data are also included in the geodatabase in Appendix A. In addition to the GIS data, information on current and proposed management measures collected from Monroe County and using best professional judgment was assessed to develop secondary sources model input. Examples of such management measure model input data include geospatially lumped assumptions about management practices such as program efficiency and frequency. Programmatic measures such as residential turf fertilizer application rates, sediment and erosion program efficiency, catch basin cleanouts, street sweeping types and areas, and pet waste education programs were assessed to develop secondary model inputs.

Potential stormwater retrofit projects presented in Table 4 were modeled using the WTM models to estimate pollutant load and stormwater runoff volume changes in relation to the baseline watershed conditions. For this study, baseline conditions are defined as input data based on the GIS datasets presented in Appendix A and assumptions about current management practices; it does not account for effects of the 51 potential retrofit projects presented in Table 4. Proposed conditions are the same as baseline conditions in terms of GIS data analyses by subwatershed, yet also account for the effects of the potential nonstructural measures, like estimated improvements to street sweet and pet waste education programs, and in addition the effects from potential structural retrofit projects as presented in Table 4. In other words, baseline condition represents current conditions without retrofit projects and proposed conditions represent current conditions with improvements to programmatic measures as well as the sum of all retrofit projects.

4.2 Watershed Treatment Model Results

WTM results for estimated total average annual loads and total average annual runoff volume for baseline and proposed conditions for the Allen Creek Main Branch, West Brook and Allen Creek East Branch subwatersheds are presented in Table 5. Results are presented independently by subwatershed, rather than as cumulative loads and volumes, because not all three of the subwatersheds discharge to the same location. Allen Creek Main Branch and Allen Creek East Branch discharge to Irondequoit Creek and West Brook discharges to the Erie Canal. WTM results for average annual load and runoff volume reductions for each of the 51 proposed projects are presented in Table 6.

WTM results show the average annual TN load to surface waters in Allen Creek Main Branch is approximately 78,800 pounds per year for baseline conditions and 73,600 pounds/year for proposed conditions, which represents a percent reduction of about 7%. For the East Branch subwatershed, the estimated average TN load is approximately 50,900 pounds per year for baseline conditions and about 47,900 pounds per year for proposed conditions, which represents a percent reduction of about 6%. For the West Brook subwatershed, the estimated average TN load is approximately 13,000 pounds per year for baseline conditions and about 12,700 pounds per year for proposed conditions, which represents a percent reduction of about 3%.

The estimated average annual TP load to surface waters in Allen Creek Main Branch is approximately 19,900 pounds per year for baseline conditions and 18,700 pounds per year for proposed conditions, which represents a percent reduction of about 6%. For the East Branch subwatershed, the estimated average TP load is approximately 11,800 pounds per year for baseline conditions and about 11,000 pounds per year for proposed conditions, which represents a percent reduction of about 7%. For the West Brook subwatershed, the estimated average TP load is approximately 3,200 pounds per year for baseline conditions and about 3,100 pounds per year for proposed conditions, which represents a percent reduction of about 2%.

The estimated average annual TSS load to surface waters in Allen Creek Main Branch is approximately 3.7 million pounds per year for baseline conditions and 3.5 million pounds per year for proposed conditions, which represents a percent reduction of about 6%. For the East Branch subwatershed, the estimated average TSS load is approximately 2.2 million pounds per year for baseline conditions and about 2.1 million pounds per year for proposed conditions, which represents a percent reduction of about 7%. For the West Brook subwatershed, the estimated average TSS load is approximately 505,000 pounds per year for baseline conditions and about 495,000 pounds per year for proposed conditions, which represents a percent reduction of about 2%.

The estimated average annual fecal coliform load to surface waters in Allen Creek Main Branch is approximately 5.7 $x10^{15}$ colonies per year for baseline conditions and 5.5 $x10^{15}$ colonies per year for proposed conditions, which represents a percent reduction of about 3%. For the East Branch subwatershed, the estimated average fecal coliform load is approximately 1.9 $x10^{15}$ colonies per year for baseline conditions and about 1.7 $x10^{15}$ colonies per year for proposed conditions, which represents a percent reduction of about 9%. For the West Brook subwatershed, the estimated average fecal coliform load is approximately 5.4 $x10^{12}$ colonies per year for baseline conditions and about 5.3 $x10^{12}$ colonies per year for proposed conditions, which represents a percent reduction of about 0.5%.

