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Monroe County, New York

Mill Creek Stormwater Assessment

January 12, 2015

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Mill Creek Stormwater Assessment

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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 Mill 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 Mill 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 6,500 acre Mill Creek watershed is mostly located within the Town of Webster, just east of the City of Rochester in Monroe County, New York. Mill Creek flows northward and discharges into Lake Ontario. “Known” surface-water pollutants for Mill Creek and its tributaries include Priority Organics (PCBs, dioxin), Pesticides (mirex) and “suspected” pollutants which include dissolved oxygen depletion/oxygen demand, nutrients, pathogens and silt/sediment. Suspected sources of these pollutants consist of industrial, municipal, on-site septic systems, construction for residential development and urban stormwater runoff (NYSDEC 2007). 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 Green Infrastructure Rapid Assessment Plan Mill Creek Watershed (2013) [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 50 potential retrofit projects for the Mill Creek watershed. 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 projects include, but are not limited to: new and retrofit stormwater wet ponds, bioretention (within public highway rights-of-way and within residential cul-de-sacs) 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). Project scores ranged from a maximum of 14 points to a minimum of 3 points. One constructed wetland project ranked highest (14 points) out of the 50 total projects. Twelve wet pond retrofit projects ranked second highest (each had 12 points). The next highest ranked projects (11 points each) included two bioretention projects within highway public rights-of-way and five new wet ponds.

A predictive model was developed for the Mill Creek watershed 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. Model results for both scenarios are evaluated in conjunction with the results of the project rankings to yield a final project prioritization matrix recommended for the Mill Creek watershed.

As a result of the rapid assessment ranking and the WTM modeling, four forested riparian buffer projects and five bioretention projects (four within public highway rights-of-way and one within a public school's grounds) are the highest recommended projects for reducing stormwater runoff. A constructed wetland project, three forested riparian buffers, four wet pond retrofits and two bioretention projects within public rights-of-way are the mostly highly recommended projects due to their estimated pollutant load reductions in total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), and fecal coliform bacteria. Overall, all 50 projects assessed in this study: 27 bioretention projects (17 in residential cul-de-sacs, nine in public highway rights-of-way, and one in a public school), 10 wet pond retrofits, seven new wet ponds and five forested riparian buffer projects, are recommended because each is estimated to yield load reductions in TSS, TP, TN and fecal coliform bacteria

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 also 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 base flows 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 Mill 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 25.2 miles of streams 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 PCBs, (dioxin), and pesticides (mirex) as known pollutants and dissolved oxygen/oxygen demand, nutrients, pathogens, and silt/sediment are suspected pollutants (NYSDEC 2007). The PWL (NYSDEC 2007) describes primary suspected sources of these pollutants including industrial, municipal, on-site septic systems, construction for residential development and urban stormwater runoff (NYSDEC 2007).

1.1 Purpose

This Mill 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 the Watershed Treatment Model (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), 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 Mill Creek watershed. This assessment uses the 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 Mill Creek watershed. The results include a prioritized list of 50 potential stormwater retrofit projects, such as new and retrofit wet ponds, bioretention on public highway right-of-way (bioretention ROW) and bioretention in residential cul-de-sacs, and forested riparian buffers, which are expected to improve water quality and attenuate stormwater runoff if implemented. The 50 potential projects are comprised of some projects (33) that are identified in the Green Infrastructure Rapid Assessment Plan Mill Creek Watershed completed by SCMC and MCDES in 2013 (Appendix D), and some new projects (17) identified in this stormwater assessment.

The desktop planning analysis helped to develop an understanding and characterization of the Mill Creek watershed. Previously completed scientific studies reported for Mill Creek were collected and reviewed to understand historical and current watershed conditions. One particularly noteworthy study was the 2009 Stressed Stream Analysis of the Mill Creek Watershed by Dr. Mark R. Noll of the State University of New York (SUNY) College at Brockport.

The SUNY Brockport study concluded most total phosphorus levels analyzed from 2008 and 2009 sampling events to be only slightly elevated compared to natural background

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conditions and therefore not significant enough for concern for eutrophication or algal blooms. Results for one sampling site located downstream of a residential area with on-going construction and a retention basin that collects and releases stormwater discharge from the site, did indicate significantly elevated total phosphorus levels compared to results for other sites and natural background levels. The study concluded high total phosphorus concentrations measured for samples from this site may be attributed to stormwater runoff discharges of sediment from retention basin and the construction areas (Noll 2009).

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 Mill Creek watershed. After potential projects were identified, projects were assessed according to the Rapid Assessment Methodology developed by Monroe County to guide project evaluation and scoring. 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 a WTM watershed model developed to help estimate each project’s influence on pollutant loads and stormwater runoff.

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 majority of the Mill Creek watershed is located within the Town of Webster with portions located in the Village of Webster and Town of Penfield, just east of the City of Rochester, New York and Irondequoit Bay (Figure 1). The headwaters are located in the Town of Penfield and the Creek flows from south to north for about 8 miles to its outlet to Lake Ontario at Webster Park. The approximately 10-square-mile watershed is part of the larger Irondequoit-Ninemile River Basin (Hydrologic Unit Code 04140101). The average annual rainfall in the watershed is 32 to 34 inches (United States Department of Agriculture, Natural Resources Conservation Service [USDA] 2010).

2.1 Watershed Characteristics

2.1.1 Streamflow

The approximately 6,500 acre Mill Creek watershed contains 28 miles of streams, of which about 28% have been channelized. (SCMC and MCDES 2013). No USGS gages operate on streams within the watershed, however the annual mean discharge in the watershed is estimated to be approximately 15 cfs. This discharge is estimated from the Northrup Creek Gage in the nearby Town of Greece (USGS 0422026250), which has a similar drainage area of 10 square miles (6,400 acres)

