FINAL

MANY MIND CREEK
WATERSHED RESTORATION AND PROTECTION PLAN

Prepared for

Atlantic Highlands Environmental Commission
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EXECUTIVE SUMMARY

Over time, the water and habitat quality of Many Mind Creek, Atlantic Highlands and Middletown, New Jersey has become degraded due to increases in impervious cover, bank degradation and compaction, sedimentation, non-point source (NPS) loadings, loss of riparian buffer habitat and historical fill activities. Furthermore, the stream has seen increased flooding as a result of development within the watershed.

Based on the condition of Many Mind Creek, a 319(h) grant was issued by New Jersey Department of Environmental Protection (NJDEP) to Atlantic Highlands in 2003, with Weston Solutions, Inc. (Weston®) as the lead consultant. From 2005 through 2007 a characterization and assessment of Many Mind Creek and its watershed was conducted. In November 2007, the *Characterization and Assessment of Many Mind Creek Report* (Weston, 2007), which summarizes and interprets the data collected and forms preliminary recommendations for the creek and watershed, was submitted to NJDEP. Based on prior presentation of findings that were given in that report, NJDEP determined in October 2007 that a Watershed Restoration and Protection Plan (rather than a Regional Stormwater Management Plan) was an appropriate final deliverable because the Many Mind Creek watershed is not as critically impaired as many other waterways across the state. Specifically, the primary water quality impairments of Many Mind Creek include elevated coliform levels as well as elevated levels of both nitrogen and phosphorus above state water quality criteria.

This Watershed Restoration and Protection Plan builds on the recommendations of the Characterization and Assessment Report and provides a framework for improving non-point source water quality within the Many Mind Creek watershed. The plan meets the nine minimum requirements of a Watershed Restoration Plan (USEPA, 2005).

A number of recommended Best Management Practices (BMPs) for addressing issues with both stormwater quality and quantity are evaluated. Based on a feasibility evaluation of cost, effectiveness, and overall impact (Table 7-1) those BMPs with the highest priority in order to reduce or control stormwater flow include public education programs, rain barrels, and increased infiltration. For the reduction of pollutant loading and sedimentation, the highest priority BMPs include public education programs, stream clean-outs, and bank stabilization or restoration.

1.0 INTRODUCTION

In 1987, the Clean Water Act established the section 319 Nonpoint Source Management Program (319(h)) which authorizes the U.S. Environmental Protection Agency (USEPA) to direct grant programs to distribute monies to states, territories, and tribes to improve the management of nonpoint source (NPS) pollution. New Jersey receives these funds because of the development of the Nonpoint Source Assessment Report produced by the State and the current Nonpoint Source Management Program. New Jersey is authorized to use these funds through its Department of Environmental Protect NJDEP) to implement projects and programs that will result in a reduction of NPS pollution (NJDEP, 2005).

In 2002, the Atlantic Highlands Environmental Commission (AHEC) partnered with Weston Solutions, Inc. (Weston®) in proposing that a baseline watershed assessment of Many Mind Creek (Figure 1-1) be undertaken as the basis for developing a Regional Stormwater Management Plan (RSWMP) for addressing non-point source (NPS) pollution and habitat degradation, as well as flooding issues. Although the stream is not listed on the Federal 303(d) list of impaired waters, historically the water and habitat quality of the creek have become degraded, and the stream has seen increased flooding as a result of development within the watershed. The increase in impervious cover within the watershed has exacerbated flooding, and has adversely impacted the natural buffers and banks of the creek, as well as its water quality. Bank degradation and compaction, sedimentation, non-point source (NPS) loadings, loss of riparian buffer habitat and historical fill activities have all contributed to the decline in water and habitat quality within the creek, as well as aesthetic and recreational opportunities for local residents.

Based on the condition of Many Mind Creek, a 319(h) grant was issued by NJDEP to Atlantic Highlands in 2003, with Weston® as the lead consultant. From 2005 through 2007 a characterization and assessment of Many Mind Creek and its watershed was conducted. In November 2007, the *Characterization and Assessment of Many Mind Creek Report* (Weston, 2007) was submitted to NJDEP. Based on prior presentation of findings that were later given in that report, NJDEP determined in October 2007 that a Watershed Restoration and Protection Plan was a more appropriate final deliverable because the Many Mind Creek watershed is not as

Watershed Boundary
Creek Centerline
Municipality Boundary
Sampling Location

WESTON SOLUTIONS
Restoring Resource Efficiency

N
W E
S

0 575 1,150 2,300 Feet

Figure 1-1
WATERSHED
MANY MIND CREEK
ATLANTIC HIGHLANDS/
MIDDLETOWN, NEW JERSEY

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critically impaired as many other waterways across the state (Beth Torpey, personal communication). Specifically, the primary water quality impairments of Many Mind Creek include coliform levels as well as elevated levels of both nitrogen and phosphorus above state water quality criteria. However, the concentrations of these three parameters found in Many Mind Creek (see Weston, 2007) are often an order of magnitude lower than other waterways within New Jersey that have been targeted for Total Daily Maximum Load (TMDL) determinations and inclusion in the Regional Stormwater Management Plan (RSWMP) track.

This Watershed Restoration and Protection Plan is an outcome of and addendum to the Characterization and Assessment Report, which summarizes and interprets the data collected and forms preliminary recommendations for the creek and watershed. This Plan builds on the recommendations of the Characterization and Assessment Report and addresses the nine minimum requirements of a Watershed Restoration Plan (USEPA, 2005), which are listed below:

> a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan and to achieve any other watershed goals identified in the watershed-based plan, as discussed in item (b) below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed.
>
> b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above.
>
> c. A description of the nonpoint source (NPS) management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map and description) of the critical areas in which those measures will be needed to implement this plan.
>
> d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan. Possible sources of funding include Section 319(h) Programs, the New Jersey Environmental Infrastructure Trust, U.S. Department of Agriculture's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage the public's early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above (NJDEP, 2005).

1.1. Purpose

The objective of the 319(h) grant was for Weston to provide a characterization and assessment of the watershed through the preparation of a baseline ecological and stormwater survey of the Many Mind Creek watershed in order to identify and characterize the impairments and problems that are present. This assessment included studies of watershed hydrology, surface water chemistry and sediment, and habitat, including analysis of the benthic macroinvertebrate community. The analysis of the collected baseline information is provided within the Many Mind Creek Characterization and Assessment Report (Weston, 2007), which included preliminary recommendations for best management practices (BMPs) to address water quality issues. Based on a review and discussion of the preliminary recommendations by Atlantic Highlands, Middletown, the NJDEP, and the RSWMP committee, Weston has prepared this Watershed Restoration and Protection Plan. This Watershed Restoration and Protection Plan summarizes findings from this assessment, identifies alternatives for stormwater management for existing and future scenarios, compares alternatives with respect to benefits and costs, and selects preferred alternatives based on environmental benefits, costs, and feasibility. In addition,

a long-term watershed monitoring program is proposed as part of the plan to gauge its progress and long-term success.

1.2. Scope

The geographic scope of the project was the upstream two-thirds of Many Mind Creek, between its headwaters and the area of Jackson Bridge at First Avenue. The creeks' downstream third could not be included because of its disturbance by an ongoing contaminant remediation and restoration project being carried out by New Jersey Natural Gas under NJDPEP supervision.

The Scope of Work (SOW) for this project was broken down into two phases in accordance with the two goals noted above

1.2.1. Phase I

Phase I consisted of the formation of a RSWMP committee, designation of a lead planning agency, submission of a Quality Assurance Project Plan (QAPP), and a baseline watershed assessment. The baseline watershed assessment formed the basis of the Characterization and Assessment Report and included:

- Review and mapping of all existing watershed information to determine historical and current land use cover, soils and topography, critical areas, point and non-point sources, inputs from other water bodies, and current storm sewer facilities.

- Collection and analysis of surface water and sediment from 6 locations within Many Mind Creek. Eight complete rounds (4 during dry weather and 4 in wet weather) of surface water samples were collected and analyzed and one baseline round of sediment samples was collected and analyzed.

- Surface water and sediment analytical data were compared to ecologically-based screening guidelines and NJDEP Surface Water Quality Standards to determine what NPS pollutants are impacting stream quality. Those pollutants were the focus for the analysis of source contributions from different portions of the watershed, by comparing concentrations and loadings of those parameters along the stream. Results were also compared to land use cover within each sub-watershed to determine source contributions by land use type. Results of this analysis provide the basis of recommendations for the Watershed Restoration and Protection Plan regarding control of NPS pollutants.

- Sampling and analysis of benthic macroinvertebrates from the same 6 locations within the watershed, to gauge the extent of ecological impacts from stream degradation, using

the NJDEP-accepted *Izaak Walton League Save our Streams* protocol. This also created baseline data for long-term future monitoring within the watershed.

- Storm water modeling to characterize NPS pollution entering the stream. Both HEC RAS and Stormwater Management (SWMM) models were based on existing data as well as additional data collected concurrently with the water quality samples taken for chemical analysis. These data included flow, velocity, current channel condition, and stream cross-section data. The HEC RAS model was conducted by Rutgers University and was used to predict flood elevations for storm events of different magnitude and frequency. The United States Environmental Protection Agency's (USEPA) SWMM modeling software was used to model pollutant loading within the drainage area and project both flood flows and pollutant loadings for future development scenarios. The SWMM model uses soil, land use, drainage area characteristics, evaporation and infiltration rates to simulate runoff and pollutant loading from storm events.

- Habitat surveys that were conducted along Many Mind Creek. Observations of streambed substrate, channel morphology, plant species composition, vegetative cover, erosion or obvious habitat degradation were recorded. Incidental observations of fish and wildlife, including reptiles and amphibians, were also recorded. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) *Stream Visual Assessment Protocol* (SVAP) was used to evaluate present stream corridor conditions. Activities and observations were photo-documented as part of the baseline watershed assessment.

Results of the characterization and assessment of the creek were used to develop preliminary recommendations regarding BMPs for improving stream water quality.