The estimated average runoff volume to surface waters in Allen Creek Main Branch is approximately 10,700 acre-feet per year for baseline conditions and 10,670 acre-feet per year for proposed conditions, which represents a percent reduction of about 0.3%. For the East Branch subwatershed, the estimated average runoff volume is approximately 7,580 acre-feet per year for baseline conditions and about 7,560 acre-feet per year for proposed conditions, which represents a percent reduction of about 0.3%. For the West Brook subwatershed, the estimated average runoff volume is approximately 1,550 acre-feet per year for baseline conditions and about 1,540 acre-feet per year for proposed conditions, which represents a percent reduction of about 0.4%.

The relatively low percent reduction in estimated runoff volume between proposed and baseline conditions using WTM may be, in part, attributed to the way in which runoff volume reduction is handled in WTM. In WTM, runoff volume reduction pertains to the volume of stormwater that is removed from the surface water conveyance system through infiltration to groundwater (i.e., consumptive). Therefore, the reduction in runoff volume estimated using WTM does not account for the attenuation of stormwater by BMPs, as this volume of water is considered to still be part of the surface water conveyance system and not consumptive.

Table 5 Summary of Estimated Total Average Annual Loads to Surface Waters in Allen Creek Subwatersheds

		TN (pounds/year)			TP (pounds/year)			TSS (pounds/year)			Fecal Coliform billion/year			Runoff Volume acre-feet/year		
Subwatershed	Drainage Area (acres)	Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	% Change
Allen Creek East Branch	6,303	50,935	47,894	-6	11,801	10,956	-7	2,247,303	2,081,991	-7	1,894,285	1,731,173	-9	7,581	7,558	-0.3
West Brook	1,422	13,013	12,681	-3	3,168	3,102	-2	505,104	494,890	-2	535,735	533,096	-0.5	1,548	1,541	-0.4
Allen Creek Main Branch	8,487	78,760	73,555	-7	19,983	18,696	-6	3,678,645	3,453,983	-6	5,714,652	5,534,522	-3	10,704	10,667	-0.3

Table 6 Retrofit Project Average Annual Load and Runoff Volume Reductions

Project ID	Subwatershed	Practice Type	TN (pounds/year)	TP (pounds/year)	TSS (pounds/year)	Fecal Coliform Bacteria (billion colonies/year)	Runoff Volume (acre-feet/ year)
D1-E	ALLEN EAST	Dry Water Quantity Pond	1	0	30	0	0
D6-E	ALLEN EAST	Dry Water Quantity Pond	7	3	396	0	0
D8-E	ALLEN EAST	Dry Water Quantity Pond	9	4	474	0	0
P1-E	ALLEN EAST	Wet Pond	819	278	56,650	64,758	0
P2-E	ALLEN EAST	Bioretention Right-Of-Way	74	13	2,284	3,082	6
P3-E	ALLEN EAST	Bioretention Right-Of-Way	43	6	1,459	1,969	4
P4-E	ALLEN EAST	Bioretention Right-Of-Way	35	6	1,068	1,442	3
P5-E	ALLEN EAST	Bioretention Right-Of-Way	10	2	318	429	1
P12-E	ALLEN EAST	Wet Pond	254	87	17,466	19,965	0
P13-E	ALLEN EAST	Wet Pond	602	207	41,271	47,177	0
Rip-1-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-2-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-3-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-4-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-5-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-6-E	ALLEN EAST	Forested Riparian Buffer	9	2	254	332	1
Rip-7-E	ALLEN EAST	Forested Riparian Buffer	35	8	983	1,285	5
Rip-8-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-9-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0