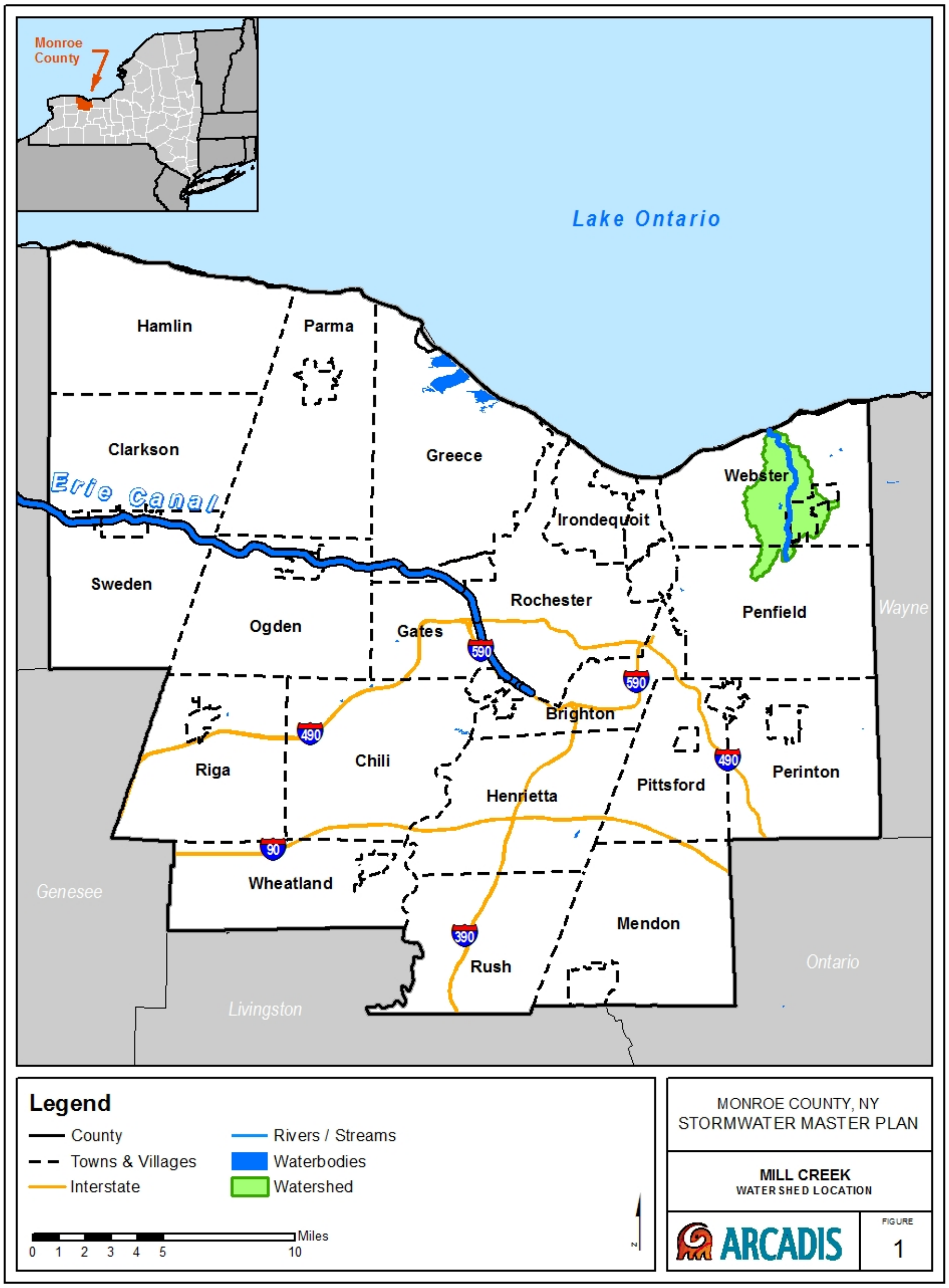

Figure 1 Location of Mill Creek Watershed, Monroe County, New York

2.1.2 Land Use

The Mill Creek watershed is currently characterized by predominantly residential land use, and to a lesser extent vacant land and commercial uses (Figure 2, Table 1). Commercial and industrial land uses are concentration in the center of the watershed, along the Route 104 and Main Ridge Road (Figure 2). Northern and southern portions of the watershed are mostly residential and Webster Park (wild, forested, conservation land and public parks) is located at the southern-most part of the watershed where Mill Creek discharges to Lake Ontario.

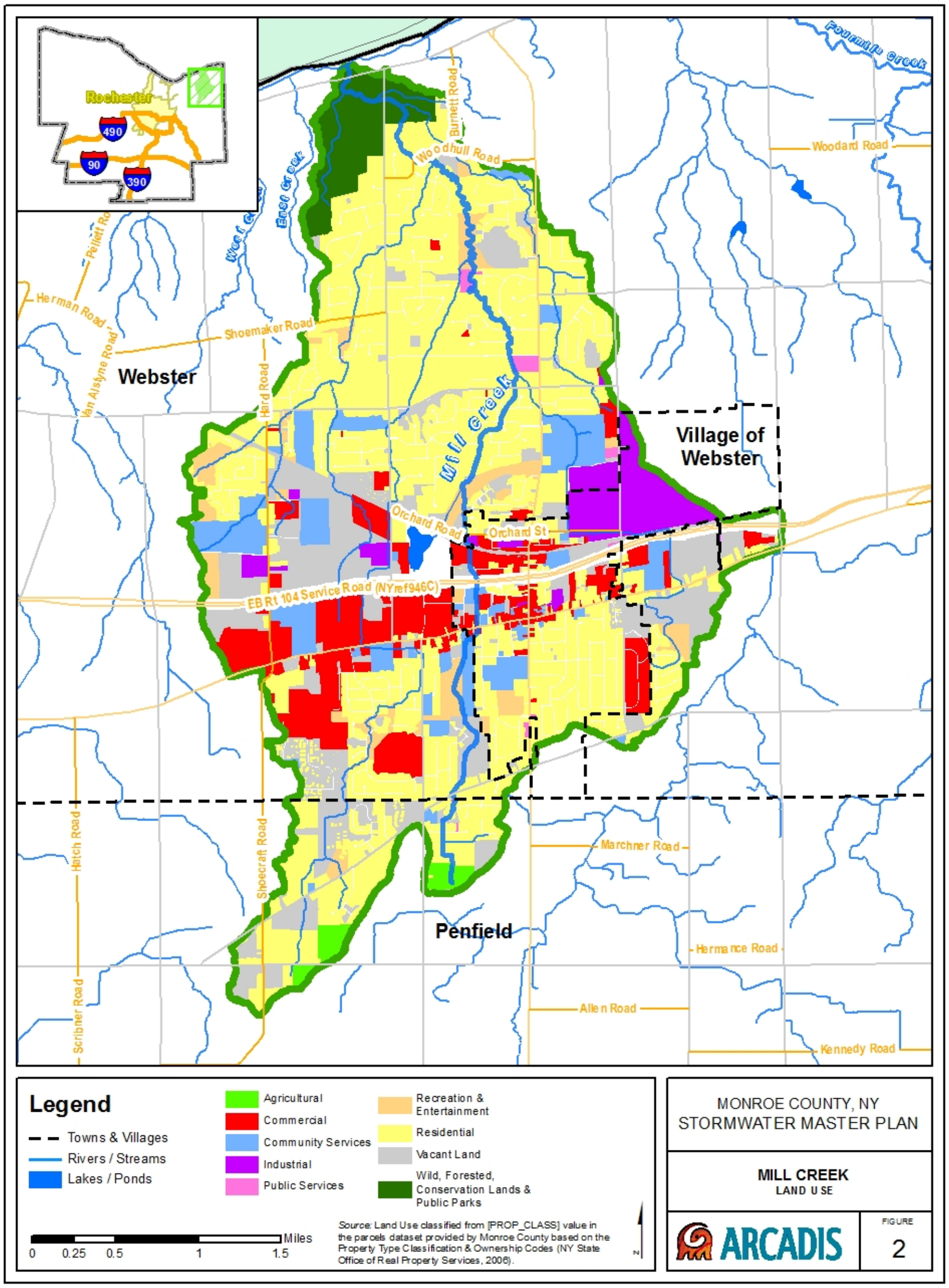

Figure 2 Current Land Use in Mill Creek Watershed

Table 1 Watershed Data

Metric	Mill Creek Watershed[1]
Area (acres)	6,484
Mapped Stream Length (miles)	28
Percent (%) of Stream Channelized[1]	28
Primary/Secondary Land Use	
Agricultural (%)	1
Residential (%)	50
Vacant Land (%)	17
Commercial (%)	11
Recreational and Entertainment (%)	4
Community Service	8
Industrial (%)	5
Public Services (%)	<1
Wild, Forested, Conservation Lands, and Public Parks (%)	4
Number of Stormwater Treatment Ponds (count)	Unknown
Number of Stormwater Outfalls (count)	225
Current Impervious Cover (%)	30
Estimated Future Impervious Cover (%)[1]	34
Wetlands (acres)	200
Municipal Jurisdictions	
Town of Webster (%)	70
Village of Webster (%)	15
Town of Penfield (%)	15

Note:
1. Values from 2013 Green Infrastructure Rapid Assessment Mill Creek Watershed by SCMC and MCDES (Appendix D)

2.1.3 Impervious Cover

About 30% of the Mill Creek watershed is covered by impervious surfaces (Table 1, Figure 3). Impervious cover GIS data processing and analyses are described in the GIS methodology summary included in Appendix A.