1.2.2. Phase II

Phase II of this project involved further evaluation of proposed BMPs and finalizing them in this Watershed Restoration and Protection Plan after discussion with the Borough, Middletown, NJDEP, and the RSWMP committee.

Stormwater management measures in this Watershed Restoration and Protection Plan are evaluated and designed to meet the design and performance standards necessary to address water quality objectives. Stormwater management measures considered include: land use planning to enhance or protect land or water areas necessary for flood control and water quality, and restoration measures such as bank stabilization and revegetation. Selected measures and performance standards are consistent with the USEPA Phase II stormwater rule. A set of preferred alternatives according to effectiveness and cost is provided, as well as an evaluation of

sites available for restoration within the watershed as per the October 1998 *Stream Corridor Restoration Manual* (FISRWG 1998) and other appropriate references.

The measures and sites selected are consistent with and contribute to the proposed plan for a Many Mind Creek Greenway that provides for a low-impact trail for hiking and biking, a vegetated buffer at least 50 feet wherever possible, protection of wetlands to aid in flood control and habitat and water quality preservation, and recreational aesthetic and neighborhood-connecting values for residents.

1.3. RSWMP Committee

For this project, the Atlantic Highlands Environmental Commission partnered with representatives of the following stakeholders to form the project RSWMP committee:

- NJDEP;
- Monmouth County Planning Board (Lead Planning Agency);
- The Borough of Atlantic Highlands;
- Middletown Township;
- The Friends of Many Mind Creek (FMMC);
- Monmouth University;
- Brookdale Community College;
- Freehold Soil Conservation District;
- The National Oceanographic and Atmospheric Administration (NOAA);
- Clean Ocean Action;
- New York/New Jersey Baykeeper;
- AmeriCorps; and,
- Weston Solutions, Inc.

The RSWMP committee was initiated with the mailing of certified letters to potential committee members and stakeholders in January 2005. The initial formal meeting of the RSWMP committee was held in February 2005. At the February 2005 meeting, the RSWMP Committee designated Monmouth County Planning Board (MCPB) as the Lead Planning Agency (LPA) and voted Mr. Tom Kellers as Acting Chair. On April 18, 2005 the LPA passed a formal resolution of commitment to the project, stating that it would continue its support and leading role until the RSWMP is formally adopted into the area-wide Water Quality Management Plan after the contract with the grantee has concluded.

On May 27, 2005, the RSWMP committee was approved by Mr. Robert Mancini, Section Chief, Bureau of Watershed Planning NJDEP. Soon after, the NJDEP Division of Watershed Management approved that designation of MCPB as the Lead Planning Agency on June 3, 2005. In June 2006, Mr. Kellers retired and his project role was assumed by Mr. Turner Shell of the MCPB. Throughout 2006 and 2007 oversight of the 319(h) grant program has been conducted by Dr. Paul Boyd, Chair of the Atlantic Highlands Environmental Commission.

In October 2007, NJDEP Regional Stormwater Management Plan (RSWMP) Technical Review Committee (TRC) determined that based on the size of the Many Mind Creek Watershed and the identified impairments a Regional Stormwater Management Plan was an inappropriate endpoint for the project and that a Watershed Plan was a more appropriate final deliverable.

The remainder of this Watershed Restoration and Protection Plan includes the following elements:

- Overview of findings and recommendations from the Characterization and Assessment Report;
- Watershed management measures;
- Reducing or controlling stormwater flow;
- Reducing pollutant loading and sedimentation;
- Land use and resource planning and protection;
- Selection and implementation of measures; and
- Conclusions and plan implementation.

Throughout these sections, additional efforts have been devoted to integrating education and stewardship and environmental partnerships where possible.

2.0 OVERVIEW OF THE FINDINGS AND RECOMMENDATIONS OF THE CHARACTERIZATION AND ASSESSMENT REPORT

The following section provides a brief overview of the Findings and Recommendations of the Characterization and Assessment Report for Many Mind Creek (Weston 2007).

The observed degradation within Many Mind Creek is primarily due to increased stormwater flows, bank erosion and resulting sedimentation, as well as fecal coliform contamination throughout the creek. Aside from the headwaters portion, Many Mind Creek is experiencing at least moderate habitat degradation in a number of areas. Water quality ratings dropped consistently from the headwaters down to the most downstream sampling location. As Many Mind Creek travels through the watershed, the benthic macroinvertebrate diversity decreases, and the number and variety of habitat perturbations increases. Habitat disturbance in the stream appears correlated with development and impervious cover in the watershed, as well with as a decrease of vegetated buffers and resulting increased bank erosion at downstream portions of the watershed.

In addition, microbiological testing during this and previous studies indicates that total coliform, fecal coliform, *E. coli*, and fecal streptococci are present throughout Many Mind Creek. Therefore, there is high likelihood of non-point source pollution throughout the length of the creek. The main sources of total coliform are likely to be animal and pet waste, since the only known septic systems in the watershed are in the southwest corner of the watershed within Middletown. These areas, shown on Figure 2-1, drain to the lower creek including only sampling location MMC06. Review of the total coliform data (Tables 2-4 through 2-9 and Appendix C of the Characterization and Assessment Report [Weston, 2007]) indicates that there is no increase in bacteria at MMC06 and that concentrations are fairly high throughout the creek.

As the population within the Many Mind Creek watershed has remained fairly stable and land use has not changed significantly in recent years, the observed impacts to Many Mind Creek and within the watershed are not likely due to recent changes in the landscape. Similarly, the scope for future land use changes is limited and thus unlikely to significantly further affect Many Mind Creek water quality. Therefore, restoration and protection efforts need to focus on changes that

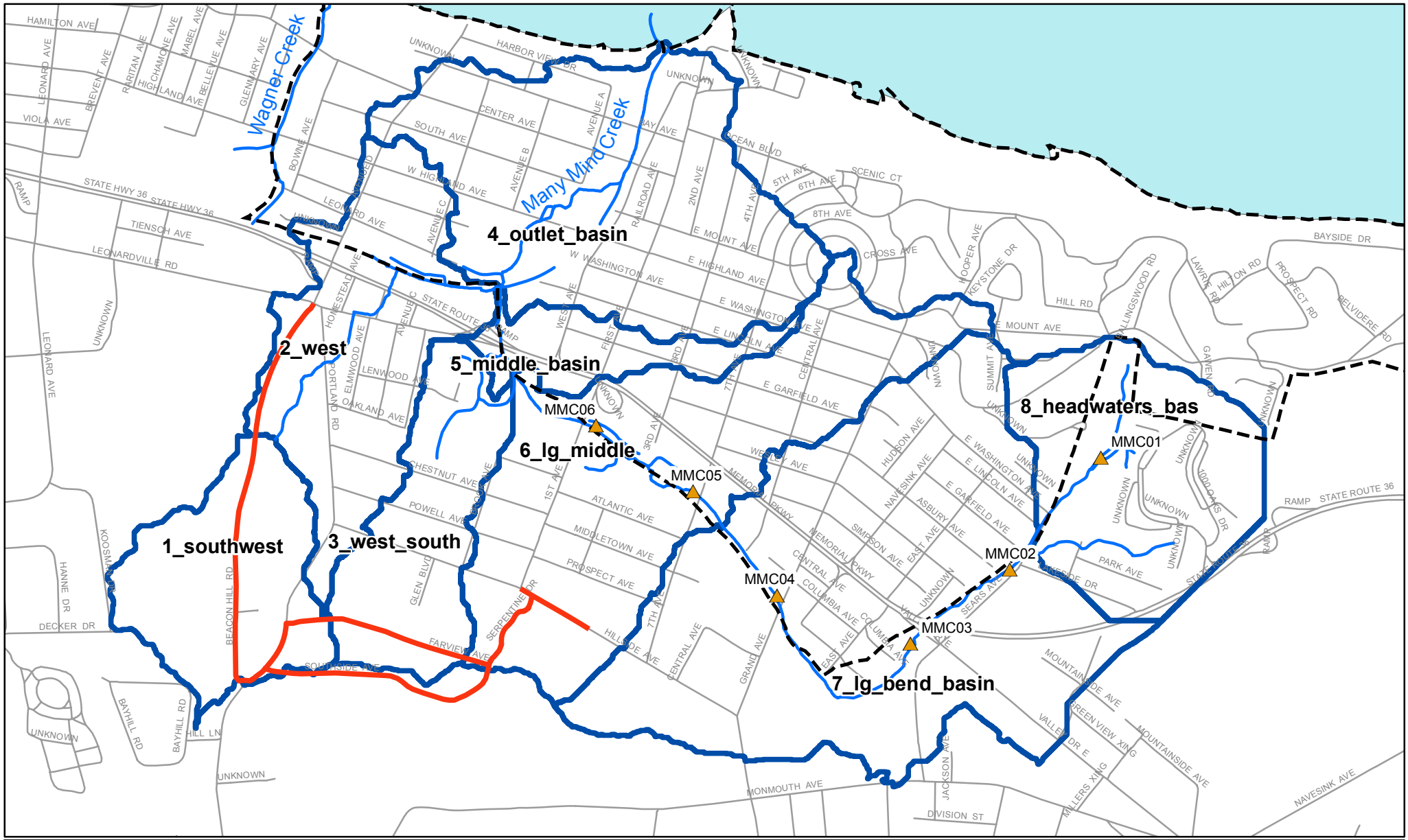

Figure 2-1
SUBWATERSHEDS
MANY MIND CREEK
ATLANTIC HIGHLANDS/
MIDDLETOWN, NEW JERSEY

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can be accomplished within the current land use and environmental framework. This may include a combination of both institutional and structural types of controls.

Institutional controls focus on recommendations and solutions that individuals can control, such as enforcing pet ordinances or utilizing infiltration-friendly landscaping. Structural controls, as the name implies, describe improvements that include the engineering and construction of structures that can help reduce stormwater flow or related impacts (i.e., detention ponds).