Table 6 Retrofit Project Average Annual Load and Runoff Volume Reductions

Project ID	Subwatershed	Practice Type	TN (pounds/year)	TP (pounds/year)	TSS (pounds/year)	Fecal Coliform Bacteria (billion colonies/year)	Runoff Volume (acre-feet/ year)
Rip-10-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-11-E	ALLEN EAST	Forested Riparian Buffer	0	0	0	0	0
Rip-12-E	ALLEN EAST	Forested Riparian Buffer	30	8	841	1,099	4
W2-E	ALLEN EAST	Wet Pond	4	1	285	326	0
W4-E	ALLEN EAST	Wet Pond	127	44	8,719	9,967	0
W5-E	ALLEN EAST	Wet Pond	113	39	7,692	8,793	0
D7-W	WEST BROOK	Dry Water Quantity Pond	6	3	256	0	0
W12-W	WEST BROOK	Wet Pond	9	3	525	673	0
D2-M	ALLEN MAIN	Dry Water Quantity Pond	4	2	209	0	0
D3-M	ALLEN MAIN	Dry Water Quantity Pond	3	1	127	0	0
D4-M	ALLEN MAIN	Dry Water Quantity Pond	1	0	62	0	0
D5-M	ALLEN MAIN	Dry Water Quantity Pond	4	2	231	0	0
D6-M	ALLEN MAIN	Dry Water Quantity Pond	3	1	145	0	0
D8-M	ALLEN MAIN	Dry Water Quantity Pond	0	0	0	0	0
D9-M	ALLEN MAIN	Dry Water Quantity Pond	4	2	184	0	0
D13-M	ALLEN MAIN	Dry Water Quantity Pond	0	0	0	0	0
O1-M	ALLEN MAIN	Bioretention Right-Of-Way	47	8	1,490	1,975	4
O3-M	ALLEN MAIN	Bioretention Right-Of-Way	1	0	26	34	0
P1-M	ALLEN MAIN	Wet Pond	393	145	26,550	29,809	0

Table 6 Retrofit Project Average Annual Load and Runoff Volume Reductions

Project ID	Subwatershed	Practice Type	TN (pounds/year)	TP (pounds/year)	TSS (pounds/year)	Fecal Coliform Bacteria (billion colonies/year)	Runoff Volume (acre-feet/ year)
P2-M	ALLEN MAIN	Wet Pond	292	101	20,603	23,132	0
P3-M	ALLEN MAIN	Wet Pond	481	193	30,715	34,485	0
P5-M	ALLEN MAIN	Wet Pond	469	165	32,644	36,651	0
Rip-13-M	ALLEN MAIN	Forested Riparian Buffer	6	1	162	208	1
Rip-14-M	ALLEN MAIN	Forested Riparian Buffer	20	5	567	727	3
Rip-15-M	ALLEN MAIN	Forested Riparian Buffer	19	4	576	739	3
Rip-16-M	ALLEN MAIN	Forested Riparian Buffer	0	0	0	0	0
W1-M	ALLEN MAIN	Wet Pond	17	6	1,107	1,243	0
W2-M	ALLEN MAIN	Wet Pond	24	9	1,647	1,849	0
W8-M	ALLEN MAIN	Wet Pond	73	26	5,074	5,697	0
W13-M	ALLEN MAIN	Wet Pond	53	19	3,629	4,074	0
W20-M	ALLEN MAIN	Wet Pond	168	58	11,837	13,290	0
Wtlnd-1-M	ALLEN MAIN	Wetland	257	75	10,252	12,381	0
		TOTAL	**4,525**	**1,540**	**288,812**	**327,592**	**32**

Notes:

N/A = Forested riparian buffer projects that could not be simulated using WTM because these projects are located on non-urban land uses.

Highlighting = Largest load or runoff volume reductions by parameter (TP, TN, TSS, fecal coliform, and runoff volume).

5. Summary

Fifteen projects had a total score of 13 or more as a result of the rapid assessment ranking. These project types included a forested riparian buffer project, and dry and wet pond projects in the Allen Creek East and Main Branch subwatersheds (Table 4). The forested riparian buffer project in the Allen Creek Main Branch subwatershed was the highest ranked project due to high scores for "Watershed Benefits" (6 points), "Feasibility" (5 points), and "Cost Effectiveness" (3 points). The forested riparian buffer was awarded the highest number of points for Watershed Benefits due to its ability to provide infiltration, adequate flood storage and channel protection volumes, water quality, and public education benefits. Each of the top 15 projects received the highest possible 5 points for feasibility due to their location on public lands and ease of access. In addition, these projects received 3 points (the highest possible) for cost effectiveness because their unit costs were below $11 per cubic foot of stormwater treated.

