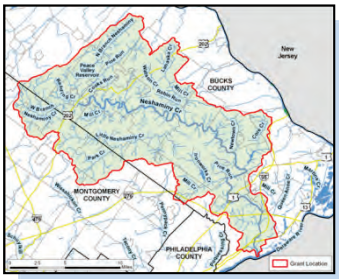
NESHAMINY CREEK WATERSHED
SEDIMENT REDUCTION PLAN
FOR MUNICIPAL IMPLEMENTATION

BUCKS AND MONTGOMERY COUNTIES, PENNSYLVANIA



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Pennsylvania Coastal Zone Management Program

FINAL REPORT

"Neshaminy Creek Watershed Sediment Reduction Plan

For Municipal Implementation"

March 2014

CZM PROJECT NUMBER: 2012.PD.05

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pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PENNSYLVANIA COASTAL ZONE MANAGEMENT PROGRAM

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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Numerous individuals, municipal officials and staff, and engineering firms committed their time and expertise to complete the project (they are listed in Appendix 6). We are grateful for their interest in preserving the Neshaminy Creek.

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Neshaminy. *The name of a creek which enters the Delaware (River) in Bucks County; also the name of a village in the same county. A corruption of Nischam–hanne "two–streams" or "double stream," signifying a stream formed by the joining of two branches. …The creek is mentioned in the first Deed of land from the Indians to William Penn, in 1682, and is also mentioned in six other Deeds from 1683 to 1697.*

~ Excerpted from:

A History of the Indian Village and Place Names in Pennsylvania,

By Dr. George P. Donehoo

Wennawoods Publishers, Lewisburg, PA, 1999

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EXECUTIVE SUMMARY

INTRODUCTION

This *Neshaminy Creek Watershed Sediment Reduction Plan* has been developed in accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES).

The NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man–made ditches. Permits regulate discharges with the goals of 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater.

Second generation NPDES permits (PAG–13) require any regulated MS4[1] municipality that discharges to an impaired waterway with a Total Maximum Daily Load (TMDL)[2], to develop, implement, and enforce a MS4/TMDL plan that will achieve the pollutant reductions consistent with the Pennsylvania Department of Environmental Protection's (PADEP) TMDL report. Federal regulations also require that any PADEP–designated impaired waterway must have a TMDL developed. PADEP finalized the Neshaminy Creek watershed's TMDL in December 2003 in a report titled *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania*.

The primary goal of the *Neshaminy Creek Watershed Sediment Reduction Plan for Municipal Implementation* (this document, "the Plan") is to synthesize a watershed–wide plan to both address those impaired waterways for the Neshaminy Creek watershed (Figure A2, Appendix 1), as well as comply with the established TMDL. In addition, to ensure that the proposed Plan will be accepted for implementation by both State and Federal agencies, this Plan addresses the nine elements of a comprehensive watershed plan as identified by US EPA.

[1] The stormwater requirements of the federal Clean Water Act are administered under the Pennsylvania Department of Environmental Protection's Municipal Separate Storm Sewer (MS4) Program. A MS4 is a conveyance or system of conveyances that is: 1) Owned by a state, city, town, village, or other public entity that discharges to waters of the Commonwealth; 2. Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.); 3. Not a combined sewer; and 4. Not part of a Publicly Owned Treatment Works (sewage treatment plant).

[2] A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

The Plan identifies additional efforts needed by a municipality to help fulfill the TMDL sediment reduction baselines. In addition, the Plan establishes guidelines for municipalities to implement sound water and land use practices to reduce sediment loads to surface waters, to control the amount of runoff resulting from existing development.

WATERSHED DESCRIPTION

The Neshaminy Creek watershed is situated in southeastern Pennsylvania and encompasses 232 square miles. The watershed, located in Bucks and Montgomery counties, Pennsylvania crosses through 41 municipalities before discharging into the Delaware River in lower Bucks County (Figure A1, Appendix 1). The watershed is comprised of approximately 24 percent developed land, 38 percent agriculture, 36 percent wooded and 2 percent other. There are approximately 418 miles of streams within the watershed, 203 of which have been included on Pennsylvania's 303(d) list[3] for aquatic life impairments.

METHODOLOGY FOR STUDYING THE HYDROLOGY OF THE WATERSHED

The use impairments within the Neshaminy Creek watershed have been documented to be caused by elevated point source loadings of phosphorus during baseflow and elevated sediment loading related to non–point source loading during storm events. The Pennsylvania Department of Environmental Protection's (PADEP) 2003 watershed–wide TMDL analysis focused on total suspended solids (TSS) as the pollutant of primary concern while other pollutants are of concern in select areas of the watershed. The TMDL analysis revealed that 75.5 percent of sediment loading has been found to be attributable to streambank erosion while the remaining is attributable to upland erosion and runoff. This pattern has been intensified due to changes in watershed development over the past ten years which has seen a 20 percent increase in developed land.

Four criteria will be used to determine the necessary loading reductions associated with the implementation of the recommended projects. The four methods include: 1) baseline TSS monitoring; 2) stormwater sampling to quantify project specific reduction efficiencies;
3) simplified watershed–based pollutant modeling; and 4) photo–documentation. These methods will be used to determine if the Plan needs to be revised and document the progress being made in both reducing the TSS loads and attaining the desired mean TSS concentration.