Impervious cover is concentrated in the center of the watershed, along with the dense corridor of commercial and industrial land uses along the Route 104 and Main Ridge transportation routes. Some of the potential retrofit projects selected for evaluation as part of this assessment are located downstream of these areas to help mitigate stormwater runoff and pollutant loads from this area.

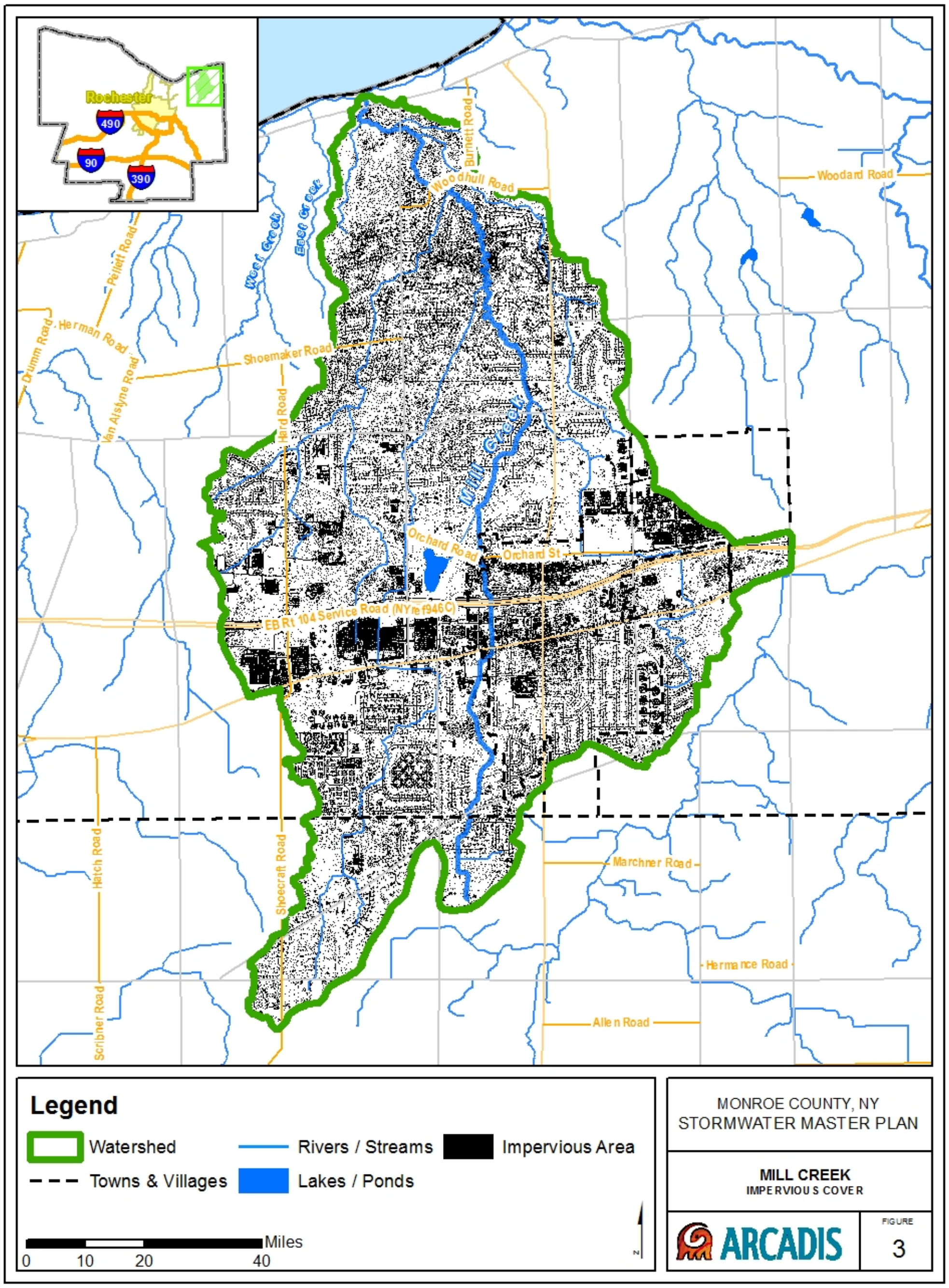

Figure 3 Current Impervious Cover in Mill Creek Watershed

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 4). Applying the total percent impervious cover of 30%, the ICM yields a stream quality prediction of “non-supporting” for the Mill Creek watershed.

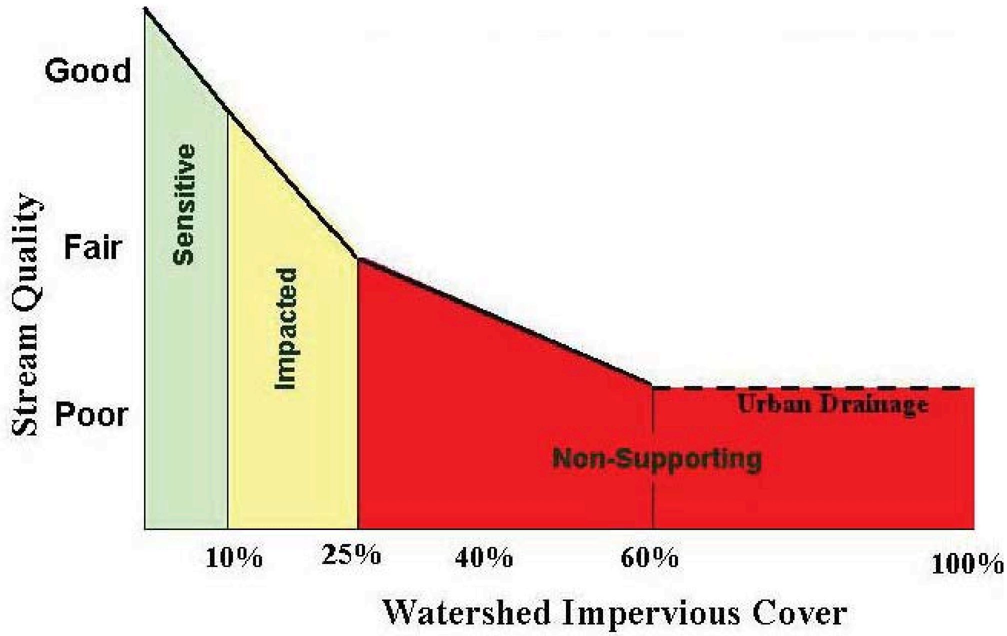

Figure 4 Impervious Cover Model (CWP 2003)

2.1.4 Soil

The predominant Hydrologic Soil Group (HSG) in the watershed is Group B (48%), which is well drained, facilitates stormwater infiltration, and is a desired characteristic for many retrofit project types (Figure 5). Group C soil, which is somewhat poorly drained soil, comprises 33%; Group D soil, which is poorly drained soil, comprises approximately 14% watershed (SCMC and MCDES 2013).