Projects ranked highest (top 10) for pollutant load reductions as a result of the WTM modeling included wet ponds in the Allen Creek East Branch and Main Branch subwatersheds (P1-E, P13-E, P3-M, P5-M, P1-M, P2-M, P12-E, W20-M, and W4-E) and a wetland in Allen Creek Main Branch (Wtlnd-1-M) (Table 9). Projects ranked highest for runoff volume reduction included a wet pond in Allen Creek East Branch (P2-E), forest riparian buffers and bioretention within public rights-of-way in Allen Creek East Branch and Allen Creek Main Branch (Rip7-E, Rip12-E, O1-M, P3-E, P4-E, Rip-14-M, Rip-15-M, Rip-6-E and P5-E) (Table 9). These projects ranked highest due to their simulated ability to provide a greater proportion of the target water quality storage volume and treatment for a large proportion of their respective drainage areas.

Projects ranked in the top 10 for load or runoff volume reductions as a result of the WTM were responsible for 85% or more of the total load or runoff reductions of all projects combined. The sum of the load reductions for projects ranked in the top 10 for TN load reduction were responsible for 85% of the total load reduction of all projects combined. The sum of the load reductions for projects ranked in the top 10 for TP load reduction were responsible for 88% of the total load reduction of all projects combined. The sum of the load reductions for projects ranked in the top 10 for TSS load reduction were responsible for 89% of the total load reduction of all projects combined. The sum of the load reductions for projects ranked in the top 10 for fecal coliform load reduction were responsible for 89% of the total load reduction of all projects combined. The sum of the runoff volume reductions for projects ranked in the top 10 for runoff reduction were responsible for 98% of the total runoff volume reduction of all projects combined.

An assessment of WTM average annual load and runoff reductions for various project types and their associated target and available water quality volumes revealed that pond projects, both wet and dry, are responsible for the greatest estimated load and runoff reductions and that these project types have the greatest estimated proportion of their target water quality volume available.

Additional pollutant load and runoff reductions can likely be achieved if additional projects (other than the ones selected for this assessment) are selected for implementation from those assessed as part of the Green Infrastructure Rapid Assessments completed for Allen Creek Main Branch and Allen Creek East Branch (Monroe County Department of Environmental Services and the Stormwater Coalition of Monroe County, 2013a and 2013 b). Moreover, additional pollutant load reductions can be expected to be achieved should Monroe County and others in the Monroe County Stormwater Coalition implement policies, such as increased operation and maintenance and public education and outreach programs to support improving stormwater quality and reducing runoff.

It is important to note WTM was not capable of simulating the load and runoff reductions associated with ten of the potential forested riparian buffer projects (Rip-1-E, Rip-2-E, Rip-3-E, Rip-4-E, Rip-5-E, Rip-8-E, Rip-9-E, Rip-10-E, Rip-11-E and Rip-16-M) because these projects are located on non-urban land uses (i.e., rural or agricultural land uses). Therefore, the benefits of these projects could not be justly compared to the other projects which were simulated in the WTM models. However, the pollutant load and runoff reductions associated with these forested riparian buffer projects were estimated using the WTM results for load and runoff reductions for forested riparian buffers on urban land uses. To this end, the average annual load and runoff reductions for buffers on non-urban land uses were estimated by multiplying the buffers' drainage areas by the mean average annual load and runoff reductions per unit area of drainage area for buffer projects on urban land uses. As a result, the estimated total average annual load and average annual runoff volume reductions for these 10 buffer projects on non-urban land uses is as follows:

- Total Nitrogen: 471 pounds/year
- Total Phosphorus: 115 pounds/year
- Total Suspended Solids: 13,194 pounds per year
- Fecal coliform bacteria : 17.2×10^{12} colonies/year
- Runoff volume: 62 acre-feet/year

The USGS (2005) study states that on average, the Allen Creek watershed generates 6.30 pounds per acre per year of TN, 0.50 pound per acre per year of TP, and 480 pounds per acre per year of TSS. These annual unit loads are based on available observed water quality data in the Irondequoit Creek basin and results from the HSPF model previously developed for the Irondequoit Creek basin (including the Allen Creek watershed). When the unit loads from the USGS study are applied to the sum of the Allen Creek Main Branch, Allen Creek East Branch, and West Brook study areas (16,212 acres), they result in

102,136 pounds of nitrogen, 8,107 pounds of phosphorus, and 7,781,760 pounds of TSS. In comparison, the WTM estimates (provided in Section 6) predict a total baseline annual load for the total study area of approximately 143,000 pounds of nitrogen, 35,000 pounds of phosphorus, and 6,430,000 pounds of TSS.