The two primary categories of recommendations include 1) reducing or better controlling stormwater flow, and 2) reducing the pollutant loading and sedimentation. A listing of the proposed recommendation within these two categories follows:

A) Reducing or controlling stormwater flow

1) Increased infiltration
2) Pervious surfaces (e.g., increasing retention and detention time)
3) Detention or retention basins
4) Green roof technologies
5) Rain barrels
6) Rain gardens

B) Reducing pollutant loading and sedimentation

1) Bank stabilization and restoration
2) Increased riparian vegetation width
3) Enhanced street cleaning frequency
4) Upgraded pet control measures
5) Stream clean-out

3.0 WATERSHED MANAGEMENT MEASURES

3.1. Potential Benefits from Implementation of BMPs

Significant enhancement of water quality can be achieved by implementing a combination of selected stormwater runoff BMPs listed in Section 2 of this report. Table 3-1 includes reported removal efficiencies for structural BMPs, as reported by the North Carolina Department of the Environment and Natural Resources Stormwater BMP Manual (NCDENR, 2007). Of those BMPs listed, three have been proposed for the Many Mind Creek watershed. The three BMPs that have been modeled for this report include 1) increased street sweeping, 2) infiltration devices, and 3) riparian buffer zones. There are no documented efficiency ratings (and hence no modeling effort) for the other BMPs proposed above in Section 2, however, they are discussed further in Sections 4 and 5.

Table 3-1
BMP Ability for Stormwater Quantity and Quality Control

	Quantity Control	TSS Removal Efficiency	TN Removal Efficiency	TP Removal Efficiency	Fecal Removal Ability	High Temperature Concern
Bioretention	Possible	85%	40%	45%	High	Med
Stormwater wetlands	Yes	85%	40%	35%	Med	High
Wet detention basin	Yes	85%	25%	40%	Med	High
Sand filter	Possible	85%	35%	45%	High	Med
Filter strip	No	25-40%	20%	35%	Med	Low
Grassed swale	No	35%	20%	20%	Low	Low
Restored riparian buffer	No	60%	30%	35%	Med	Low
Infiltration devices	Possible	85%	30%	35%	High	Low
Dry extended detention basin	Yes	50%	10%	10%	Med	Med
Permeable pavement system	No	0%	0%	0%	Low	Med
Rooftop runoff management	Possible	0%	0%	0%	Low	Med

Source: NCDENR Stormwater BMP Manual, chapter revised 7-02-07 (NCDENR, 2007)
Notes:
TSS – Total Suspended Solids
TN – Total Nitrogen
TP – Total Phosphorus

Important non-structural methods for improving water quality include promotion of pet waste control and an increase in street sweeping and litter control. Numerical values for pollutant removal efficiencies for implementation of pet waste controls are not available. Fecal coliform concentrations measured in Many Mind Creek have been found to exceed NJDEP water quality criteria. It is not known whether these exceedances are attributable to human or animal sources. However, it is well documented that pet wastes in residential areas contribute significant amounts of coliform contamination to surface waters (Jiang and Worthington, 2005). It has been estimated that for watersheds of up to twenty-square miles draining to small coastal bays, two to three days of droppings from a population of about 100 dogs would contribute enough bacteria and nutrients to temporarily close a bay to swimming and shellfishing (USEPA, 1993). Pet waste control involves changing public behavior by educating residents about the importance of picking up after pets and providing facilities (i.e., plastic bags and trash receptacles) to facilitate the BMP. Although difficult to quantify, better enforcement of pet waste control measures remains a key recommendation of this study.

3.2. Simulated impacts of non-structural BMPs

Structural BMPs are often not easy to retrofit in existing urban watersheds. Therefore, Weston has focused on simulating the impacts of non-structural BMPs that are best suited for implementation in an urban setting. Three strategies for improving the water quality in Many Mind Creek were simulated in the SWMM model to evaluate their potential benefits:

1. Increased street sweeping
2. Increasing infiltration
3. Riparian buffer restoration

3.2.1. Increased Street Sweeping

Increased street sweeping (from the current frequency of 2-3 times per year) was simulated by assuming the frequency of this activity would be once per month in the following land use categories:

- High density residential
- Commercial/services
- Industrial
- Other urban built-up

The efficiency of increased street sweeping in terms of pollutant removal ranges from 40 to 70 percent for total suspended solids and 20 to 74 percent for total phosphorus (PADEP, 2006). Removal efficiency values of 50 percent for total suspended solids and 25 per cent for total phosphorus were selected for the increased street sweeping simulation in SWMM.

Removal efficiencies are not reported for fecal coliform bacteria. Stormwater runoff from areas used by pets carries coliform bacteria that are associated with solids. Significant numbers of coliform bacteria are known to be associated with particles in stormwater (Schillinger and Gannon, 1982). Removal efficiencies for fecal coliform bacteria were estimated to be half of the efficiency for total suspended solids (Weston, 1994). The removal efficiency for coliform bacteria was estimated to be 25 percent for street sweeping in the above listed land uses.

Increased Street Sweeping: Removal Efficiencies

Parameter	Removal Efficiency (%)
Total suspended solids	50
Total phosphorus	25
Fecal coliform	25

3.2.2. Increased Infiltration

Infiltration devices are typically trenches, swales, or basins that function to reduce runoff volume, recharge groundwater, and have high removal efficiencies for both sediment particles and for pollutants adsorbed onto sediment particles. Infiltration devices typically transfer more stormwater to the soil than any most types of BMPs, and they can be constructed to closely mimic the natural hydrology of an area.

Increased infiltration was simulated within the Many Mind Creek watershed by creating designation that simulated infiltration BMPs for 10 percent of the area in the following land use categories:

- Commercial/Services
- High Density Residential
- Medium Density Residential
- Industrial
- Other Urban Built Up

Infiltration basins and soakage trenches are reported to remove an average of 85 percent of total suspended solids and 60 percent of TP. Porous pavement average removal efficiencies are similar at 71 percent for total suspended solids and 66 percent for total phosphorus (Hallock, 2007). Increasing infiltration has consistently been shown to be an effective means of reducing pollutant loads and overall runoff volumes to surface waters. Increased infiltration can also be accomplished by disconnecting impervious areas within the watershed. Weston assumed that a combination of increased infiltration BMP measures would be implemented and assigned the following removal efficiencies for the infiltration BMPs:

Increased Infiltration: Removal Efficiencies

Parameter	Removal Efficiency (%)
Total suspended solids	70
TDS spell out	25
Total phosphorus	50
Nitrogen	30
Fecal Coliform	86

It is important to note also that increased infiltration could also have a significant affect on reducing the overall volume of stormwater during storm events.

3.2.3. Riparian Buffer Restoration

Riparian buffers provide benefits to water quality and habitat by filtering runoff, providing shade, habitat, and food for benthic and aquatic organisms, and stabilizing creek banks subject to erosion. The vegetation in riparian buffers also performs nutrient uptake, reducing the amount of nitrogen and phosphorus that reaches the stream. Opportunities exist for implementation of this effective BMP, especially in the headwaters basin. However, many areas that could benefit from riparian buffer restoration are bounded by roads or private property, which limits the potential for implementation stabilization and restoration activities.

The following removal efficiencies were applied to the medium density residential land use category in the headwaters basin to simulate further riparian buffer restoration efforts:

Riparian Buffer Restoration: Removal Efficiencies

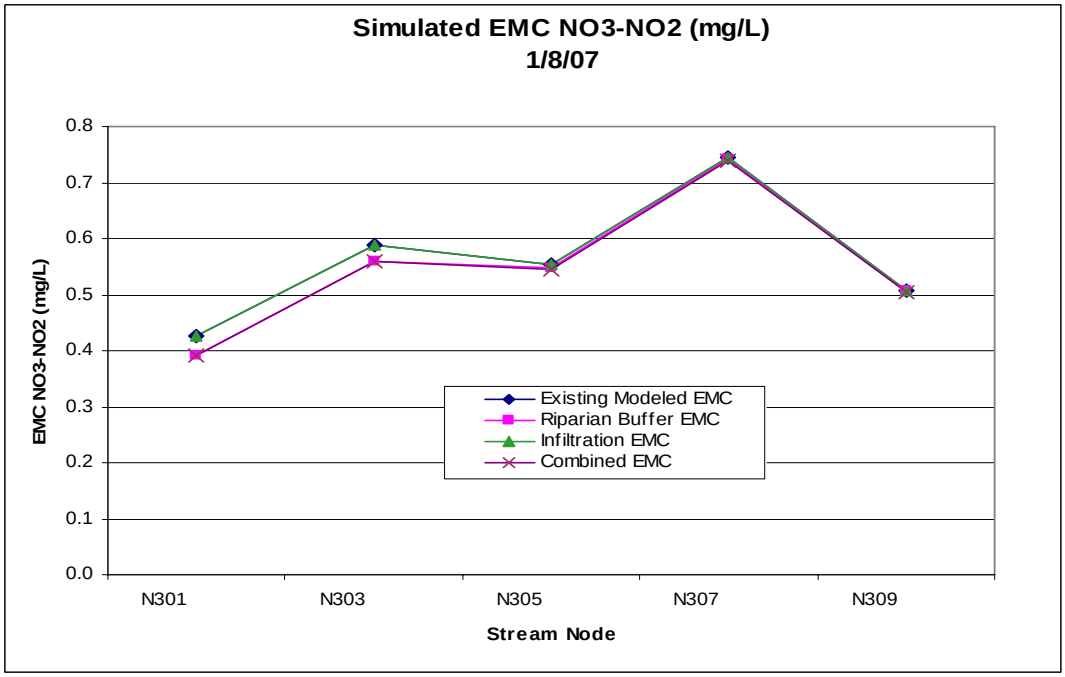
Parameter	Removal Efficiency (%)
Total suspended solids	85
Total phosphorus	85
Nitrogen	50
Fecal Coliform	42.5