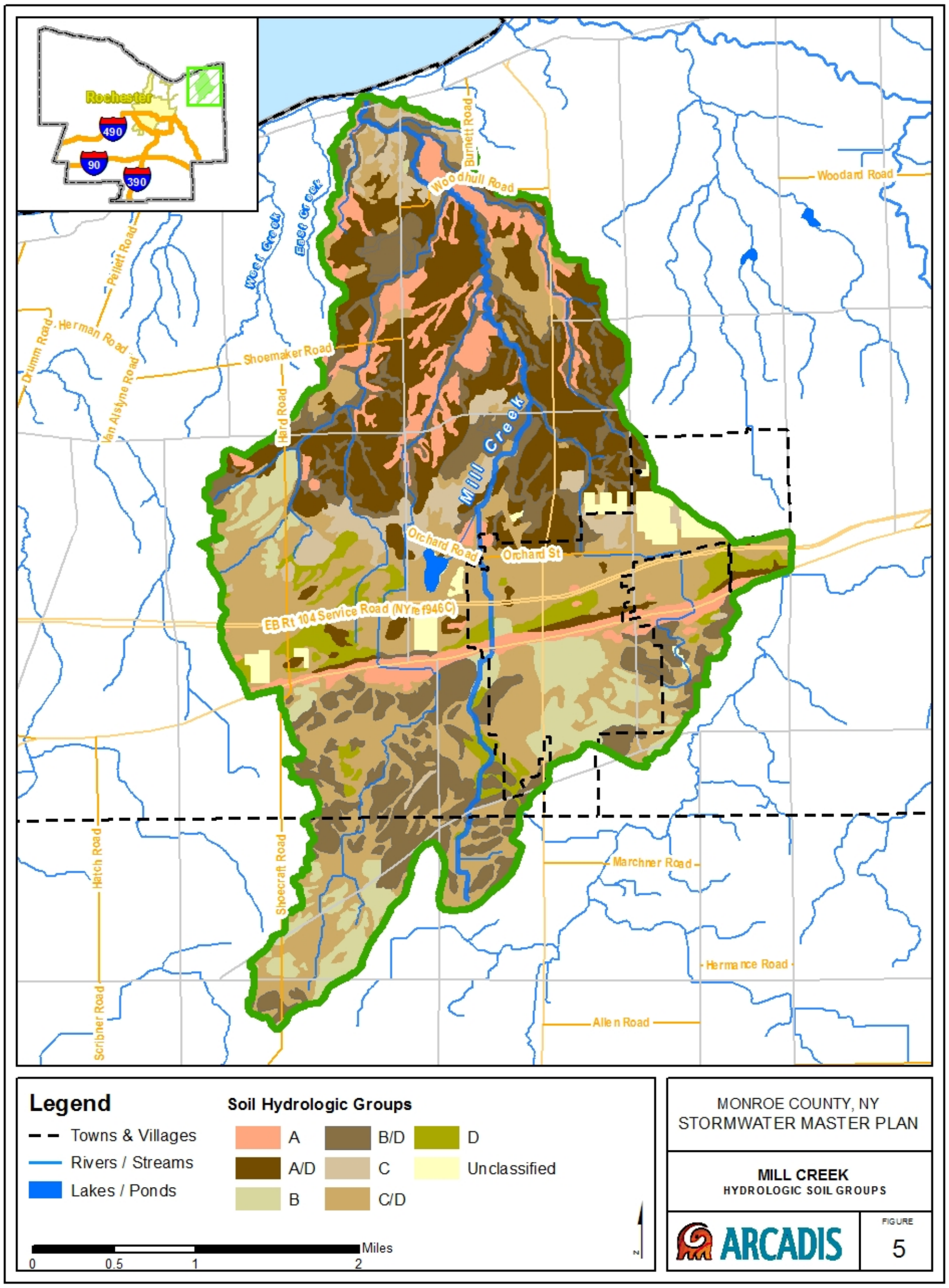

Figure 5 Hydrologic Soil Groups in Mill Creek East Watershed

A custom soil survey report was generated for the Mill Creek watershed using the USDA's Web Soil Survey application and is included in Appendix B. According to this report, the dominant soil types of the watershed include:

- Mf: Massena fine sandy loam, 616 acres or 9.5%
- HlB: Hilton loam, 3 to 8 percent slopes, 497 acres or 7.7%
- ApA: Appleton loam, 0 to 3 percent slopes, 415 acres or 6.4%

2.1.5 Water Quality

A total of 25.2 miles of streams in Mill Creek are listed as having "minor impacts" according to the PWL (NYSDEC 2007) (Appendix C), as summarized below:

- *Pollutants of concern in the watershed*. PCBs (dioxin), pesticides (mirex), dissolved oxygen depletion/oxygen demand, nutrients, pathogens, and silt/sediment
- *Sources of pollutants*. Urban stormwater runoff, construction, on-site septic systems, municipal and industrial land uses, streambank erosion
- *Challenges*. Manipulated stream channels (channelized) and hydromodification, denser concentration of impervious cover along transportation corridor traversing center portion of watershed, degraded aquatic habitat
- *Positives*. Sewage discharges to Mill Creek and its tributaries have improved in recent years due to improvements to the sanitary sewer collection system

The designated uses of fish consumption is "known to be stressed" and aquatic life, public bathing and recreation are reported as "suspected to be impaired" for dissolved oxygen, nutrients, pathogens and silt/sediment from industrial, municipal, on-site septic systems and urban storm runoff (Appendix C).

Potential stormwater hotspots were identified during the development of the Green Infrastructure Rapid Assessment Mill Creek Watershed (Appendix D). 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. 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 Mill Creek watershed were reviewed to identify existing flood-prone areas and retrofit projects that could provide flood storage benefits. Interviews with DPW staff at the Town of Webster during development of the rapid assessment and a review of their Comprehensive Drainage Study identified drainage issues which have been addressed by an active stormwater management program in the Town. Some minor drainage concerns persist in low-lying areas.

There are ten reported stream erosion sites on Mill Creek from previous assessments done by the Monroe County Soil & Water Conservation District in 2001. All sites were visited to support the Mill Creek rapid assessment and showed mostly minor eroded stream banks.

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3. Retrofit Assessment

A total of 50 potential stormwater retrofit projects located in the Mill Creek watershed were selected for evaluation and ranking as part of this stormwater assessment (Table 2). Project types include bioretention areas (within public highway right-of-ways and residential cul-de-sacs), new and retrofit stormwater wet ponds and forested riparian buffers (Figure 6). Design sheets for these types of stormwater retrofit projects from the Urban Subwatershed Restoration Manual No. 3 (CWP 2007) are included in Appendix E.