The WTM serves as a tool to rank and screen proposed retrofit projects. Based on this load comparison between the USGS study and the WTM results, it can be concluded that the WTM predicted loads are within a reasonable range and are suitable for screening retrofit projects.

6. Conclusions and Recommendations

In comparing project ranking results from the rapid assessment (which were computed prior to WTM modeling) with the load and runoff volume reductions computed using WTM, the projects with the highest rank included wet ponds, a wetland, bioretention projects within public rights-of-way and forested riparian buffer projects (P1-E, P13-E, P3-M, P5-M, P1-M, P2-M, Wtlnd-1-M, P12-E, W20-M, and W4-E) (Table 7, the ten projects that had the highest final ranks are highlighted in yellow). While wet ponds and a wetland were found to have the most pollutant load reduction benefits out of the projects that could be modeled using WTM, one wet pond, and many bioretention and forested riparian buffer projects had the greatest benefits for runoff volume reductions. As a result, it is recommended that a combination of these highest ranked project types be considered for further evaluation and potential implementation. Forested riparian buffer projects are especially recommended due to their additional benefits in providing important biological habitat and greenspace, which were not quantified as part of this study.

Nine ponds (D1-E, D6-E, D8-E, P1-E, P12-E, P13-E, W2-E, W4-E, W5-E) south of the Erie Canal along Allen Creek East Branch and tributaries are identified as potential projects that could provide water quality treatment and flood storage. Flood storage in these ponds could reduce peak flows downstream along Allen Creek East Branch between the Erie Canal and French Road, and reduce the risk of flooding in this area. Two proposed ponds (D8-M and W13-M), located between Brighton Henrietta Town Line Road and Castle Road, could provide flood storage to help protect this commercial area from flooding. Due to the heavily residential land use south of Castle Road, properties available to construct flood storage/ water quality treatment projects are limited. As a result, no flood storage projects are identified for this area. Finally, one proposed pond (W8-M) near the Evans Farm Road subdivision, and 11 additional proposed ponds (P3-M, W20-M, D6-M, D4-M, D13-M, D8-M, D9-M, W13-M, W1-M, W2-M, P2-M) upstream along Allen Creek and tributaries could provide flood storage to help protect the Evans Farm Road subdivision from flooding.

ARCADIS recommends that Monroe County complete site visits and more detailed site-specific engineering evaluations for the projects recommended in this stormwater assessment prior to implementation. Detailed hydrologic and hydraulic analysis of these projects prior to or as a part of detailed design will help verify the load and runoff volume reductions concluded in this stormwater assessment.

ARCADIS also recommends that Monroe County explore potential teaming and cost-sharing opportunities with other municipal, state, federal, and local government agencies, as well private and/or nonprofit watershed conservation groups and schools and universities to initiate more detailed studies of the recommended projects.