[3] Section 303(d) of the federal Clean Water Act (CWA) requires Pennsylvania to identify all waters within the Commonwealth for which effluent limitations required by the CWA are not stringent enough to implement any water quality standard applicable to such waters. The 303(d) List includes those water quality limited segments that still require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. Water quality limited segments are defined as waterbodies that do not meet water quality standards even after the application of technology–based treatment requirements to point and nonpoint sources of pollution. Water quality standards are defined as the combination of designated water uses to be protected and the water quality criteria necessary to protect those uses.

IMPLEMENTATION

Each sub–watershed has a set of proposed BMPs to be implemented. The milestones set for each sub–watershed are: 1). the completion of each recommended BMP; and/or 2). the determination that the recommended BMP can or cannot be implemented; and/or 3). the decision to implement a BMP project that was not originally described in this Implementation Plan. In addition, from a long–term perspective, each sub–watershed will be tracked (once a year and every five years) based on the percentage of projects completed.

The annual tracking will entail listing and documenting any projects that were completed during that year. Any water quality data collected during that year should also be included. In addition to the short annual assessments, detailed 5 year assessments should be conducted to evaluate the accumulated activities and associated pollutants removed over a five year period. This five year evaluation should be tied into the 5 year tiered approach used to attain specific goals in percent reductions in TSS associated with the implementation of the TMDL. The milestones for the watershed as a whole will be the completion of a specific project or projects, the estimated amount of TSS removed on an annual basis, and comparing this removed annual load to the targeted load reduction as outlined in the TMDL.

INTRODUCTION

PLAN BACKGROUND, DESCRIPTION, AND OBJECTIVES

The Neshaminy Creek watershed encompasses 232.84 square miles and is located in Bucks and Montgomery counties, Pennsylvania (Figure A1, Appendix 1). The watershed is comprised of approximately 24 percent developed land, 38 percent agriculture, 36 percent wooded and 2 percent other. There are approximately 418.64 miles of streams within the watershed, 203 of which have been included on Pennsylvania's 303(d) list for aquatic life impairments.

The Pennsylvania Department of Environmental Protection (PADEP) implements an on–going surface waters assessment program. Those waterways found to be impaired are listed on the PA Integrated List of impaired waters. Federal regulations require that a Total Maximum Daily Load (TMDL) be developed for any impaired waterway and that the TMDL must be implemented until the waterway is no longer impaired. PADEP assessments have determined that several stream segments within the Neshaminy Creek watershed are impaired from excess sediment contributions. PADEP finalized the sediment TMDL in December 2003 in a report titled, *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania*. That report provides a listing of fourteen sub–basins of the Neshaminy watershed (also referred to as sub–watersheds) where runoff from urbanized and/or developing areas have caused impairments. Sediment reduction baselines were determined to be used as targets for improving the water quality of the creek.

In November 2010, PADEP approved the *Neshaminy Creek Watershed Act 167 Stormwater Management Plan*. That plan was an update to a previously existing stormwater management plan required through Act 167, the Stormwater Management Act[4]. Counties are responsible for preparing the plans and developing ordinance language for municipalities to use when enacting stormwater management ordinances. Although stormwater runoff is required to be controlled by the standards and criteria set in the PADEP – approved stormwater management plans, the plans only regulate activities associated with new development or redevelopment. While Act 167 plans identify existing problems for future correction, they do not solve existing flooding or runoff problems.

In addition to enacting a stormwater management ordinance, PADEP requires municipalities classified as urban areas by the U.S. Census to implement a stormwater management program as part of the National Pollutant Detection Elimination System (NPDES) permit requirements. The associated permit is referred to as PAG–13 or the Municipal Separate Storm Sewer System

[4] Pennsylvania's Storm Water Management Act (Act 167) was enacted in 1978. This Act was in response to the impacts of accelerated stormwater runoff resulting from land development in the state. Municipalities are required to adopt and implement ordinances to regulate development consistent with these plans.

(MS4) permit[5]. All of the municipalities in both Montgomery and Bucks Counties within the Neshaminy Creek watershed are required to comply with this permit and implement a stormwater management program. The goal of each program should be to reduce the discharge of pollutants to the "maximum extent practicable," to protect water quality, and to satisfy the requirements of the Clean Water Act.

The second generation NPDES (PAG–13) permit, which was to become effective March 16, 2013, will require any regulated MS4 with discharges to an impaired waterway with a TMDL to develop, implement, and enforce a MS4 plan that will achieve the pollutant reductions consistent with the TMDL report. The renewal date has been temporarily postponed. Presently, thirty-one municipalities in Bucks and Montgomery Counties within the Neshaminy Creek watershed will need to implement sediment reduction efforts in order to comply (Figure A2, Appendix 1). Through abiding by the Act 167 requirements, municipalities have been accustomed to maintaining municipal–owned stormwater facilities and enforcing the requirements of their stormwater ordinances. Any new stormwater BMP that is imposed as the result of a local ordinance in the Neshaminy Creek watershed will now need to reduce sediment pollutant loadings to the MS4 permit requirements. However, these actions alone are not expected to be enough to reduce the sediment loads in the Neshaminy Creek as required by the TMDL. More efforts are needed to reduce the sediment loads, so that one day, the Neshaminy Creek will no longer be impaired. The goal of this plan is to determine what additional efforts will be needed, both by individual municipalities and collectively, to help fulfill the TMDL sediment reduction baselines.