Table 2 Potential Stormwater Projects Selected for Evaluation

Project ID	Project Type	Source
R1	Bioretention Right-of-Way	ARCADIS
R2	Bioretention Right-of-Way	ARCADIS
R3	Bioretention Right-of-Way	ARCADIS
R4	Bioretention Right-of-Way	ARCADIS
R5	Bioretention Right-of-Way	ARCADIS
R6	Bioretention Right-of-Way	ARCADIS
R7	Bioretention Right-of-Way	ARCADIS
R8	Bioretention Right-of-Way	ARCADIS
R9	Bioretention Right-of-Way	ARCADIS
F1	Forested Buffer	ARCADIS
F2	Forested Buffer	ARCADIS
F3	Forested Buffer	ARCADIS
F4	Forested Buffer	ARCADIS
F5	Forested Buffer	ARCADIS
P17	New Wet Pond	ARCADIS
P18	New Wet Pond	ARCADIS
P1	New Wet Pond	Monroe County
P12	New Wet Pond	Monroe County
P2	New Wet Pond	Monroe County
P8	New Wet Pond	Monroe County
P9	New Wet Pond	Monroe County
O1	Bioretention Residential Cul-De-Sac	Monroe County
O11	Bioretention Residential Cul-De-Sac	Monroe County
O12	Bioretention Residential Cul-De-Sac	Monroe County

Table 2 Potential Stormwater Projects Selected for Evaluation

Project ID	Project Type	Source
O13	Bioretention Residential Cul-De-Sac	Monroe County
O14	Bioretention Residential Cul-De-Sac	Monroe County
O15	Bioretention Residential Cul-De-Sac	Monroe County
O16	Bioretention Residential Cul-De-Sac	Monroe County
O17	Bioretention Residential Cul-De-Sac	Monroe County
O18	Bioretention Residential Cul-De-Sac	Monroe County
O19	Bioretention Residential Cul-De-Sac	Monroe County
O2	Bioretention Residential Cul-De-Sac	Monroe County
O20	Bioretention Residential Cul-De-Sac	Monroe County
O22	Bioretention Residential Cul-De-Sac	Monroe County
O24	Bioretention Residential Cul-De-Sac	Monroe County
O55	Bioretention Residential Cul-De-Sac	Monroe County
O7	Bioretention Residential Cul-De-Sac	Monroe County
O8	Bioretention Residential Cul-De-Sac	Monroe County
O9	Bioretention Residential Cul-De-Sac	Monroe County
W17	Wet Pond Retrofit	Monroe County
W24	Wet Pond Retrofit	Monroe County
W27	Wet Pond Retrofit	Monroe County
W50	Wet Pond Retrofit	Monroe County
W51	Wet Pond Retrofit	Monroe County
W54	Wet Pond Retrofit	Monroe County
W55	Wet Pond Retrofit	Monroe County
W56	Wet Pond Retrofit	Monroe County
W57	Wet Pond Retrofit	Monroe County
W9	Wet Pond Retrofit	Monroe County
Wtld1	Constructed Wetlands	ARCADIS

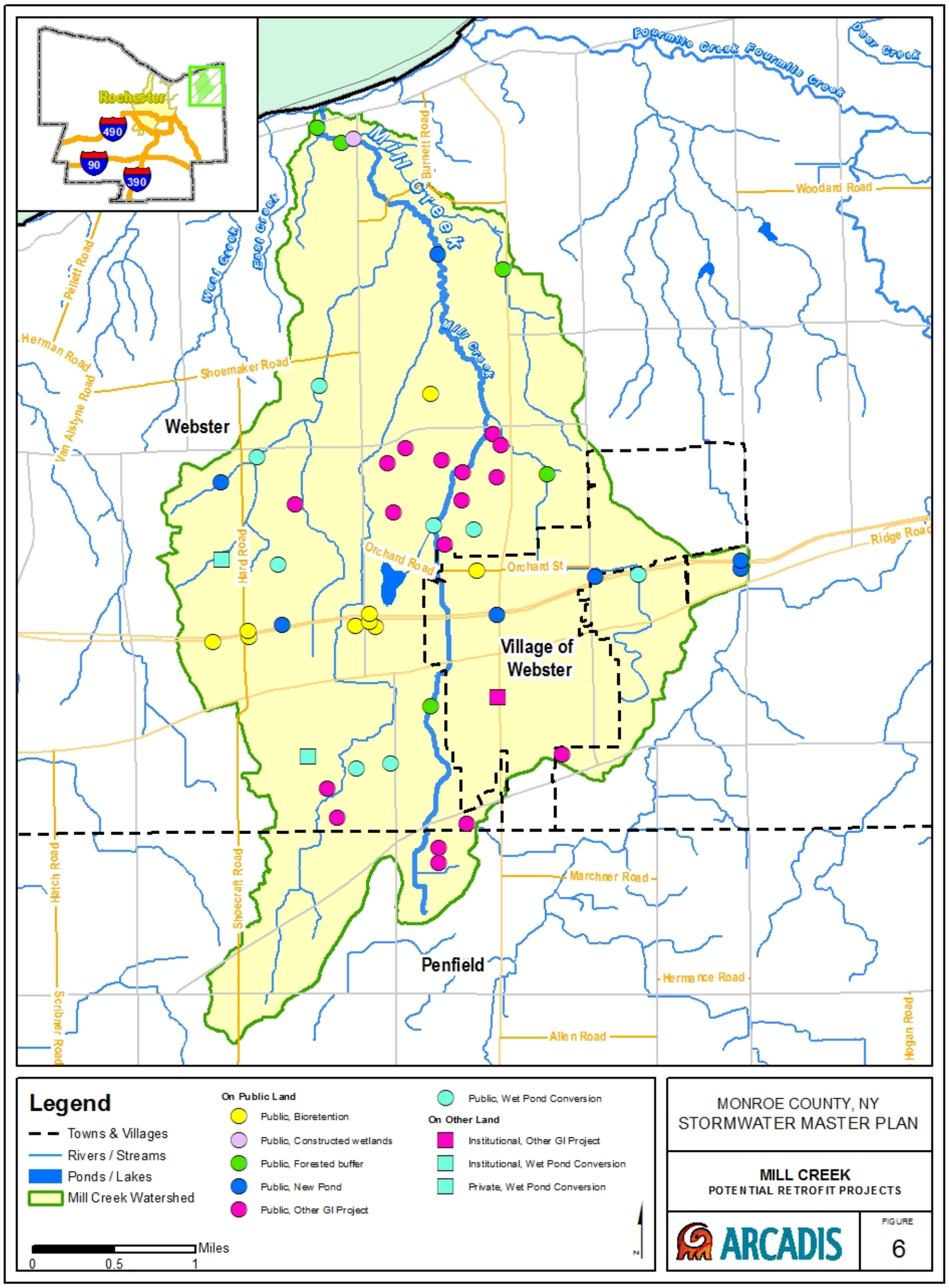

Figure 6 Potential Stormwater Retrofit Projects in the Mill Creek Watershed

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 the Mill Creek Watershed (Appendix D) were reviewed. The highest ranked 35 projects from the rapid assessment were selected for evaluation in this stormwater assessment. In addition to these selected projects, 15 other potential stormwater retrofit projects were identified by GIS reconnaissance for evaluation in this stormwater assessment. Thus, a total of 50 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 Green infrastructure Rapid Assessment Plan Mill Creek Watershed [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" table of the rapid assessment (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 determine a total score for each existing project.