Table 7 Proposed Projects Ranked by Load Reduction and Rapid Assessment Score

	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)			
	TN		TP		TSS		Fecal Coliform		Runoff Volume Reduction		Total Score from Rapid Assessment	
Final Rank	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Billion Colonies/ Year	Project ID	Acre-Feet/ Year	Project ID	Total Score
1	**P1-E**	819	**P1-E**	278	**P1-E**	56,650	**P1-E**	64,758	P2-E	6	Rip-16-M	14
2	**P13-E**	602	**P13-E**	207	**P13-E**	41,271	**P13-E**	47,177	Rip-7-E	5	D1-E	13
3	**P3-M**	481	**P3-M**	193	**P5-M**	32,644	**P5-M**	36,651	Rip-12-E	4	D2-M	13
4	**P5-M**	469	**P5-M**	165	**P3-M**	30,715	**P3-M**	34,485	O1-M	4	D3-M	13
5	**P1-M**	393	**P1-M**	145	**P1-M**	26,550	**P1-M**	29,809	P3-E	4	D6-E	13
6	**P2-M**	292	**P2-M**	101	**P2-M**	20,603	**P2-M**	23,132	P4-E	3	D8-E	13
7	**Wtlnd-1-M**	257	**P12-E**	87	**P12-E**	17,466	**P12-E**	19,965	Rip-14-M	3	P12-E	13
8	**P12-E**	254	**Wtlnd-1-M**	75	**W20-M**	11,837	**W20-M**	13,290	Rip-15-M	3	P13-E	13
9	**W20-M**	168	**W20-M**	58	**Wtlnd-1-M**	10,252	**Wtlnd-1-M**	12,381	Rip-6-E	1	P1-E	13
10	**W4-E**	127	**W4-E**	44	**W4-E**	8,719	**W4-E**	9,967	P5-E	1	P2-M	13
11	W5-E	113	W5-E	39	W5-E	7,692	W5-E	8,793	Rip-13-M	1	P3-M	13
12	P2-E	74	W8-M	26	W8-M	5,074	W8-M	5,697	O3-M	0	W20-M	13
13	W8-M	73	W13-M	19	W13-M	3,629	W13-M	4,074	D1-E	0	W2-E	13
14	W13-M	53	P2-E	13	P2-E	2,284	P2-E	3,082	D6-E	0	W4-E	13
15	O1-M	47	W2-M	9	W2-M	1,647	O1-M	1,975	D8-E	0	W5-E	13
16	P3-E	43	O1-M	8	O1-M	1,490	P3-E	1,969	P1-E	0	D6-M	12

Table 7 Proposed Projects Ranked by Load Reduction and Rapid Assessment Score

	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)			
	TN		TP		TSS		Fecal Coliform		Runoff Volume Reduction		Total Score from Rapid Assessment	
Final Rank	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Billion Colonies/ Year	Project ID	Acre-Feet/ Year	Project ID	Total Score
17	Rip-7-E	35	Rip-7-E	8	P3-E	1,459	W2-M	1,849	P12-E	0	D7-W	12
18	P4-E	35	Rip-12-E	8	W1-M	1,107	P4-E	1,442	P13-E	0	P1-M	12
19	Rip-12-E	30	P3-E	6	P4-E	1,068	Rip-7-E	1,285	Rip-1-E	0	P2-E	12
20	W2-M	24	P4-E	6	Rip-7-E	983	W1-M	1,243	Rip-2-E	0	P3-E	12
21	Rip-14-M	20	W1-M	6	Rip-12-E	841	Rip-12-E	1,099	Rip-3-E	0	P4-E	12
22	Rip-15-M	19	Rip-14-M	5	Rip-15-M	576	Rip-15-M	739	Rip-4-E	0	P5-E	12
23	W1-M	17	Rip-15-M	4	Rip-14-M	567	Rip-14-M	727	Rip-5-E	0	Rip-2-E	12
24	P5-E	10	D8-E	4	W12-W	525	W12-W	673	Rip-8-E	0	Rip-3-E	12
25	Rip-6-E	9	W12-W	3	D8-E	474	P5-E	429	Rip-9-E	0	W8-M	12
26	D8-E	9	D7-W	3	D6-E	396	Rip-6-E	332	Rip-10-E	0	D13-M	11
27	W12-W	9	D6-E	3	P5-E	318	W2-E	326	Rip-11-E	0	D4-M	11
28	D6-E	7	Rip-6-E	2	W2-E	285	Rip-13-M	208	W2-E	0	D5-M	11
29	D7-W	6	P5-E	2	D7-W	256	O3-M	34	W4-E	0	D8-M	11
30	Rip-13-M	6	D2-M	2	Rip-6-E	254	D1-E	0	W5-E	0	D9-M	11
31	D5-M	4	D5-M	2	D5-M	231	D6-E	0	D7-W	0	O3-M	11
32	W2-E	4	D9-M	2	D2-M	209	D8-E	0	W12-W	0	P5-M	11
33	D2-M	4	W2-E	1	D9-M	184	Rip-1-E	0	D2-M	0	W13-M	11