The use impairments within the Neshaminy Creek watershed have been documented to be caused by elevated point source loadings of phosphorus during baseflow and elevated sediment loading from non–point source loading during storm events. PADEP's watershed–wide TMDL analysis focused on total suspended solids (TSS) as the pollutant of primary concern while other pollutants are of concern in select areas of the watershed. The TMDL analysis revealed that 75.5 percent of sediment loading has been found to be attributable to streambank erosion while the remaining is attributable to upland erosion and runoff. This pattern has been intensified due to changes in watershed development over the past 10 years which has seen a 20 percent increase in developed land.

In order to address the elevated TSS loads in an objective and systematic manner, the TMDL identified fourteen sub–watersheds dominated with impaired waterways (Figure A2, Appendix 1). The existing and targeted TSS loads (waste allocation load, including a 10 percent margin of

[5] The stormwater requirements of the federal Clean Water Act are administered under the Pennsylvania Department of Environmental Protection's Municipal Separate Storm Sewer (MS4) Program. In December 2002, DEP issued a General Permit ("PAG–13") for use by MS4s that fall under the National Pollutant Discharge Elimination System (NPDES) Phase II program, requiring the implementation of a stormwater management program for minimizing the impacts from runoff. Several extensions have occurred since the expiry of the initial 5 year permit period, the latest of which extended the permit deadline to March 2013.

safety) were identified for each of the 14 sub–watersheds and are listed in Table 1. For convenience, the sub–watersheds have been ranked from highest to lowest relative to the targeted reductions. The 10 percent margin of safety is a State and Federal standard and is typically added to a TMDL when detailed statistical analyses were not conducted to establish a margin of safety. This margin of safety has been integrated in the plan and in attaining the targeted loads.

Sub–basin #4 West Branch has the highest required reduction of approximately 5 million pounds per year. Pine Run has the second with 2.14 million and Little Neshaminy Creek has the third with 1.43 million. The remaining 11 sub–watersheds have required reductions less than 1 million pounds per year, varying from 918,390 pounds for Neshaminy Creek South #1 to 25,356 pounds for Sub–basin #1 West Branch (Table 1). In total, the required annual TSS reduction for the Neshaminy Creek watershed is approximately 14.14 million pounds. This document serves as a Plan to outline a means to begin attaining these targeted reductions in TSS for the Neshaminy Creek watershed.

ISSUES OF CLARIFICATION

A public meeting was hosted by the Bucks County Planning Commission on November 21, 2013, after the municipalities and other stakeholders within the Neshaminy Creek watershed had an opportunity to review the first draft of the Sediment Reduction Plan. A number of issues were raised during the meeting, which will be identified and clarified here before moving into the formal Sediment Reduction Plan.

Issue #1: Why should a municipality sign onto this TMDL–based Sediment Reduction Plan?

Some concern was raised that since the municipalities are responsible for MS4 permits as well as participating in the Act 167 Plan, there is no need to sign onto the TMDL–based Sediment Reduction Plan. Another concern is that the TMDL Plan would just produce an added layer of bureaucratic / regulatory paperwork.

First, it should be emphasized that, unlike the MS4 permits, this TMDL–based Plan is not mandatory. The TMDL is a voluntary program. While many of the recommendations identified in this TMDL–based Plan are required and mandatory under other programs, the TMDL Plan itself is not mandatory.

Second, the reason why a municipality would want to sign onto the Plan is that it increases their chances of receiving Federal and State funding for the implementation of many of the recommendations identified in the Plan. While a number of the measures discussed in the Plan can be directly implemented on a local or county level (e.g. development of ordinances for riparian buffers, naturalizing or retrofitting existing dry detention basins), larger stormwater or streambank projects can be considerable in cost to implement. However, if a municipality or

sub–watershed is part of a TMDL Plan, the chances of receiving Federal or State funding increase.

Third, the TMDL Plan allows existing resources and funds to be pooled together on a watershed basis, instead of based on political or property boundaries. This provides a means of successfully completing larger projects.

Issue #2: Can projects that are completed under a MS4 permit or as part of the requirements of an Act 167 Plan be counted as credit toward the TMDL?

The simple answer is – yes. Any watershed–based project that was conducted and quantified / documented in some manner can also be credited toward a municipality's TMDL contribution. However, relative to funding sources, it should be noted that any funds that originate from the Non–Point Source (319)(h) Section of the Clean Water Act used to implement watershed projects can be credited toward a TMDL but cannot be credited toward a municipality's MS4 permit. In contrast, funds provided through PA DEP's Growing Greener grant program to implement watershed projects can be credited toward both a TMDL and a municipality's MS4 permit.

Issue #3: Can past watershed or stormwater projects be credited toward a TMDL?

The Neshaminy Creek watershed TMDL was revised and completed in 2003. Thus, any appropriate, recognized and documented watershed or stormwater management measures that were implemented from 2003 to the present (and into the future) can be credited toward a municipality's contribution toward a TMDL Plan.

Issue #4: Can street sweeping be used / credited toward a TMDL?

Yes, street sweeping can be used and credited toward a TMDL Plan but it should not be the only "housekeeping" management measure a municipality implements relative to nonpoint source pollution. For the sake of this Plan, unless actual data is directly provided, the amount of TSS removed through street sweeping will be calculated with methodology previously developed (Maryland Department of the Environment, 2011).