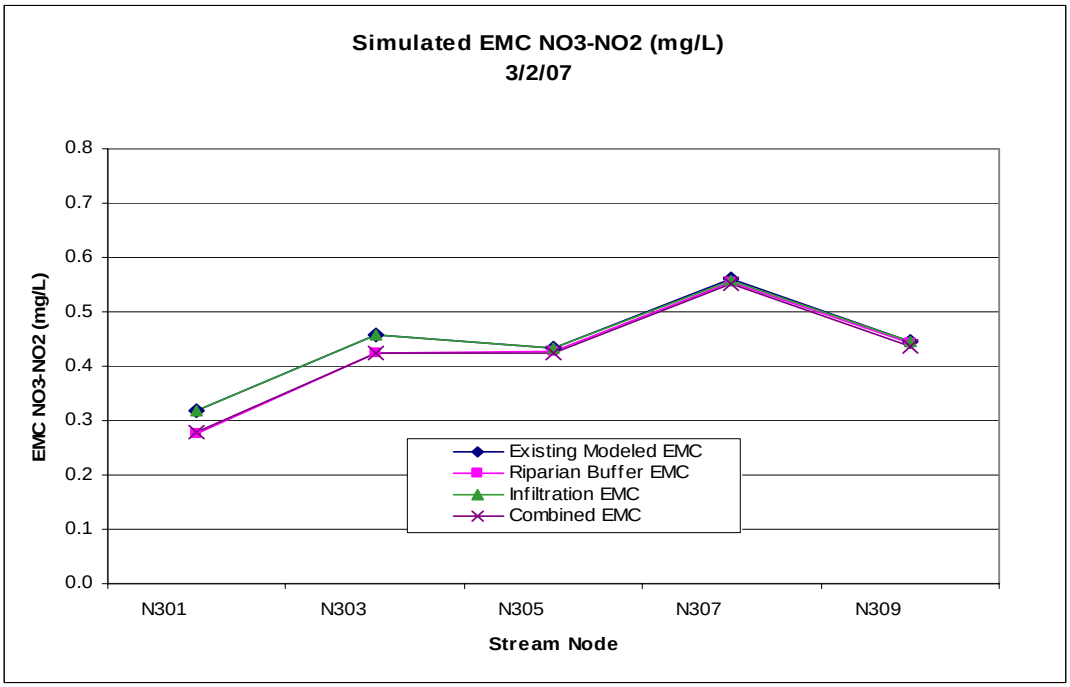
The State of New Jersey recently implemented riparian zone requirements (October 2007) under the revised Flood Hazard Act Rules (N.J.A.C. 7:13). Under the new rules landowners and others will not be able to build, remove vegetation, or disturb soils within 25 feet of the stream without a permit.

3.2.4. Results of BMPs in pollutant removal

This section presents results of the SWMM simulation of implementing the above referenced BMPs. The in-stream concentrations resulting from individual BMPs and from a combined use of BMPs are presented in graphic form for each parameter. Each graph contrasts the impact of the BMP with the original in-stream concentrations. Two storms and their preceding dry weather periods were used to model each parameter and the storm date is indicated in the graph title for each parameter. The results are shown below in graphs for removal of nitrogen, phosphorus, fecal coliform bacteria and total suspended solids, respectively. In each graph, the event mean concentration (EMC) describes the simulated specific pollutant washoff from the land uses within the Many Mind Creek watershed. The X-axis represents the sampling locations on Many Mind Creek starting from location MMC02 (N301) on the left and working downstream towards the right (MMC06 = N309). It should be noted that the most upstream location (MMC01) is not modeled as there is no information for the incoming stream flow. The Y-axis represents the expected concentration of the modeled parameter (in the units noted in the title) at each location.

Nitrogen

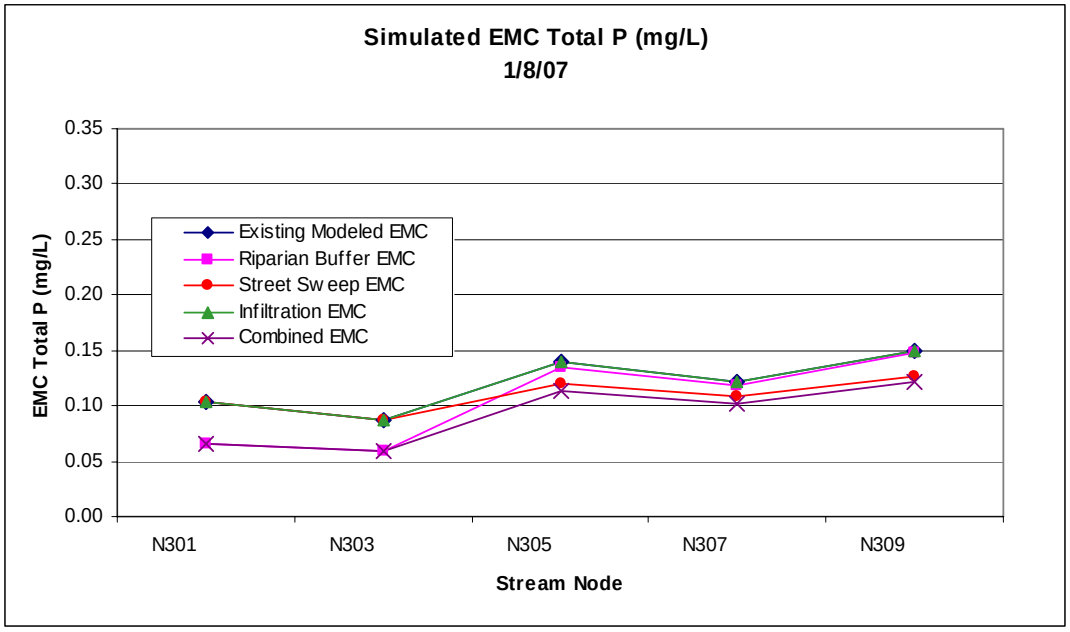


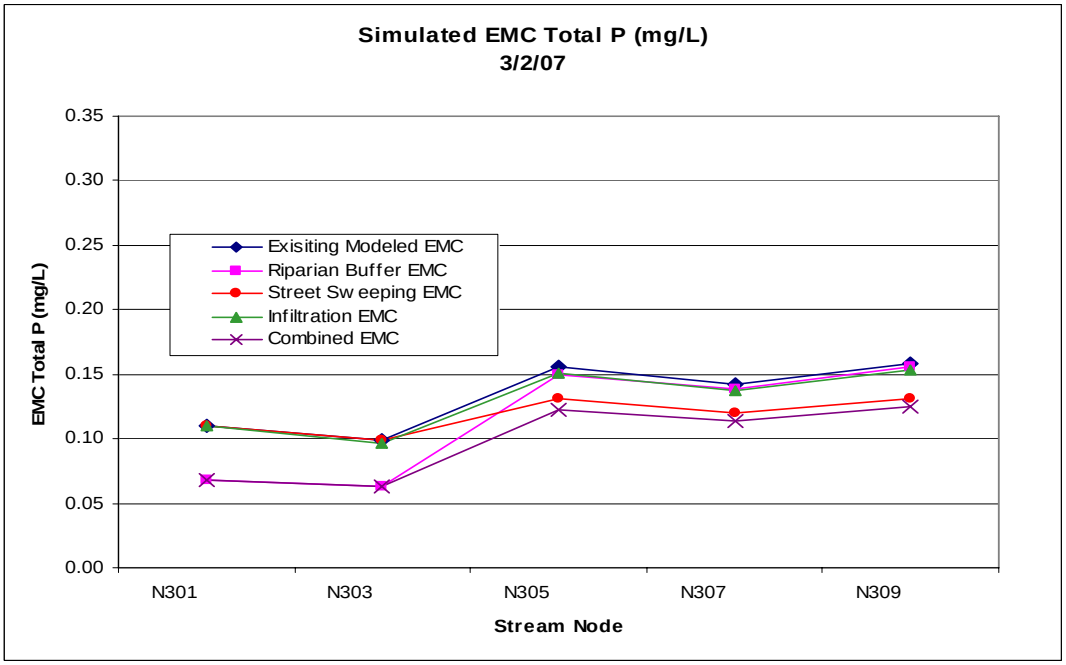


The simulated effect of the BMPs on nitrate-nitrite concentrations in the stream shows that riparian buffer restoration provides the majority of any enhancement to the stream water quality. The effect is diminished in a downstream direction because riparian buffer restoration was only implemented in the headwaters. The graphs of nitrogen removal show the potential for this BMP

if it can be implemented in more segments of the stream corridor. The effect of increased infiltration on nitrate-nitrite levels is not significant. Street sweeping is not included in this simulation because removal efficiencies for nitrate-nitrite are not reported for street sweeping.