After computing total scores for the potential projects selected for evaluation in this stormwater assessment, projects were ranked and classified 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

Table 3 Ranking Protocol (Monroe County 2013)

Project Type	Feasibility	Watershed Benefits	Cost Effectiveness	Maximum Possible Score
Neighborhood Green Infrastructure	Neighborhoods considered meet these criteria and 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***	Community revitalization = 1 point Water quality = 1 point Education = 1 point Source control = 1 point ***4 points***	Neighborhood green infrastructure practices vary in cost effectiveness from a score of 3 to 1; therefore, average with 2 points each ***2 points***	8
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 a maximum of 14 points to a minimum of 3 points (Table 4). One constructed wetland project ranked highest (14 points) out of the 50 total projects. Twelve wet pond retrofit projects ranked second highest (each had 12 points). The next highest ranked projects (11 points each) included two bioretention projects within highway public rights-of-way and five new wet ponds. Projects that ranked highest scored the maximum number of points for "Feasibility" (5 points) because of their location on public lands and the ease of access to the sites. In addition highest ranked projects had high scores (4-6 points) for "Watershed Benefits" because in general they provide for infiltration, channel protection volume, flood storage, pollutant source and/or erosion control. One new wet pond project ranked lowest because it received a score of 3 total points; 0 points for "Feasibility," 0 points for "Watershed Benefits" and 3 points for "Cost Effectiveness."

3.3 Retrofit Project Diagrams

Potential stormwater 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
Wtld1	Constructed Wetlands	Mill Creek	5	6	3	14
W17	Wet Pond Retrofit	Mill Creek	5	4	3	12
W24	Wet Pond Retrofit	Mill Creek	5	4	3	12
W27	Wet Pond Retrofit	Mill Creek	5	4	3	12
W50	Wet Pond Retrofit	Mill Creek	5	4	3	12
W51	Wet Pond Retrofit	Mill Creek	5	4	3	12
W54	Wet Pond Retrofit	Mill Creek	5	4	3	12
W9	Wet Pond Retrofit	Mill Creek	5	4	3	12
O55	Bioretention	Mill Creek	5	3	3	11
R1	Bioretention ROW	Mill Creek	5	3	3	11
R2	Bioretention ROW	Mill Creek	5	3	3	11
P1	New Pond	Mill Creek	5	3	3	11
P12	New Pond	Mill Creek	5	3	3	11
P2	New Pond	Mill Creek	5	3	3	11
P8	New Pond	Mill Creek	5	3	3	11
P9	New Pond	Mill Creek	5	3	3	11
O1	Bioretention	Mill Creek	3	4	3	10
O11	Bioretention	Mill Creek	3	4	3	10
O12	Bioretention	Mill Creek	3	4	3	10
O13	Bioretention	Mill Creek	3	4	3	10

Table 4 Ranked Potential Projects

Project ID	Category	Subwatershed	Feasibility	Watershed Benefits	Cost Effectiveness	Total Score
O14	Bioretention	Mill Creek	3	4	3	10
O15	Bioretention	Mill Creek	3	4	3	10
O16	Bioretention	Mill Creek	3	4	3	10
O17	Bioretention	Mill Creek	3	4	3	10
O18	Bioretention	Mill Creek	3	4	3	10
O2	Bioretention	Mill Creek	3	4	3	10
O7	Bioretention	Mill Creek	3	4	3	10
O8	Bioretention	Mill Creek	3	4	3	10
O9	Bioretention	Mill Creek	3	4	3	10
R4	Bioretention ROW	Mill Creek	1	6	3	10
R5	Bioretention ROW	Mill Creek	5	2	3	10
R6	Bioretention ROW	Mill Creek	5	2	3	10
P17	New Wet Pond	Mill Creek	5	2	3	10
O19	Other GI Project	Mill Creek	3	4	3	10
O20	Other GI Project	Mill Creek	3	4	3	10
O22	Other GI Project	Mill Creek	3	4	3	10
O24	Other GI Project	Mill Creek	3	4	3	10
R7	Bioretention ROW	Mill Creek	5	1	3	9
R8	Bioretention ROW	Mill Creek	5	1	3	9
R9	Bioretention ROW	Mill Creek	5	1	3	9

Table 4 Ranked Potential Projects

Project ID	Category	Subwatershed	Feasibility	Watershed Benefits	Cost Effectiveness	Total Score
F1	Forested Buffer	Mill Creek	4	1	3	8
F2	Forested Buffer	Mill Creek	4	1	3	8
F3	Forested Buffer	Mill Creek	3	2	3	8
F4	Forested Buffer	Mill Creek	4	1	3	8
F5	Forested Buffer	Mill Creek	4	1	3	8
W55	Wet Pond Retrofit	Mill Creek	3	2	3	8
W56	Wet Pond Retrofit	Mill Creek	3	2	3	8
W57	Wet Pond Retrofit	Mill Creek	3	2	3	8
R3	Bioretention ROW	Mill Creek	1	3	3	7
P18	New Wet Pond	Mill Creek	0	0	3	3

4. Watershed Treatment Model

A WTM (Caraco 2013) was developed for the Mill 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. Baseline and proposed 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 for the watershed using local 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 (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 WTM 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 50 potential retrofit projects presented in Table 4. Proposed conditions are the same as baseline conditions in terms of GIS data analyses, yet differ by additional benefits from improvements to programmatic measures and by accounting for the effects of the potential retrofit projects presented in Table 4.

4.2 Watershed Treatment Model Results

WTM results for total average annual loads and total average annual runoff volume for baseline and proposed conditions are presented in Table 5. WTM results for average annual load and runoff volume reductions for each of the 50 proposed projects are presented in Table 6.

WTM results show the average annual TN load to surface waters in the Mill Creek watershed Main Branch is approximately 49,000 pounds per year for baseline conditions and 38,600 pounds per year for proposed conditions. The percent reduction between baseline and proposed conditions for total nitrogen is 21%. The amount of the TN load to surface waters that comprises the stormwater load is approximately 42,400 pounds per year for baseline conditions and 32,000 pounds per year for proposed conditions.

The average annual TP load to surface waters in Mill Creek is approximately 12,100 pounds per year for baseline conditions and about 9,000 pounds per year for proposed conditions. The percent reduction between baseline and proposed conditions for TP is 26%. Of the total load, the stormwater load comprises approximately 11,300 pounds per year for baseline conditions and about 8,200 pounds per year for proposed conditions.

The average annual TSS load to surface waters in Mill Creek is approximately 2.21 million pounds per year for baseline conditions and 1.76 million pounds per year for proposed conditions. The percent reduction between baseline and proposed conditions for TSS is 20%. The storm load component of the total load is 2.17 million pounds per year for baseline conditions and 1.73 million pounds per year for proposed conditions.