Issue #5: Can the establishment of riparian buffers through the development of ordinances be credited toward the TMDL?

The answer is yes. Ordinances that are used to protect existing lands through the establishment of riparian buffers can be used toward crediting a TMDL Plan. However, in order to receive credit the ordinance must be developed and passed and some type of documentation of the improved conditions must be conducted. For example, if the ordinance is passed but no effort is being done to implement the identified level of protection, no credit will be given. Also, if an ordinance is passed and riparian buffers are designed and allowed to be established along forested or transitional lands along impaired waterways, credit will be given. However, if the ordinance is passed and no effort is documented that establishes the buffer, no credit will be given.

Transition lands are natural or undeveloped lands that surround or expand upon the Core Lands or provide opportunities for connectivity. Core Lands are lands that have high natural quality and represent the significant natural communities that were once widespread in this region.

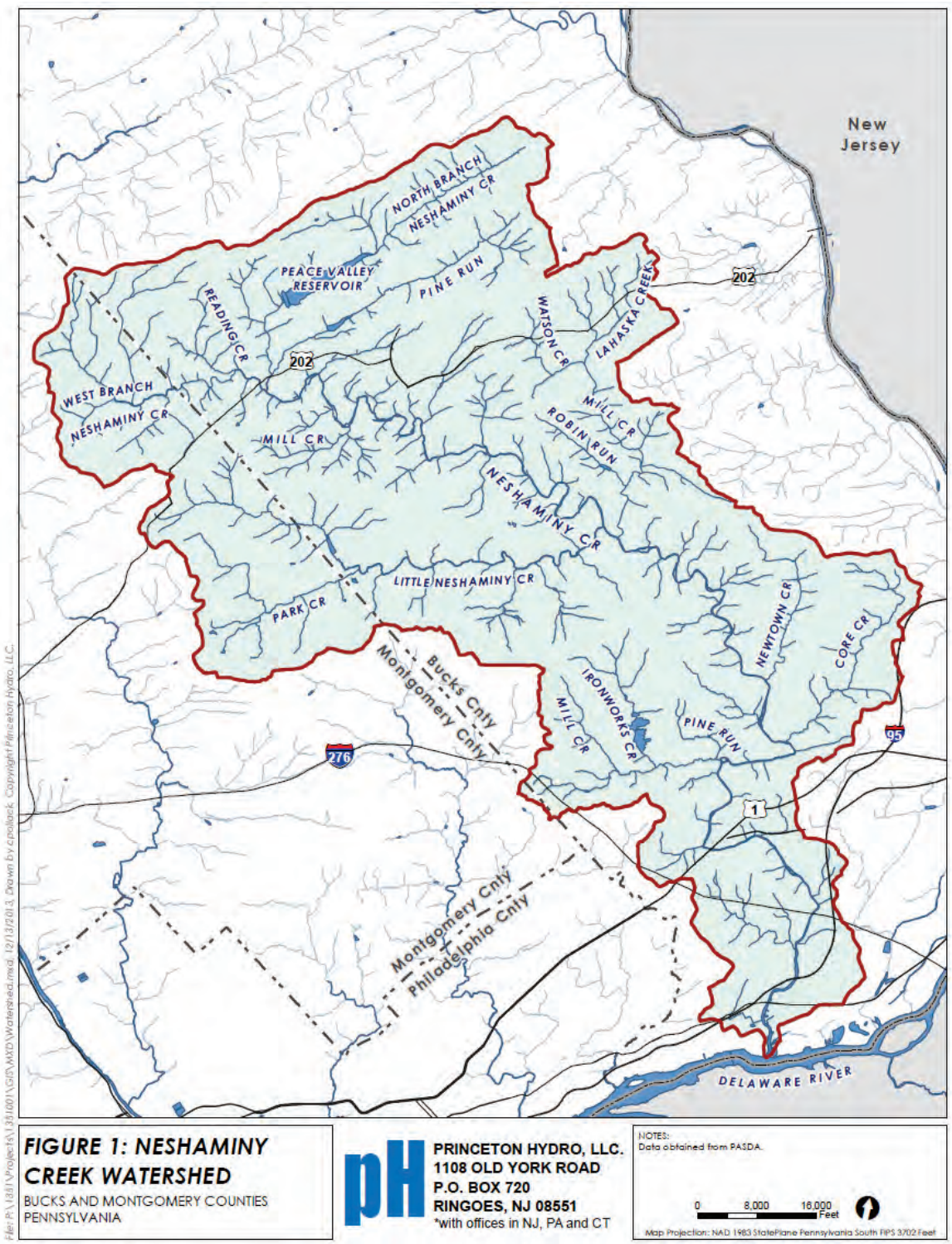

New Jersey
NORTH BRANCH NESHAMINY CR
PEACE VALLEY RESERVOIR
PINE RUN
READING CR
WEST BRANCH NESHAMINY CR
202
WATSON CR
LAHASKA CREEK
MILL CR
ROBIN RUN
NESHAMINY CR
LITTLE NESHAMINY CR
PARK CR
Bucks Cnty
Montgomery Cnty
276
IRONWORKS CR
NEWTOWN CR
CORE CR
95
1
Montgomery Cnty
Philadelphia Cnty
DELAWARE RIVER
FIGURE 1: NESHAMINY CREEK WATERSHED
BUCKS AND MONTGOMERY COUNTIES
PENNSYLVANIA
PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
*with offices in NJ, PA and CT
NOTES:
Data obtained from PASDA.
0
8,000
16,000
Feet
Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
File: P:\1361\Projects\1361001\GIS\MXD\Watershed.mxd, 12/13/2013, Drawn by cpollack, Copyright Princeton Hydro, LLC