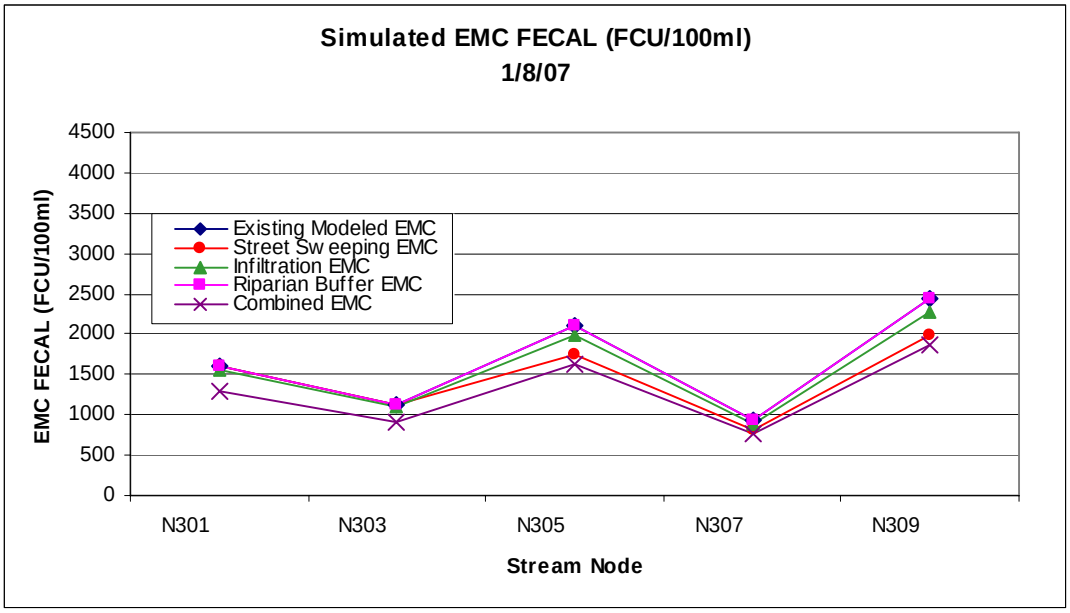
Phosphorus

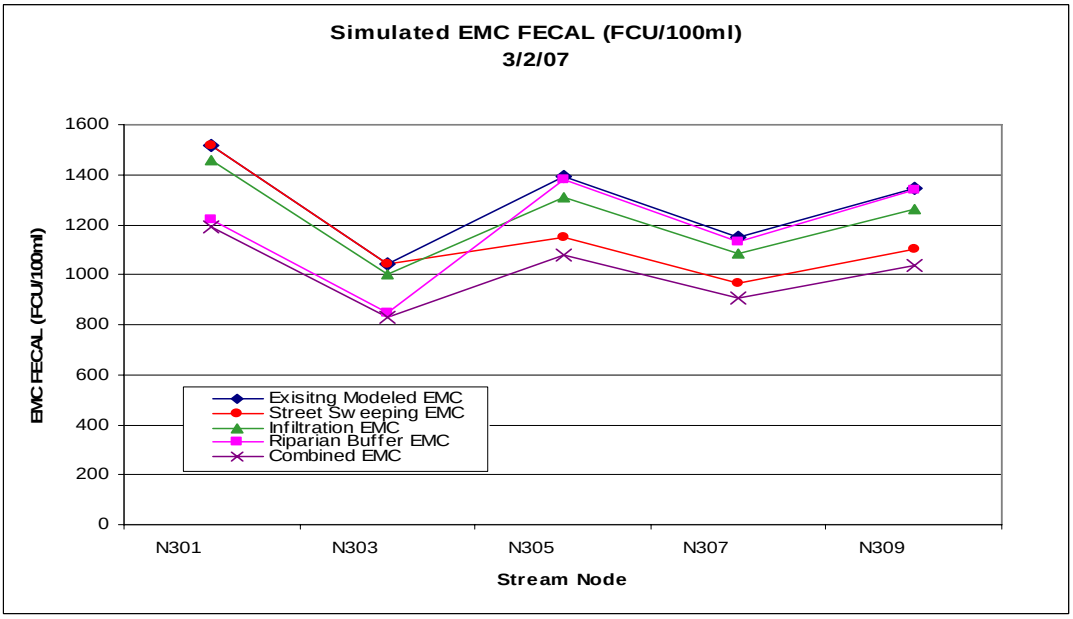




The effects of the simulated riparian buffer restoration on phosphorus removal are evident in the upstream reaches of the stream. The effect of the riparian buffer restoration could be increased by augmenting state regulations in downstream locations. The benefits of street sweeping become evident in downstream locations where high-density residential, industrial, and commercial land uses dominate the watershed. Increased infiltration is not shown to have a significant impact on phosphorus concentrations in the stream.

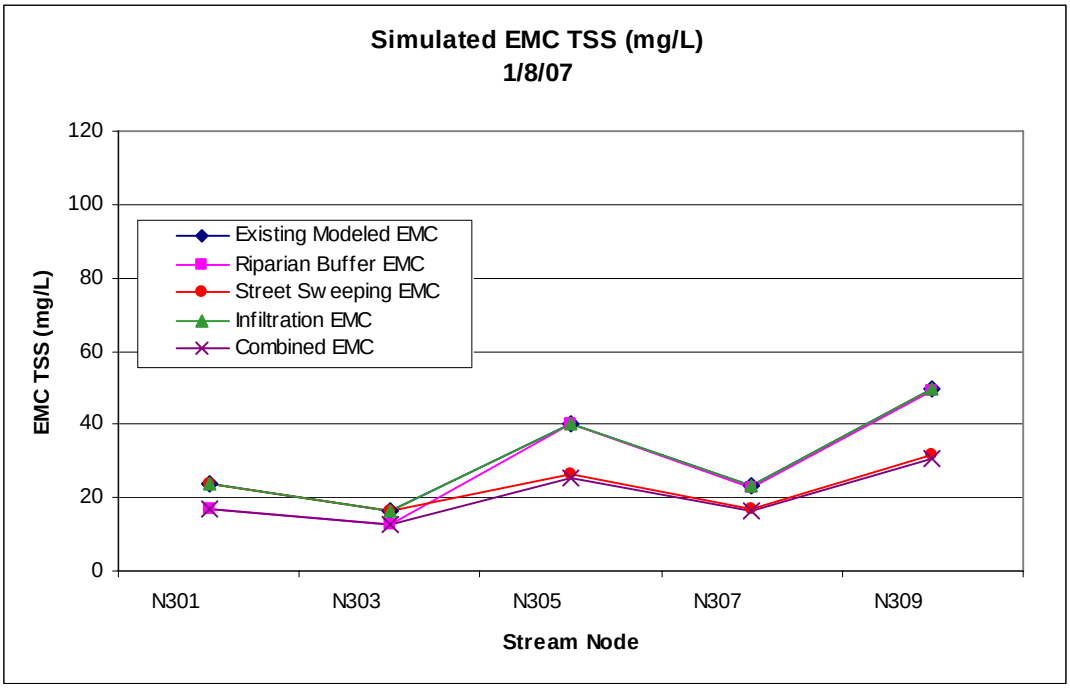
Fecal Coliform Bacteria



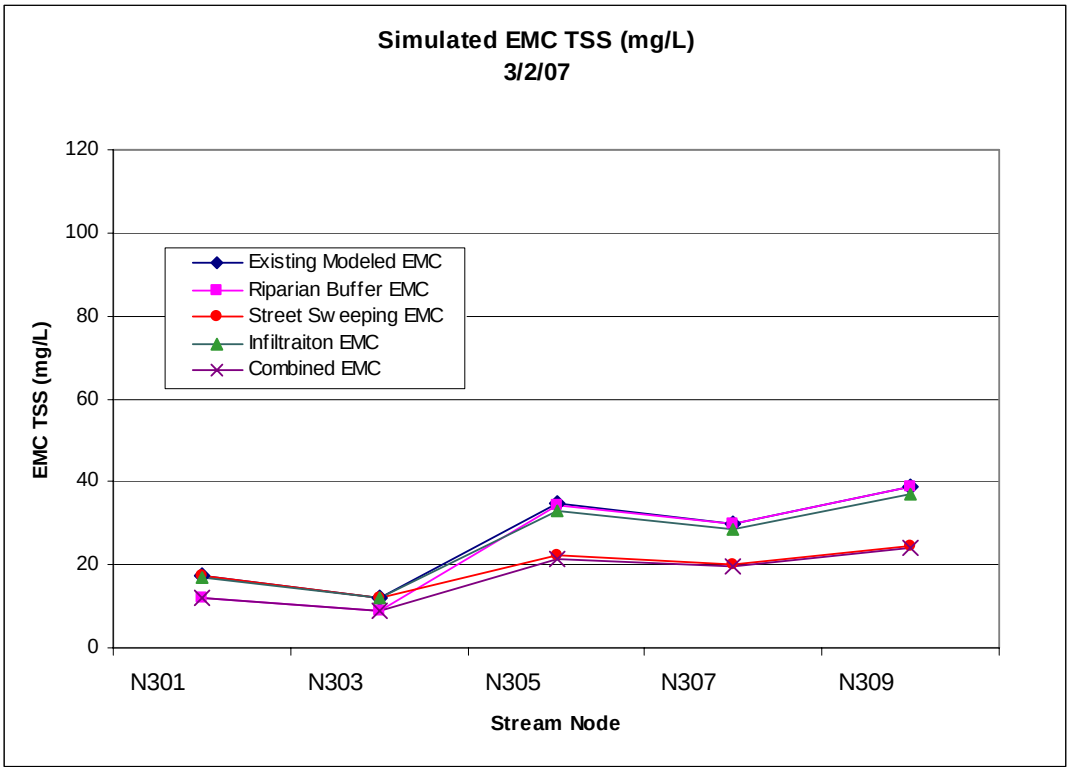


The effect of street sweeping on removal of fecal coliform bacteria becomes evident in downstream locations where high-density residential, industrial, and commercial land uses dominate the watershed. Increased infiltration is shown to have an impact on the fecal coliform bacteria concentrations in the stream in all reaches. Simulating the removal efficiency of riparian buffer restoration for fecal coliform bacteria as half of the reported efficiency for total suspended solids removal produced a significant impact in the upstream reaches where this BMP was specified. The combined effect of all BMPs is significant for removal of fecal coliform bacteria for the length of the simulated stream reach.

Total Suspended Solids



Total Suspended Solids (continued)



Similar to other parameters, the effect of street sweeping on removal of total suspended solids is evident in downstream locations where high-density residential, industrial, and commercial land uses dominate the watershed, and the benefits of riparian buffer restoration are most evident in the upstream reach where it was implemented. Increased infiltration is not shown to have an impact on the concentrations of total suspended solids in the stream.

Overall, the SWMM modeling effort shows that all three of the modeled BMPs show significant decreases in the parameters, however, over different areas of the watershed. Street sweeping has a greater impact in downstream areas of the watershed and primarily helps to reduce the sediment load and to a lesser degree the coliform loadings. Infiltration strips and buffer zones have a greater impact in upstream areas of the watershed. Infiltration strips have the greatest impact on reducing coliform loadings while riparian buffer zones have the greatest overall impact on reductions, including significant reductions in suspended solids, phosphorus, and nitrogen.