Average annual fecal coliform loads to surface waters in Mill Creek totaled about 3.11 $x10^{15}$ colonies per year for baseline conditions and about 2.66 $x10^{15}$ colonies per year for proposed conditions. The percent reduction between baseline and proposed conditions for fecal coliform is 15%.

Table 5 Summary of Estimated Total Average Annual Loads to Surface Waters in Mill Creek Watershed

Watershed	Drainage Area (acres)	TN lb/year			TP lb/year			TSS lb/year			Fecal Coliform billion/year			Runoff Volume acre-feet/year		
		Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	% Change	Baseline	Proposed	Change
Mill Creek	**6,484**	**48,973**	**38,633**	**-21**	**12,087**	**8,951**	**-26**	**2,207,174**	**1,762,068**	**-20**	**3,114,908**	**2,656,834**	**-15**	**7,036**	**6,630**	**-6**

Table 6: Retrofit Project Average Annual Load and Runoff Volume Reductions, Mill Creek

Project ID	Practice Type	Drainage Area (ac)	TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)	Bacteria (billion colonies/ year)	Volume (acre-feet/year)
F1	Other Practice (User Defined)	436.58	288	72	8,271	10,184	35
F2	Other Practice (User Defined)	899.18	620	152	18,083	22,266	76
F3	Other Practice (User Defined)	403.74	223	54	6,604	8,132	28
F4	Other Practice (User Defined)	6,329.27	573	139	16,826	20,719	71
F5	Other Practice (User Defined)	6,480.00	353	86	10,334	12,724	44
O1	Bioretention	4.15	19	4	564	717	1
O11	Bioretention	2.41	12	3	366	465	1
O13	Bioretention	1,041.00	24	5	714	908	2
O12	Bioretention	1,058.20	23	5	684	870	2
O14	Bioretention	73.47	17	4	501	638	1
O15	Bioretention	1,177.65	14	3	436	554	1
O16	Bioretention	64.02	22	4	659	838	2
O17	Bioretention	0.96	16	3	488	621	1
O18	Bioretention	20.73	24	5	746	949	2
O8	Bioretention	0.91	14	3	426	541	1
O7	Bioretention	2.44	14	3	422	536	1
O9	Bioretention	4.50	24	5	702	894	2
O2	Bioretention	2.39	25	5	739	940	2
W24	Wet Pond	8.27	86	30	6,206	6,686	0
W27	Wet Pond	35.68	163	62	9,478	9,611	0

Table 6: Retrofit Project Average Annual Load and Runoff Volume Reductions, Mill Creek

Project ID	Practice Type	Drainage Area (ac)	TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)	Bacteria (billion colonies/ year)	Volume (acre-feet/year)
W17	Wet Pond	31.45	154	63	8,545	8,665	0
O55	Bioretention	27.65	116	22	3,632	4,619	9
P9	Wet Pond	22.56	64	23	3,840	3,894	0
P8	Wet Pond	30.44	298	119	16,796	17,032	0
R9	Bioretention	38.05	82	16	2,554	3,249	6
R7	Bioretention	22.53	55	10	1,783	2,268	4
R8	Bioretention	22.81	67	12	2,168	2,758	5
W51	Wet Pond	76.92	317	129	17,536	17,782	0
W50	Wet Pond	32.29	71	29	3,963	4,018	0
P12	Wet Pond	1.44	100	36	5,998	6,082	0
R6	Bioretention	22.56	105	18	3,478	4,424	8
R2	Bioretention	5.18	109	22	3,296	4,192	8
R1	Bioretention	11.09	356	62	11,748	14,943	27
R5	Bioretention	12.48	139	21	5,019	6,383	11
R3	Bioretention	9.41	139	25	4,473	5,690	10
W55	Wet Pond	86.71	1,061	433	58,748	59,572	0
P2	Wet Pond	4.04	39	15	2,277	2,309	0
P1	Wet Pond	2.67	184	72	10,490	10,637	0
W9	Wet Pond	48.95	934	367	53,209	53,955	0
W56	Wet Pond	1,028.36	1,144	458	64,252	65,153	0

Table 6: Retrofit Project Average Annual Load and Runoff Volume Reductions, Mill Creek

Project ID	Practice Type	Drainage Area (ac)	TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)	Bacteria (billion colonies/ year)	Volume (acre-feet/year)
O20	Bioretention	2.97	19	4	546	695	1
O19	Bioretention	4.70	21	4	618	786	1
O24	Bioretention	4.46	13	3	371	472	1
W57	Wet Pond	808.66	169	68	9,436	9,569	0
W54	Wet Pond	1,149.70	141	57	7,831	7,940	0
R4	Bioretention	13.07	559	116	16,376	20,829	39
P18	Wet Pond	4,022.11	145	59	8,021	8,134	0
O22	Bioretention	4.13	20	4	609	775	1
P17	Wet Pond	93.41	128	53	7,024	7,123	0
Wtlnd1	Wetland	41.96	1,589	478	63,343	73,408	0
		TOTAL	**10,895**	**3,444**	**481,228**	**527,147**	**405**

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

Of these totals, the storm load comprised 1.36 x10^{15} colonies per year of the baseline total and about 902,000 colonies per year for proposed conditions.

WTM results yielded an average annual total runoff volume for Mill Creek of approximately 7,000 acre-feet per year for baseline conditions and approximately 6,600 acre-feet per year for proposed conditions. The percent reduction between baseline and proposed conditions for total runoff volume is 6%.

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.

5. Summary

One project had a total score of 14 as a result of the rapid assessment ranking. This project was a constructed wetland in the top portion of the Mill Creek watershed (Table 4). The constructed wetland was the highest ranked project due to receiving the highest possible scores for “Watershed Benefits” (6 points), “Feasibility” (5 points), and “Cost Effectiveness (3 points). The project was awarded the highest number of points for Watershed Benefits due to its ability to provide infiltration, adequate flood storage, channel protection volumes, and water quality volumes, as well as public education benefits. Each of the top 15 projects received the highest possible five points for feasibility due to their location (or majority of 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. Watershed Benefits scores for the top 15 projects ranged from 3 to 6 points, representing points most commonly awarded for providing infiltration, adequate water quality protection volume, and pollutant source control.

Projects ranked highest (top 10) for pollutant load reductions as a result of the WTM modeling included a constructed wetland, wet pond retrofits and bioretention projects within public highway rights-of-way (Table 6). Projects ranked highest for runoff volume reduction were five forested riparian buffers and five bioretention projects (four within public highway rights-of-way and one within a residential cul-de-sac) (Table 6). 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 more than 80% 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 69% 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 72% 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 70% 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 69% 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 87% 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 Mill Creek Watershed in 2013 (Appendix D). 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.

The WTM serves as a tool to rank and screen proposed retrofit projects. When comparing the Mill Creek WTM estimated phosphorus load reduction per acre for baseline conditions with other watersheds in Monroe County that have been modeled using WTM, Mill Creek results are similar to those for other watersheds. For instance, the Mill Creek estimated total phosphorus unit load for baseline conditions is 1.86 pounds per acre per year and the unit loads estimated for Buckland Creek is 1.78 pounds per acre per year, 1.92 pounds per acre per year for Red Creek and 2.14 pounds per acre per year for Slater Creek (per email correspondence from Andy Sansone of Monroe County, New York on December 15, 2014).