Table 1
Summary of Neshaminy Creek TMDL for TSS

Sub–watershed	Existing TSS Load	Established TMDL	Targeted Reduction
Sub–basin #4 West Branch	9,859,400	4,828,640	5,030,760
Pine Run	4,089,625	1,944,239	2,145,386
Little Neshaminy Creek	8,369,480	6,937,351	1,432,129
Neshaminy Creek South #1	3,073,400	2,155,010	918,390
Neshaminy Creek Tributary #3	1,054,746	263,400	791,346
Neshaminy Creek South #2	1,780,400	1,058,322	722,078
Mill Creek	2,181,460	1,562,114	619,346
Neshaminy Creek South #3	1,414,300	899,783	514,517
Neshaminy Creek Tributary #1	721,215	209,543	511,672
Sub–basin #3 West Branch	930,419	446,989	483,430
Core Creek	1,775,981	1,327,251	448,730
Sub–basin #2 West Branch	682,119	295,629	386,490
Neshaminy Creek Tributary #2	165,561	56,144	109,417
Sub–basin #1 West Branch	154,296	128,940	25,356
Totals	**36,252,402**	**22,113,355**	**14,139,047**

All values in pounds per year.

Issue #6: Why a Sediment Reduction Plan is Needed

The *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed* is a complicated report. A technical analysis was performed and sediment TMDLs have been assigned to fourteen separate sub–watersheds and range from a 16 percent to a 75 percent required reduction. The sub–watersheds cross over forty-one municipalities within both Montgomery and Bucks counties. The report does not offer specific implementation guidance.

For many municipalities, developing their own TMDL implementation plan will take tremendous effort. Municipalities will be responsible to figure out how to reduce the sediment loads from their stormwater infrastructure, in addition to the stormwater management efforts they are already fulfilling through following the requirements of Act 167. The MS4 TMDL plan must result in measurable progress toward substantial sediment reduction loads, and physical pollutant removal measures must be installed on–the–ground and documented in the year–three permit report. Many municipalities are in the practice of using an engineer to fill out the current permit and are required to have the MS4 TMDL plan signed and sealed by a professional engineer. Developing individual TMDL plans with limited guidance from the *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania* report increases the financial burden of the permit, as it would require more work for the municipal engineer.

The intent of this Plan is to create a Sediment Reduction Plan that municipalities can endorse and implement. This plan will be more effective in meeting the water quality requirements as the measures proposed will examine the effect on the entire watershed, instead of the alternative of each municipality developing individual MS4 TMDL plans. Municipalities have the option in the permit to use a regional or watershed–wide TMDL plan to determine their sediment reduction efforts.

PROJECT JUSTIFICATION

In October 2012, the Bucks County Commissioners were awarded a Coastal Zone Management (CZM) grant (FY 2012.PD.05) for development of the *Neshaminy Creek Watershed Sediment Reduction Plan for Municipal Implementation.* Eligible organizations for receipt of Coastal Zone Management grants include municipalities, townships, boroughs, cities, and counties, as well as non–profit organizations with projects located in one of Pennsylvania's coastal zones.

The Pennsylvania Department of Environmental Protection Water Planning Office coordinates and implements the Coastal Resources Management (CRM) Program to execute sound coastal management policies in Pennsylvania's two coastal areas (Lake Erie and Delaware Estuary). DEP receives funding from the National Oceanic and Atmospheric Administration (NOAA) to administer the CRM program and provide grants to eligible organizations to undertake projects in the coastal zones.

The primary goal of the sediment reduction Plan is to synthesize a watershed–wide plan to both address those impaired waterways for the Neshaminy Creek watershed (Figure A1, Appendix 1), as well as comply with the established TMDL (Table 1). In addition, to ensure that the proposed Neshaminy Creek Sediment Reduction Plan will be accepted for implementation by both State and Federal agencies, this Plan will address the nine elements of a comprehensive watershed plan as identified by US EPA. These nine elements are:

1. Identify the sources of TSS and a prioritized ranking of these sources on a sub–watershed and site–specific basis.

2. Estimate pollutant load reductions expected for the nonpoint source management measures described in the plan.

3. Describe specific nonpoint source management measures that should be implemented and include a description of their location in the watershed.

4. Estimate the amount and potential sources of technical and financial assistance needed to implement the Plan.

5. Describe the information and education component designed to enhance public understanding of the Plan and encourage early and ongoing public participation in selecting, designing and implementing the identified nonpoint source management measures, including: creation and maintenance of a project mailing list, development of appropriate informational materials, and several public meetings held over the course of the project.

6. Provide a "reasonably expeditious" schedule for implementing the identified nonpoint source management measures, including the development of a ranking system matrix to identify priority areas where resources should be targeted.

7. Describe interim, measurable milestones (e.g., water chemistry data, number of acres permanently protected, number of streambank miles restored) for verifying whether nonpoint source management measures are being implemented effectively.

8. Describe a set of criteria that can be used to determine whether load reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed–based plan needs to be revised.