Table 7 Proposed Projects Ranked by Load Reduction and Rapid Assessment Score

	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)			
	TN		TP		TSS		Fecal Coliform		Runoff Volume Reduction		Total Score from Rapid Assessment	
Final Rank	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Billion Colonies/ Year	Project ID	Acre-Feet/ Year	Project ID	Total Score
34	D9-M	4	Rip-13-M	1	Rip-13-M	162	Rip-2-E	0	D3-M	0	W1-M	11
35	D6-M	3	D3-M	1	D6-M	145	Rip-3-E	0	D4-M	0	W2-M	11
36	D3-M	3	D6-M	1	D3-M	127	Rip-4-E	0	D5-M	0	O1-M	10
37	D4-M	1	D4-M	0	D4-M	62	Rip-5-E	0	D6-M	0	Rip-5-E	10
38	O3-M	1	D1-E	0	D1-E	30	Rip-8-E	0	D8-M	0	Rip-4-E	9
39	D1-E	1	O3-M	0	O3-M	26	Rip-9-E	0	D9-M	0	Rip-6-E	9
40	Rip-1-E	0	Rip-1-E	0	Rip-1-E	0	Rip-10-E	0	D13-M	0	Rip-9-E	9
41	Rip-2-E	0	Rip-2-E	0	Rip-2-E	0	Rip-11-E	0	P1-M	0	W12-W	9
N/A	Rip-3-E	0	Rip-3-E	0	Rip-3-E	0	D7-W	0	P2-M	0	Rip-11-E	8
N/A	Rip-4-E	0	Rip-4-E	0	Rip-4-E	0	D2-M	0	P3-M	0	Rip-12-E	8
N/A	Rip-5-E	0	Rip-5-E	0	Rip-5-E	0	D3-M	0	P5-M	0	Rip-15-M	8
N/A	Rip-8-E	0	Rip-8-E	0	Rip-8-E	0	D4-M	0	Rip-16-M	0	Rip-7-E	7
N/A	Rip-9-E	0	Rip-9-E	0	Rip-9-E	0	D5-M	0	W1-M	0	Rip-8-E	7
N/A	Rip-10-E	0	Rip-10-E	0	Rip-10-E	0	D6-M	0	W2-M	0	Rip-10-E	6
N/A	Rip-11-E	0	Rip-11-E	0	Rip-11-E	0	D8-M	0	W8-M	0	Rip-14-M	6
N/A	D8-M	0	D8-M	0	D8-M	0	D9-M	0	W13-M	0	Rip-1-E	6
N/A	D13-M	0	D13-M	0	D13-M	0	D13-M	0	W20-M	0	Wtlnd-1-M	6

Table 7 Proposed Projects Ranked by Load Reduction and Rapid Assessment Score

	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)			
	TN		TP		TSS		Fecal Coliform		Runoff Volume Reduction		Total Score from Rapid Assessment	
Final Rank	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Pounds/ Year	Project ID	Billion Colonies/ Year	Project ID	Acre-Feet/ Year	Project ID	Total Score
N/A	Rip-16-M	0	Rip-16-M	0	Rip-16-M	0	Rip-16-M	0	Wtlnd-1-M	0	Rip-13-M	4

Notes:
N/A = not applicable
Highlighting = highest ranked projects

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Appendix A

Compiled GIS Data (Table A-1 and electronic geodatabase) and GIS Methodology Summary

Appendix B

Custom Web Soil Survey Reports by Subwatersheds: Allen Creek East Branch, West Brook, Allen Creek Main Branch

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Appendix C

Priority Waterbodies List (NYSDEC 2007)

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Appendix D

Green Infrastructure Rapid Assessments: Allen Creek Main Branch and Allen Creek East Branch (Monroe County, NY 2013)

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Appendix E

Retrofit Project Design Sheets (CWP 2007 and Pennsylvania Department of Environmental Protection 2006)

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Appendix F

Potential Stormwater Retrofit
Project Diagrams

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Appendix G

WTM Models: Allen Creek East Branch, West Brook, and Allen Creek Main Branch