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 that ranked highest using both methods included a constructed wetland, wet pond retrofits and bioretention projects (Table 7, the ten projects that had the highest final ranks are highlighted in yellow). While the constructed wetland and wet pond retrofits were found to have the most pollutant load reduction benefits (TN, TP, TSS and fecal coliform bacteria) out of the projects, forested riparian buffer and bioretention projects had, by far, 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.

In addition to the constructed wetland project (Wtld1), five new wet ponds (P1, P2, P8, P9, and P12) were found to provide flood storage volumes as part of the rapid assessment. Flood storage in these ponds could reduce peak flows downstream from the Route 104 transect of the central part of the Mill Creek watershed, which is predominantly residential. In addition, due to the heavily concentrated commercial land uses along this transportation corridor, wet ponds in these locations could also help mitigate stormwater pollutant loads.

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, Mill Creek

Final Rank	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)		Total Score from Rapid Assessment	
	Total Nitrogen (TN)		Total Phosphorus (TP)		Total Suspended Solids (TSS)		Fecal Coliform (FC)		Runoff Reduction			
	Project ID	TN (lbs/year)	Project ID	TP (lbs/year)	Project ID	TSS (lbs/year)	Project ID	FC (billion colonies/year)	Project ID	RV acre-feet/year)	Project ID	Total Score
1	Wtlnd1	1,592	Wtld1	480	W56	65,514	Wtld1	73,381	F2	76	Wtld1	14
2	W56	1,146	W56	460	Wtld1	64,588	W56	65,129	F4	71	W17	12
3	W55	1,063	W55	435	W55	59,902	W55	59,550	F5	44	W24	12
4	W9	936	W9	368	W9	54,254	W9	53,936	R4	39	W27	12
5	F2	621	F2	153	F2	18,438	F2	22,258	F1	35	W50	12
6	F4	574	F4	140	W51	17,880	R4	20,821	F3	28	W51	12
7	R4	560	W51	130	F4	17,157	F4	20,711	R1	27	W54	12
8	R1	357	P8	119	P8	17,126	W51	17,775	R5	11	W9	12
9	F5	354	R4	116	R4	16,698	P8	17,026	R3	10	O55	11
10	W51	317	F5	87	R1	11,979	R1	14,937	O55	9	R1	11
11	P8	299	F1	72	P1	10,696	F5	12,720	R6	8	R2	11
12	F1	288	P1	72	F5	10,537	P1	10,633	R2	8	P1	11
13	F3	224	W57	69	W27	9,664	F1	10,181	R9	6	P12	11
14	P1	184	W17	63	W57	9,622	W27	9,608	R8	5	P2	11
15	W57	170	R1	62	W17	8,713	W57	9,565	R7	4	P8	11
16	W27	163	W27	62	F1	8,434	W17	8,661	O18	2	P9	11
17	W17	155	P18	59	P18	8,179	P18	8,131	O2	2	O1	10
18	P18	145	W54	57	W54	7,984	F3	8,129	O13	2	O11	10

Table 7: Proposed Projects Ranked by Load Reduction and Rapid Assessment Score, Mill Creek

	Load Reductions (largest to smallest)								Runoff Volume Reduction (largest to smallest)		Total Score from Rapid Assessment	
	Total Nitrogen (TN)		Total Phosphorus (TP)		Total Suspended Solids (TSS)		Fecal Coliform (FC)		Runoff Reduction			
Final Rank	Project ID	TN (lbs/year)	Project ID	TP (lbs/year)	Project ID	TSS (lbs/year)	Project ID	FC (billion colonies/year)	Project ID	RV acre-feet/year)	Project ID	Total Score
19	W54	141	F3	54	P17	7,162	W54	7,938	O9	2	O12	10
20	R5	140	P17	53	F3	6,734	P17	7,120	O12	2	O13	10
21	R3	139	P12	37	W24	6,328	W24	6,684	O16	2	O14	10
22	P17	128	W24	30	P12	6,116	R5	6,381	O19	1	O15	10
23	O55	116	W50	29	R5	5,117	P12	6,080	O22	1	O16	10
24	R2	109	R3	25	R3	4,561	R3	5,688	O1	1	O17	10
25	R6	105	P9	23	W50	4,040	O55	4,618	O20	1	O18	10
26	P12	100	O55	22	P9	3,915	R6	4,422	O14	1	O2	10
27	W24	86	R2	22	O55	3,703	R2	4,190	O17	1	O7	10
28	R9	82	R5	21	R6	3,546	W50	4,017	O15	1	O8	10
29	W50	71	R6	18	R2	3,361	P9	3,892	O8	1	O9	10
30	R8	67	R9	16	R9	2,605	R9	3,248	O7	1	R4	10
31	P9	64	P2	15	P2	2,322	R8	2,757	O24	1	R5	10
32	R7	55	R8	12	R8	2,211	P2	2,308	O11	1	R6	10
33	P2	39	R7	10	R7	1,818	R7	2,267	W24	0	P17	10
34	O2	25	O9	5	O18	761	O18	948	W27	0	O19	10
35	O18	24	O2	5	O2	753	O2	939	W17	0	O20	10
36	O13	24	O13	5	O13	728	O13	908	P9	0	O22	10
37	O9	24	O18	5	O9	716	O9	893	P8	0	O24	10
38	O12	23	O12	5	O12	697	O12	869	W51	0	R7	9
39	O16	22	O16	4	O16	672	O16	838	W50	0	R8	9

Table 7: Proposed Projects Ranked by Load Reduction and Rapid Assessment Score, Mill Creek

Final Rank	Load Reductions (largest to smallest) Total Nitrogen (TN) Project ID	TN (lbs/year)	Total Phosphorus (TP) Project ID	TP (lbs/year)	Total Suspended Solids (TSS) Project ID	TSS (lbs/year)	Fecal Coliform (FC) Project ID	FC (billion colonies/year)	Runoff Volume Reduction (largest to smallest) Runoff Reduction Project ID	RV acre-feet/year)	Total Score from Rapid Assessment Project ID	Total Score
40	O19	21	O19	4	O19	630	O19	785	P12	0	R9	9
41	O22	20	O22	4	O22	621	O22	775	W55	0	F1	8
42	O1	19	O1	4	O1	575	O1	717	P2	0	F2	8
43	O20	19	O20	4	O20	557	O20	694	P1	0	F3	8
44	O14	17	O14	4	O14	511	O14	637	W9	0	F4	8
45	O17	16	O17	3	O17	498	O17	621	W56	0	F5	8
46	O15	14	O15	3	O15	444	O15	554	W57	0	W55	8
47	O8	14	O8	3	O8	434	O8	541	W54	0	W56	8
48	O7	14	O7	3	O7	430	O7	536	P18	0	W57	8
49	O24	13	O24	3	O24	379	O24	472	P17	0	R3	7
50	O11	12	O11	3	O11	373	O11	465	Wtld1	0	P18	3
Sum		**10,911**		**3,458**		**490,682**		**526,952**		**405**		**497**

Notes:
Highlighting = highest ranked projects

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