9. Describe a monitoring plan to evaluate the effectiveness of implementation efforts over time, including recommendations for corrective actions to be taken if plan goals are not met and/or nonpoint source management measures are not implemented properly.

Through the course of this Plan, the nine elements will be specifically identified and addressed within the context of the Neshaminy Creek watershed. Thus, this Plan complies with both the tasks originally established in the proposed Scope of Work as well as with the requirements for an approved Watershed Implementation Plan (also known as a WIP).

IDENTIFIED BEST MANAGEMENT PRACTICES (BMPS)

A wide variety of watershed–based Best Management Practices (BMPs) are recognized by PA DEP and are described in great detail in the *Pennsylvania Stormwater Best Management Practices Manual* (PA DEP, 2006). For the development of this Plan, a series of management measures were identified for implementation and focus heavily on total suspended solids (TSS) as the primary pollutant of concern, although these measures will obviously contribute toward the reduction of other nonpoint source pollutants such as phosphorus. Additionally, streambank and shoreline stabilization practices will be a critical component of the Plan since streambank erosion accounts for slightly over 75 percent of the TSS loads in the Neshaminy Creek TMDL.

It should be emphasized that while these are the recommended BMPs under the Plan, they are by no means the only management measures that could be utilized. Any alternative or innovative BMP or Manufactured Treatment Device could also be utilized; however, some type of justification and past documentation of TSS removal rates would be required for approval. Unless otherwise stated, more detailed information on the listed management measures can be found in the PA Stormwater BMP Manual.

RIPARIAN BUFFERS (STREAMBANK RESTORATION)

Re–establishing stable, vegetated buffers along perennial, intermittent and ephemeral streams is a key BMP. The wider the buffer, the more effective it will be. At a minimum, buffer width should be 35 feet from the top of the stream bank; however, a width of 100 feet would be optimal. In the Plan, impaired waterways that are forested (e.g. forested lands, recreational lands) are recommended to be as wide as possible and are given the full TSS removal rate of 65 percent (as per *PA Stormwater BMP Manual*). In contrast, it is assumed that any impaired waterway flowing through agricultural, developed and transitional lands will require more extensive physical work and will also tend to have a shorter buffer length, close to the 35 feet minimum. Thus, for these lands, the TSS removal rate associated with such work was lowered to 40 percent.

RETROFIT OF EXISTING DRY DETENTION BASINS

Hundreds of these basins are found throughout the Neshaminy Creek watershed and were designed primarily for controlling the peak rate of stormwater runoff with a minimal amount of water quality benefits. However, such basins can be easily modified or retrofitted to increase their capacity to remove TSS from stormwater. Such retrofitted basins are given a TSS removal rate of 60 percent. However, even if no structural modifications or retrofits are conducted but the basins are simply allowed to “naturalize” (i.e., allow vegetation to grow in basin, cutting only at the end of the growing season), such basins are typically given a TSS removal rate of 30 percent.

VEGETATED (WATER QUALITY) SWALE

A large number of roadside swales exist throughout the watershed. These swales were originally designed to get the water off the road; however, these structures can be modified and planted to increase their ability to remove pollutants. A modified or upgraded swale has a removal rate of 50 percent for TSS.

RAIN GARDEN / BIORETENTION

These BMPs are essentially excavated, shallow surface depressions with a special soil blend to maximize infiltration and planted with vegetation to treat runoff. These BMPs have high pollutant removal rates but tend to be limited to treating 1 to 2 acres of land (e.g. private residence, parking lots). Their removal rate for TSS is typically 85 percent.

CONSTRUCTED WETLANDS

This BMP is larger in scale than bioretention systems and typically involves a shallow marsh system planted with a variety of plant types, including emergent vegetation that is designed to treat stormwater runoff. Unlike rain gardens and bioretention systems, constructed wetlands treat larger drainage areas (typically from 10 to 100 acres); however, this BMP does require a substantial amount of land for design and installation. The removal rate of constructed wetlands for TSS is typically 85 percent.

MULTI–CHAMBERED BAFFLE BOXES (MANUFACTURED TREATMENT DEVICE – MTD)

The multi–chambered baffle box systems are MTDs. A number of companies manufacture these systems, and they have been documented to be relatively effective at removing TSS and other associated pollutants, with a relatively small amount of maintenance. Such MTDs are particularly effective in highly urban or suburban areas where land is not available for the installation of larger BMPs. These systems can be retrofitted into existing infrastructure and their TSS removal rate, recognized by US EPA, is approximately 70 percent (US EPA, 2001).

SUB–WATERSHED DESCRIPTIONS

SUB–BASIN #4 WEST BRANCH OF NESHAMINY CREEK

The Sub–basin #4 West Branch sub–watershed is located in Bucks and Montgomery counties and is about 15 square miles in size. The Bucks County municipalities include Hilltown Township, New Britain Township, Chalfont Borough and New Britain Borough. The Montgomery County municipalities include Franconia Township, Hatfield Township, Montgomery Township, and Hatfield Borough.

The Sub–basin #4 West Branch sub–watershed consists of the main stem of the West Branch of Neshaminy Creek and several unnamed tributaries. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 22.8 miles of streams. With the referenced watershed approach, a TMDL was established for the Sub–basin #4 West Branch sub–watershed. Thus, the waste load allocation (WLA) was established along with a 10 percent margin of safety, resulting in a targeted reduction of 5,030,760 pounds of TSS per year (Table 1), making it the largest existing and targeted reduction of TSS for the Neshaminy Creek watershed.