4.0 REDUCING OR CONTROLLING STORMWATER FLOW

There are several means of increasing retention and detention time of stormwater within the watershed. These include institutional means, such as acquisition and preservation of open space and ordinances requiring water reuse at facilities that discharge large amounts of water into the stormwater system. Engineering controls are a second means of increasing retention or detention times, and include construction of stormwater detention basins, constructed wetlands and similar means of retaining stormwater.

Because most of the Many Mind Creek watershed has already been developed and very little open space remains along the creek, there are limited opportunities for land acquisition as a means of controlling stormwater flows. As a result, this section focuses on water reuse and detention basins.

4.1. Detention or retention basins

Detention or retention basins are a remedy that are often result in positive and immediate results and are also typically relatively straight forward to design. Furthermore, the impacts can often be monitored directly with immediate feedback on effectiveness. The primary goal of a retention or detention system in this watershed would be to store the significant pulse of stormwater that rushes directly into Sandy Hook Bay, typically carrying a greater pollutant load than under baseline conditions. However, in a well developed watershed such as the Many Mind Creek watershed, there is often limited area and opportunities for significant stormwater control devices such as detention or retention basins.

However, a few opportunities exist where Atlantic Highlands or Middletown may have the opportunity to purchase lands (primarily in the lower watershed) where such structures could be built. One such opportunity exists along Many Mind Creek just down stream of the Seventh Avenue road crossing; here there is a 1.2 acre vacant parcel with 477 feet of creek frontage – Block 85 Lot 1 of Atlantic Highlands. The lot is relatively narrow, contains a significant share of wetlands, and a creek buffer is required; because its buildability therefore seems limited, it might be available for a reasonable purchase price with funding from Open Space Tax Funds. This type of property could serve as a location for construction of a stormwater detention basin,

preservation of the riparian corridor, stabilization of the creek bank, and creation of a creekside trail of the proposed Many Mind Greenway. In principle but subject to professional hydraulic analyses, its location seems suitable for management of stormwater flows that accrue along the upper half of the creek and for reducing flood conditions that occur downstream from the site. A basin there could also reduce pollutant loads arriving there from the upper half of the creek, including runoff from Kara Homes and Highway 36. The primary limitation to this action is the capital requirements for the land and construction of the basin.

Another potential option would be to utilize the current remediation in the lower tidal sections of the creek in the Borough to construct a floodplain area that could more easily absorb stormwater flow and allow some time for solids settlement or pollutant uptake before direct discharge to Sandy Hook Bay. This option has been envisaged in Greenway plans prepared by the Borough Engineer for Borough-owned creekside land south of Bay Avenue, and in restoration plans for the Giuliani tract north of Bay Avenue prepared by the Amy Greene environmental consulting firm. Rutgers University has studied and reported on the hydraulics of this option (Rutgers 2005).

4.2. Increased Infiltration

Designating areas throughout the watershed for increased stormwater infiltration is another example of a method to reduce stormwater flow, which does not require setting aside large tracts of land for construction. The general theory is to provide portions of the landscape where stormwater typically flows overland, and changing the nature of the surface such that some of the stormwater load is allowed to infiltrate into the ground. This typically requires permeable soils that allow stormwater to quickly dissipate into the ground surface before becoming saturated to the point of inefficiency. This recommendation is different from a detention/retention basin as it could spread the load of stormwater control over a large number of smaller infiltration areas, including personal property in the form of rain gardens or infiltration strips. Rain gardens can be a simple and easily implemented BMP for private land owners. Helpful information is available in the Rain Garden Manual for New Jersey (NPSNJ, 2005). Increased infiltration could also be employed on property right-of-ways where stormwater overland flow is noted.

4.3. Pervious Surfaces

Reduction of impervious surfaces and instead installing permeable or pervious surfaces is another potential BMP that can help reduce stormwater flow, increase groundwater recharge and improve water quality. Pervious surfaces can include asphalt, concrete, or even interlocking concrete blocks with soil and grass growing within the voids. These surfaces allow water to pass through the surface into an underlying reservoir (i.e., stones or gravel) that provides temporary runoff storage until infiltration to the subsurface soils can occur. Primary applications for these surfaces are low traffic or parking areas that do not see a high volume of vehicular traffic but have significant areas of impervious surfaces (Hun-Dorris 2005). While the initial cost for these alternative pavement surfaces may be higher than conventional methods, the use of these surfaces can often reduce or eliminate the need for additional stormwater control devices. The actual price of these surfaces can range from $0.50 - $1.00 per square foot for pervious asphalt, $2.00 - $6.50 per square foot for porous concrete and up to $5.00 - $10.00 per square foot for interlocking concrete paving blocks (LID 2007).

In order to stimulate private landowners to implement pervious surfaces, incentives would most likely have to be provided to the landowner. Incentives could be in the form of a property tax cut or other financial savings to encourage implementation or by enacting an ordinance requiring them for new paving work.

4.4. Green Roof Technologies

Green, or vegetated, roofs are yet another stormwater reduction BMP that is gaining popularity as more easy and effective technologies become available. The primary goal of a vegetated roof is to capture and store precipitation. Other benefits include reducing heating and cooling costs for the structure beneath the roof structure, as well as aesthetics. The larger the roof the greater the impact; in a primarily residential area, a number of smaller roof plots could also have an impact similar to one large vegetated roof. Although vegetated roofs can be taken to a number of levels of development, the most straight forward systems require minimal support consisting of only annual weeding and fertilizer application.

To get an idea of potential impact of green roof technologies some assumptions were made using land use information available in the 2000 Our Town's Environment Report (AHEC, 2000).

Approximately 40 acres are designated as commercial land uses. If we assume that roughly 10 per cent of that area consists of actual rooftop area that is amenable to green roof technologies then 4 acres (or 175,000 square feet) of area would be potentially useable for this stormwater reduction method. With an average annual rainfall of 44 inches, some 4,750,000 gallons of rainfall would be captured in green roof systems. Even if we consider that only 10 percent of the rainfall actually becomes runoff, this still amounts to a reduction in almost 500,000 gallons of stormwater runoff per year. Most important, the runoff from these commercial areas is most likely to have the highest industrial pollutant load compared to other land use types. While in and of itself, green roofs may not provide a significant stormwater reduction, when applied along with other means of stormwater control a noticeable impact can be achieved. Of course, getting owners of commercial buildings to retrofit green roofs is not very likely, but the prospects for this in the case of new construction would be different if development regulations are adjusted to encourage it.

4.5. Rain Barrels

An additional recommendation that may help reduce a limited volume of stormwater flow from personal properties is the installation of rain barrels at roof gutter down spouts. Considering that a vast majority of the watershed is occupied by residential properties, there is a large total surface area of roofs that contribute to impervious surface runoff. While many gutter systems drain to lawns where infiltration can occur, a significant portion of drainage systems were observed that drain gutter runoff directly to street curbs and even in some instances directly to Many Mind Creek. This type of recommendation would not necessarily be able to be enforced by Atlantic Highlands and Middletown; however, with education and awareness it could become part of an overall approach for homeowner action.

To analyze potential impact of rain barrels, some assumptions were made using land use information available in the 2000 Our Town's Environment Report (AHEC, 2000). Approximately 400 acres are designated as residential land use in Atlantic Highlands incorporating some 1,800 households (AHEC, 200). If we assume that roughly 10 per cent of that area consists of actual rooftop area some 40 acres (or 1,750,000 square feet) of area would be potentially useable for this stormwater reduction method. With an average annual rainfall of 44 inches, some 47,500,000 gallons of rainfall would be captured in rain barrel systems. Even if

we consider that only 10 per cent of the rainfall actually becomes runoff, this still amounts to a reduction in almost 5,000,000 gallons of stormwater runoff per year. This illustration shows the high end potential for potential stormwater reduction with only a relatively small cost ($50 - $100) per household.

5.0 REDUCING POLLUTANT LOADING AND SEDIMENTATION

As noted previously, habitat disturbance in Many Mind Creek appears to be correlated with impervious cover in the watershed as well as a decrease of vegetated buffers and resulting increased bank erosion, sedimentation, and pollutant loading in the watershed. Overall, it is clear from the characterization and assessment of the Many Mind Creek watershed that stabilizing the eroding banks, reducing sedimentation, and reducing the pollutant (primarily fecal coliform) loading are primary concerns within the studied portions of Many Mind Creek. Four primary potential recommendations that have been identified throughout the characterization and assessment of the Many Mind Creek watershed include:

- Bank stabilization/restoration
- Increased riparian vegetation width
- Enhanced street cleaning frequency
- Upgraded pet control measures

Two specific recommendations for the creek that focus on both reducing pollutant loading and reducing sedimentation are bank stabilization or restoration and an increase in stream buffer or riparian vegetation width. These two recommendations have both physical as well as aesthetic results and can have a long-term impact on water quality with a relatively minimal one time implementation cost.

5.1. Bank Stabilization/Restoration

As presented in the Characterization and Assessment Report, there are a number of areas along Many Mind Creek where steep and unstable or unvegetated banks are and will continue to erode and release additional sediment to the creek. There are a number of straight forward bank stabilization methods that would help eliminate this situation. In addition to reduced sedimentation, another primary impact of bank stabilization and restoration would be to allow for a buffer along the streams to intercept direct storm flow and potentially a portion of the pollutant loading.

Much of these areas are bounded by roads or private property structures which constrain the potential options for redirecting slopes or channels. The areas most in need of such improvement are areas of the creek along Sears Avenue and downstream of where the creek passes beneath

Route 36 (at sampling location MMC03), Grand Avenue, and 7th Avenue. In addition, there are numerous opportunities for vegetative solutions that would include the removal of invasive plant species (i.e., Japanese knotweed); these species may provide cover but do not necessarily provide the root structure that can stabilize soils along the bank over a long-term period. Knotweed is notoriously difficult to eradicate, requiring extensive digging and application of an appropriate herbicide.