The dominant land uses within the Sub–basin #4 West Branch sub–watershed were agriculture (40 percent), developed lands (36 percent), and forested (19 percent). The largest existing TSS loads originate from streambank erosion (5.3 million pounds per year) and cropland (3.9 million pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 2 is estimated to remove approximately 5,127,388 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 96,628 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $5.6 and $21 million dollars (Table 3). Estimated long–term maintenance costs are provided in Appendix 2.

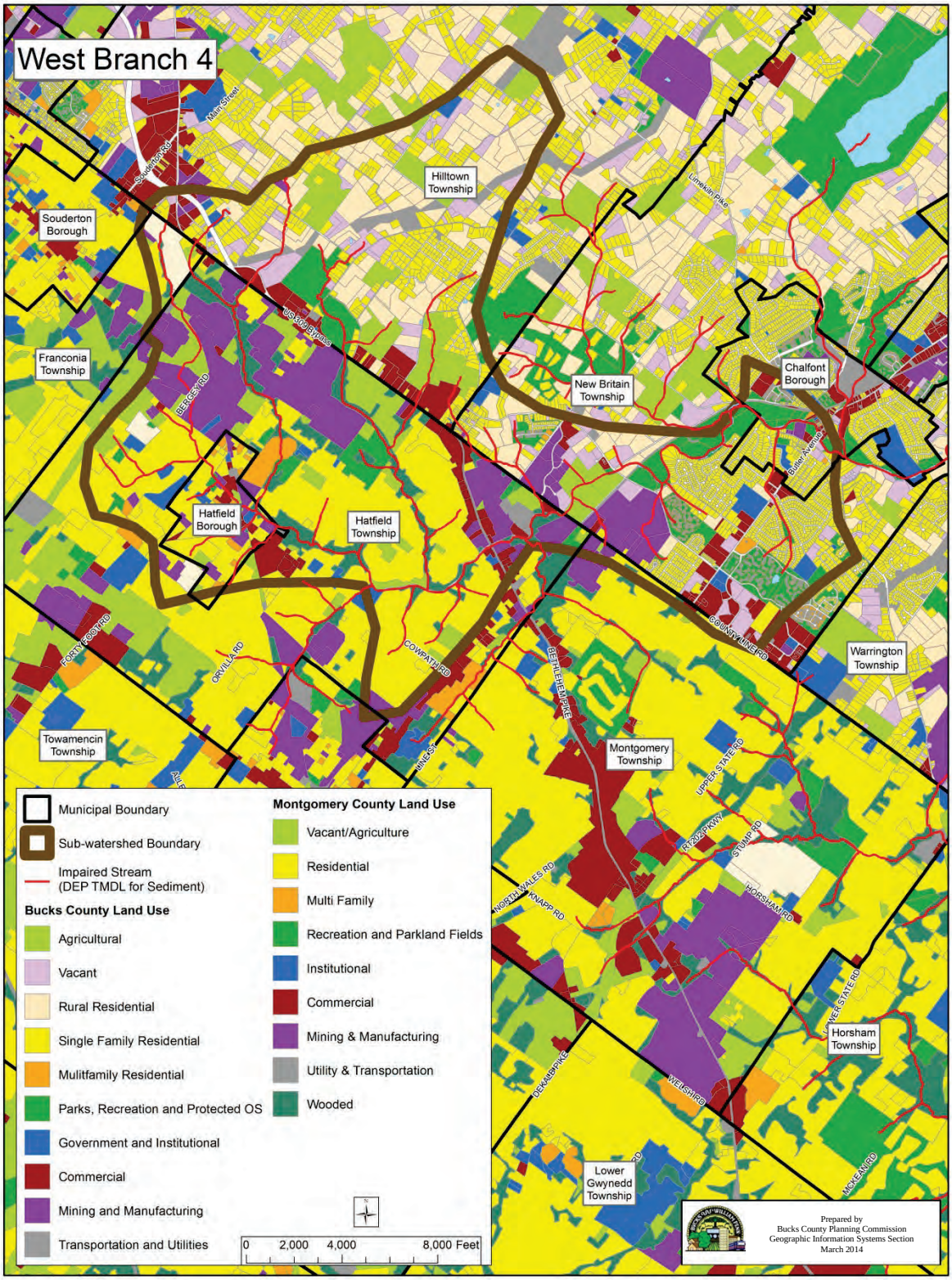
Table 2
Proposed TSS Reduction for the Sub-basin #4 West Branch

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 9.1 miles of the 22.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	847,503
Streambank restoration – Developed Lands focuses on 8.2 miles of the 22.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	762,753
Streambank restoration – Transitional Lands focuses on 1.1 miles of the 22.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	105,938
Riparian Buffers focuses on 4.4 miles of the 22.8 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	664,435
Retrofit Basins – Residential Development Approximately 99 basins in low intensity development and 35 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	40,079 10,055
Retrofit Basins – Agricultural Lands Approximately 34 basins in hay / pasture and 119 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	27,720 2,362,536
Retrofit Basins – Transitional Lands Approximately 18 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	282,974
Manufactured Treatment Devices Approximately 98 MTDs in low intensity development and 35 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	18,703 4,692
Total Amount of TSS Removed	**5,127,388**