One of the most simple and cost-effective methods for bank stabilization or restoration is the installation and planting of native riparian plant species in unvegetated areas. This method is actually the most feasible for Many Mind Creek as the primary need is to help stabilize the exposed and eroding bank areas and reduce the sediment load being contributed to the creek. This form of bank stabilization can be conducted in a relatively cost-effective manner if volunteer labor (e.g., local scouting or 4H groups, educational interest or student groups) are utilized for physical work. As such the primary costs include design planning and the actual purchase of live plants for installation.

5.2. Increased Riparian Vegetation Width

As noted above with respect to bank stabilization and restoration, increased buffer areas in the riparian corridor can have multiple impacts on the reduction of both stormwater flow and pollutant loading. Riparian or stream buffer zones are also recognized for their ability to perform a variety of functions other than water quality. These functions include providing erosion control by regulating sediment storage; stabilizing stream channels; serving as nutrient sinks for the surrounding watershed; reducing flood peaks; and serving as key recharge points for renewing groundwater supplies. They can also have the impact of creating better habitat within the stream by increasing shade which can decrease temperatures, providing greater sources of allochthonous (organic) material which benthic macroinvertebrates depend on, and reducing the inorganic sediment load.

The Development Regulations of Atlantic Highlands provide for riparian buffers: “No structure shall be located within fifty feet (50') of any natural waterway unless protective measures are taken, which in the opinion of the Borough Engineer, will not increase the likelihood of silting or flood damage at any point along said waterway” (paragraph 7.7.D.3). However, the regulation is

incomplete: it understates the value of buffers, covers only two of the several problems that buffers reduce or eliminate (silting and flood damage), fails to indicate what types of protective measures may be suitable, does not rule out the replacement of destroyed or decaying structures that already exist in buffer zones, and only invokes general engineering skills rather than hydrological/hydraulic expertise for assessing buffer questions.

More fundamentally, since development regulations only pertain to new construction, what is missing is an ordinance that would govern how, under existing conditions, creekside lands should be vegetated, preserved and maintained so as to achieve all the benefits that riparian buffers provide. For example, such an ordinance could include zoning provisions and maps that identify current and potential 50-foot stream buffers, protection of buffer zones by prohibiting removal of their vegetation, and incentives and encouragement for creation of 50-foot buffers in additional locations.

It should be noted that the proposed Many Mind Creek Greenway is supposed to provide a vegetated buffer at least 50 feet wide wherever possible, protection of wetlands to aid in flood control and habitat and water quality preservation, as well as recreational, aesthetic and neighborhood-connecting values for residents.

The NJDEP recommends a stream buffer of at least 50 feet, as provided in the Borough's development regulations. While this is not possible in all locations, some buffer is better than none, and stream buffers with the function of protecting or improving water quality can be effective starting at only 12 feet wide (USACE, 2000).

Although much of the land bordering Many Mind creek is privately owned, through education and awareness, individual homeowners can become part of the overall solution through their own action. It may be advantageous to encourage interest among creek-side property owners in providing native plant species along with a volunteer group to help install native riparian vegetation in areas currently bare or infiltrated with invasive species.

Overall, bank stabilization and creek buffers are both highly recommended and potentially cost-effective opportunities for protecting and improving water quality within Many Mind Creek that can and should include local landowners as well as volunteers and local action groups.

5.3. Enhanced Street Cleaning Frequency

Street cleaning has been shown to have a significant impact on both the quality and quantity of stormwater runoff (EODPW 2005). Atlantic Highlands and Middletown both have regular street cleaning schedules. They have also tightened the timetables for placement and collection of curbside leaf and brush to avoid clogging of stormwater drains. The recommendation is for both municipal services to conduct street cleaning more frequently, especially during times of greater potential for stormwater flow. There is also a need for more awareness of residents concerning the stormwater drainage impacts and appropriate handling of the leaves, lawn litter and brush that they leave for curbside pickup. This element should be included in the overall homeowner education and awareness plan.

5.4. Upgraded Pet Control Measures

Pet waste can be a major source of fecal coliform pollution loading (Washington State Department of Ecology 2005). Pet control ordinances are already in effect in both towns. In Atlantic Highlands it is promoted by signage in some high concentration areas and provision of "Mutt Mitt" boxes at the marina, the Avenue A beach, and Lenape Woods Nature Preserve; however, enforcement is weak and no violations or notices have been issued in recent years. The potential impact of fecal coliform contamination by animal waste can be addressed by targeting or expanding inspections of high pet concentration areas, to be followed by expanded enforcement. Further increasing the public education and awareness of the issue of pet waste as a pollution source could also be a cost-effective method the reducing the fecal coliform loading within Many Mind Creek.

5.5. Stream Clean-out

Another potential measure for improving stream water quality is to remove sediment from areas of the stream where flow is unduly restricted by culverts or other blockages. In addition, removal of coarse debris could help flows during storm events and help alleviate flooding and further bank erosion. Since effects would be primarily short-term in nature, a schedule for regular maintenance needs to be established. Before deciding on clean-out, care must be taken to assess downstream effects, especially to ensure that flows will not be so speeded up/increased in volume as to cause additional erosion.

6.0 LAND USE AND RESOURCE PLANNING AND PROTECTION

An important focus for the Many Mind Creek watershed is related to future land use and resource planning where regulatory planning efforts should be based on a rationale that takes into consideration at least some of the more critical issues affecting the Many Mind Creek watershed. A listing of some of these issues follows:

Municipal Planning – During planning periods when municipal plans (i.e. Master Plan) are reviewed, consideration should be given to the inclusion of additional zoning provisions and maps that identify current and potential 50-foot stream buffers, as noted above. If intact, 50-foot stream buffers should be protected. In the case where 50-foot stream buffers do not currently exist but may be created, a mechanism should be enacted to provide incentives for adopting this practice.

Another example of incorporating watershed protection into Master Planning is the recent inclusion of Leadership in Energy and Environmental Design (LEED) system standards for buildings within the 2007 revision of the Borough's Master Plan. A number of the LEED specific designs that are available for incorporation can have a direct impact on stormwater (i.e., rainwater use or infiltration rather than direct channeling to stormwater systems), water minimization, and water efficiency, all of which reduce the overall load on water infrastructure. Adoption of LEED-based structures or renovation can only help as part of the overall watershed management solution.

Municipal Ordinances – A tree protection ordinance is a prime example of an ordinance that can work in concert with other planning provisions (i.e., 25-foot stream buffers). While a tree ordinance already exists within the Borough as part of the Steep Slopes Ordinance (Borough Ordinances section 7.33), an additional ordinance for tree protection along stream buffers within the Borough and Middletown could provide a successful and justifiable solution to increased riparian corridor protection and erosion protection, while limiting the regulatory burden that would be caused if town-wide tree protection were mandated. The benefits of treed riparian corridors are numerous, including precipitation storage and retention, control and reduction of stormwater, and soil stabilization, not to mention the bird and wildlife habitat, temperature

moderation, oxygen generation, and visual buffering that trees provide.

Watershed-Based Planning Education - As new officials are appointed and elected to certain positions in the Borough and Middletown, they could benefit from orientation about the issues and methods involved in land and water resources protection and watershed-based planning. For example, this can take the form of workshop sessions for members of the Township Committee or Borough Council and the Planning Board, as well as key staff members. In addition, creekside landowners and other residents in the Many Mind Creek watershed could be invited to such workshops.

Public Education and Environmental Outreach – Consistent education and outreach is required to inform the public about the condition of the creek and watershed as well as the opportunities to assist in its protection and restoration. In Atlantic Highlands, such activities conducted by the Environmental Commission have included installing anti-pollution disks on storm drains with anti-pollution warnings, a town-wide mailer on stormwater management and non-point source pollution, watershed-related information dissemination at annual Earth Day and Waterfront Day events, and greenway visioning, brainstorming and planning with the special Friends of Many Mind Creek group. The Borough administration also engaged in public information outreach, as well as enforcement, to limit the period when residents deposit leaves for pick-up so as to reduce storm drain clogging and infiltration of organics.

The "river friendly program" of the Manasquan River Watershed Association can be used as a model for getting residents to buy into BMPs that can be implemented on their own land (www.manasquanriver.org/RiverFriendlyList.doc). This program is well designed, easy for residents to participate in and is an effective means by which to transmit a wide array of watershed friendly tips and tricks. In fact, a recent study by the Center for Watershed Protection (CWP, 2008) documented that water-conserving landscapes can save up to 40% of water usage in a year.

7.0 SELECTION AND IMPLEMENTATION OF MEASURES

7.1 Evaluation of Effectiveness and Costs of Alternatives

Table 7-1 provides an overall summary of the stormwater reduction recommendations along with a discussion of the estimated cost, logistical issues, overall feasibility and potential impact. The list of BMPs presented in this Watershed Restoration and Protection Plan are provided in this table and are broken down by the two general categories of reducing stormwater flow and reducing pollutant loading or sedimentation. In general the recommendations with the highest overall impact and feasibility are those where the most importance should be focused. This includes evaluation of locations for increased infiltration (vegetated strips), pervious surfaces, bank stabilization, riparian or buffer zone increases, and stream cleanouts.

7.2 Prioritization of Preferred Alternatives

Based upon a review of Table 7-1, a prioritization ranking of the overall recommended BMPs has been identified for stormwater flow reduction, as well as pollutant loading and sedimentation reductions. This prioritization ranking takes into account the estimated cost to implement, the overall feasibility and resultant impact, as well as the logistical issues that may impede implementation.

7.2.1 BMPs for the Reduction or Control of Stormwater Flow

1. Public Education Programs - Water conserving landscapes or rain gardens can easily be implemented by private landowners throughout the watershed with little cost. Volunteer efforts to organize training sessions or distribute information would be the primary cost.

2. Rain Barrels – These can be made available to private landowners throughout the watershed as well as utilized at municipal buildings. There is a small individual cost of entry, although bulk purchase could reduce cost.

3. Increased Infiltration – Could most effectively be constructed as right-of-way infiltration swales along roadways along the creek or also by private landowners in the form of rain gardens throughout the watershed.

4. Pervious Surfaces - Atlantic Highlands and Middletown could provide incentive for private landowners or businesses throughout the watershed to install these surfaces instead of standard impervious surfaces. Atlantic Highlands and Middletown could also look to utilize them at municipal facilities.

Table 7-1
Recommendations Cost, Logistics and Feasibility Matrix
Many Mind Creek, Atlantic Highlands and Middletown, New Jersey

Recommendation	Estimated Cost Range	Logistical Issues	Overall Feasibility	Overall Impact
Reducing or Controlling Stormwater Flow				
Public Education Programs (i.e., Water conserving landscapes, rain gardens)	Little to any costs beyond volunteer labor. Well established programs already exist (River Friendly Program)	Providing incentive or stimulus for public participation	Moderate	Low to moderate depending on overall participation
Rain Barrels (i.e., make them available to private landowners, utilized them on municipal buildings)	$50 - $100 per barrel	Need a large number of participants to be able to affect the amount of stormwater flow into the watershed. Need to ensure rain barrels have lids to prevent mosquito breeding	High	Low (Due to anticipated small volume treated with low participation)
Increased Infiltration (i.e., right-of-way infiltration swales, private landowner rain gardens)	$1,000 - $5,000 per application	Few opportunities in a developed watershed for land purchasing or construction of filter strips. More opportunity for rain gardens, but less impact	High effectiveness but low availability of opportunities	Moderate
Pervious Surfaces (i.e., provide incentive for private landowners or businesses to use, utilize at municipal facilities)	Similar to existing asphalt paving costs	Would need wide scale application to have an appreciable impact on stormwater quality; Borough would likely need to provide positive (tax credits) or negative (ordnance requirements) to encourage use. Application constrained to lower traffic areas (driveways, parking lots).	Moderate	High
Green Roof Technologies (i.e., provide incentives for private landowners to install, or utilized on municipal buildings)	$8-$20 per square foot, including installation	Need a large number of participants to be able to affect the amount of stormwater flow into the watershed.	High if done on new construction; low if to be retrofitted	Low (Due to small number of landowners likely to participate without incentives)
Detention or Retention Ponds (i.e., further investigate potential of acquiring properties described in Section 4.1 for construction)	Land acquisition - >$100,000 Basin design and construction - $10,000 - $100,000	Land acquisition and availability of space within the watershed Permitting Design and construction Long-term maintenance, safety and aesthetic issues	Low (High cost, limited locations for installation)	High

Table 7-1 (continued)
Recommendations Cost, Logistics and Feasibility Matrix
Many Mind Creek, Atlantic Highlands and Middletown, New Jersey

Recommendation	Estimated Cost Range	Logistical Issues	Overall Feasibility	Overall Impact
Reducing Pollutant Loading and Sedimentation				
Public Education Programs (i.e., reduced lawn maintenance and fertilizing)	Little to any costs beyond volunteer labor. Well established programs already exist (River Friendly Program)	Providing incentive or stimulus for public participation	Moderate	Low to moderate depending on overall participation
Stream Clean-out (i.e., targeted at road crossing constrictions – Grand Ave, Seventh Ave, First Ave.)	Municipal costs Potential volunteer labor	Requires state permit Needs to be repeated regularly to be effective	High	Moderate Facilitates flow but unlikely to impact water quality significantly
Bank Stabilization /Restoration (i.e., locations of focus include along Sears Ave, downstream of MMC03, as well as upstream and downstream of Grand Ave, Seventh Ave, First Ave. road crossings)	Low end is $1,000 - $10,000 per application, depending on its size and purpose, and use of volunteers	Overall effectiveness increases with amount of bank stabilization	Moderate	High
Increased Riparian Vegetation Width (i.e., homeowner buffer construction, conservation easements, or municipal designation)	Costs related to land acquisition, loss of tax revenue from easements if required, and possible planting of vegetation in currently non-vegetated areas.	Municipal regulatory environment Physical constraints Need ordinance requiring conservation easements in the riparian zone	Moderate	High
Upgraded Pet Control Measures (i.e., increase awareness and enforcement)	None	Municipal regulatory environment: ordinances exist, enforcement needed	Moderate	Moderate (May address fecal coliform if it turns out to be animal-related)
Enhanced Street Cleaning Frequency (i.e., establish minimum frequency with increases in fall)	Municipal costs	Municipal regulatory environment	Moderate	Low (May reduce sediment loadings, but would not impact flows causing scouring)

5. Green Roof Technologies - Atlantic Highlands and Middletown could provide incentives for private landowners throughout the watershed to install, or utilize them on municipal buildings when appropriate.

6. Detention or Retention Ponds – As described in Section 4.1, Atlantic Highlands and Middletown should further investigate potential of acquiring properties along the creek for the purposes of constructing detention/retention ponds.

7.2.2 BMPs for the Reduction of Pollutant Loading and Sedimentation

1. Public Education Programs – Reductions in lawn maintenance and fertilizing can easily be implemented by private landowners throughout the watershed with little cost. Volunteer efforts to organize training sessions or distribute information would be the primary cost.

2. Stream Clean-out - Targeted clean-outs at Grand Ave, Seventh Ave, and First Ave.road crossing constrictions where blockages to flow exist and significant amounts of debris accumulate.

3. Bank Stabilization/Restoration – Specific locations of focus include areas along Sears Avenue, downstream of MMC03, as well as upstream and downstream of the Grand Avenue, Seventh Avenue, First Avenue road crossings.

4. Increased Riparian Vegetation Width – This could be accomplished through homeowner buffer construction, conservation easements, or municipal designation.

5. Upgraded Pet Waste Control Measures – While already in place, an increase in awareness and enforcement could help strengthen this BMP.

6. Enhanced Street Sweeping Frequency – While already in place, establishing a minimum frequency along with increases in fall, when fallen leaves and other debris can quickly clog stormwater drains, can produce effective reductions in debris transport.

7.3 Implementation Schedule

Based on the variety of proposed recommendations, it may be difficult to provide a schedule for implementation. However, as a starting point, those recommendations with relatively easy entry and high degree of feasibility (evaluation of green roofs and rain barrels, and stream clean out) should be implemented in the first year. Also in this first year, the feasibility of the recommendations with a moderate feasibility (primarily those with municipal government requirements) should be evaluated. Based on the regulatory environment, it could be anticipated that it may take from three to five years to be able to enact the recommendations with planning or construction components (e.g. infiltration strips, riparian buffer zone ordinances, stormwater

basin design and construction). However, it is recommended that the proposed monitoring efforts be implemented prior to the commencement of any of the recommendations so that an evaluation of their effectiveness can be monitored and documented.

7. 4 Implementation Monitoring

In order to evaluate the effectiveness of the implementation of the recommended actions over time, a Many Mind Creek surface water monitoring program is recommended. This effort could certainly be conducted by volunteers or students already engaged at Monmouth University or Brookdale College. The monitoring program should be geared as such towards periodic sampling to evaluate the water quality over time, for both the steady-state system as well as during high flow events. The basis for a proposed plan would be to monitor the same six sampling locations during two dry or low flow conditions and two wet or high flow conditions annually, ideally spread throughout the year. Based on the results of the Characterization and Assessment Report, the parameters of focus should at a minimum include fecal coliform, nitrate and nitrite, total phosphorus and total dissolved solids, as well as flow volume calculations and water quality parameters such as dissolved oxygen, temperature, conductivity, and pH. The criteria for evaluating these parameters would continue to be the surface water standards currently promulgated by the NJDEP. In addition, the base of data collected during the baseline watershed assessment will be available as a start to long-term monitoring efforts.

If volunteer labor is utilized, the only costs associated would be for technical analysis of the parameters. Based on current laboratory costs, the full suite of parameters could cost $150 per sample times six sites, or $900 per round. Alternatively, the educational institutions that worked on the project (Monmouth University, Brookdale College) may have the capacity to run some or all of theses analyses themselves, reducing overall costs as well as providing increased educational opportunities.

8.0 CONCLUSIONS AND PLAN IMPLEMENTATION

This Watershed Restoration and Protection Plan provides a framework for improving non-point source water quality within the Many Mind Creek watershed. It meets the requirements for a watershed management plan as follows:

a. The Characterization and Assessment report (Weston, 2007) identified the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan and to achieve any other watershed goals the plan identifies. Sources that need to be controlled include suspended sediments in stormwater that lead to high total dissolved solids concentrations in the creek, and fecal coliform, which exceeds NJDEP criteria at several locations in the creek.

b. An estimate of the load reductions expected for the BMP measures described have been provided (Section 3.0), and demonstrate that several of the proposed BMPs (street sweeping, infiltration strips and riparian buffer zones) would be effective in improving stream water quality.

c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions has been provided (Sections 4.0 and 5.0). Based on modeling results, it is apparent that the most effective load reductions can be achieved by the following BMPs in decreasing order of importance: riparian buffer zones, street sweeping and infiltration strips. The model results also indicate that within the upper watershed, riparian buffer zones would be most effective and that street sweeping would be most effective in the lower watershed.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan is provided in Section 7.0. Possible sources of funding include additional Section 319(h) Programs, the New Jersey Environmental Infrastructure Trust, the New Jersey Corporate Business Tax Program, U.S. Department of Agriculture's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. Numerous informational/educational components have been described as a suggested means of enhancing public understanding of the project and encourage the public's early and continued participation in selecting, designing, and implementing the NPS management measures that could be implemented. The information/education component of the plan incorporates better integration of the community into the watershed management process.

f. A proposed schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious has been provided in Section 7.0, covering a three-to-five-year period.

g. A description of interim, measurable milestones for determining whether the proposed NPS management measures or other control actions are being implemented is provided in Section 7.0

h. The criteria that are proposed for use in determining whether loading reductions are being achieved over time are the NJDEP water quality standards. These would be used in any future monitoring efforts should the Borough be successful in implementing the recommended BMPs. The Many Mind Creek watershed is too small to warrant calculation of a total minimum daily load (TMDL).

i. A monitoring component (as described in Section 7.0) has been included to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above (NJDEP, 2005).

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