Table 3
Cost Estimates for Project Implementation in Sub-basin #4 West Branch

Project	Low Estimate	High Estimate
Streambank restoration – agricultural lands (6.8 miles)	$240,240.00	$960,960.00
Streambank restoration – developed lands (6.2 miles)	216,480.00	865,920.00
Streambank restoration – transitional lands (1.1 miles)	29,040.00	116,160.00
Riparian buffers – forested lands (4.4 miles)	0.00	348,480.00
Retrofit residential basins (134 basins)	201,000.00	6,700,000.00
Retrofit agricultural basins (153 basins)	229,500.00	3,825,000.00
Retrofit transitional regional basins (18 basins)	27,000.00	900,000.00
MTDs (133 units)	4,655,000.00	7,315,000.00
Total	**$5,598,260.00**	**$21,031,520.00**

Sub-basin #4 West Branch Map



PINE RUN SUB–WATERSHED OF NESHAMINY CREEK

The Pine Run sub–watershed is located in Bucks County and is about 12.0 square miles in size. Pine Run is a tributary of the North Branch of Neshaminy Creek. The municipalities within this sub–watershed include Buckingham Township, Doylestown Township, New Britain Township, Plumstead Township, Chalfont Borough and New Britain Borough. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is trout stocking and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 7.1 miles of the main stem of Pine Run from its mouth going upstream. The TMDL for Pine Run is based on the comparison of simulated TSS loads, comparing loads when the stream attained its designed use (1992) to a time when it was identified as impaired (2000).

The waste load allocation (WLA) with a 10 percent margin of safety was established, resulting in a targeted reduction of 2,145,386 pounds of TSS per year (Table 1), making it the second largest existing and targeted reduction of TSS for the Neshaminy Creek watershed.

The dominant land uses within the Pine Run sub–watershed were forested (37 percent), agriculture (36 percent) and developed lands (12 percent). However, the largest existing TSS loads originate from transitional lands (2.4 million pounds per year), streambank erosion (844,150 pounds per year) and cropland (746,981 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 4 is estimated to remove approximately 2,174,153 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 28,767 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between slightly less than $1 million and $4.0 million dollars (Table 5). Estimated long–term maintenance costs are provided in Appendix 2.

Table 4
Proposed TSS Reduction for the Pine Run Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Maintenance dredging of upper end of Pine Run Reservoir (conservatively ascribed TSS removal rate of 55%; 15% lower than PA BMP Manual)	1,970,381
Streambank restoration – Agricultural Lands focuses on 1.7 miles of the 8.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	66,741
Streambank restoration – Developed Lands focuses on 0.6 miles of the 8.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	22,247
Streambank restoration – Transitional Lands focuses on 0.7 miles of the 8.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	27,809
Riparian Buffers focuses on 0.8 miles of the 8.4 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	52,166
Create riparian zone immediately below Pine Run Reservoir (TSS removal rate of 65% as per PA BMP Manual)	12,350
Basin Retrofits (20 unidentified basins) (TSS removal rate of 60% as per PA BMP Manual)	7,500
Pine Run Swale (TSS removal rate of 50% as per PA BMP Manual)	3,047
Nottingham Way (7 basins targeted for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	2,625
Roadside Swale, Pine Run Road (TSS removal rate of 50% as per PA BMP Manual)	1,878
Roadside Swale, Ferry Road (TSS removal rate of 50% as per PA BMP Manual)	1,479
Shrine of Czestochowa includes basin retrofits, swale upgrade, two MTDs and a rain garden (TSS removal rate is an accumulative estimated total)	1,244
Confluence at North Branch and Pine Run streambank stabilization (TSS removal rate of 30% as per PA BMP Manual)	1,140
Dillon Road Apartment Complex (3 basins for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	1,125
Old Easton Road to Signature Drive (2 basins for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	750
Redfield Basin (1 basin targeted for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	546
Summer Hill Road, near Deep Glen Way (1 basin for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	375
Old Oak Road and Dillon Road (1 basin for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	375
Grundy Basin (1 basin targeted for retrofitting) (TSS removal rate of 60% as per PA BMP Manual)	375
Total Amount of TSS Removed	**2,174,153**

Table 5
Cost Estimates for Project Implementation in the Pine Run Sub–watershed

Project	Low Estimate	High Estimate
Maintenance dredging of Pine Run Reservoir	$726,000.00	$1,452,000.00
Streambank restoration – agricultural lands (1.7 miles)	36,960.00	147,840.00
Streambank restoration – developed lands (0.6 miles)	13,200.00	52,800.00
Streambank restoration – transitional lands (0.7 miles)	18,480.00	73,920.00
Riparian buffers – forested lands (0.8 miles)	0.00	63,360.00
Riparian zone below reservoir	5,280.00	26,400.00
Retrofit residential basins (20 basins)	30,000.00	1,000,000.00
Pine Run swale	7,920.00	23,760.00
Nottingham Way basins (7 basins)	10,500.00	350,000.00
Two road–side swales	10,560.00	31,680.00
Basin retrofits, swale upgrades, two MTDs and rain garden	88,000.00	280,000.00
Streambank stabilization – confluence site	2,500.00	5,000.00
Dillon Road Apartment Complex – three basin retrofits	4,500.00	150,000.00
Old Easton Road – two basin retrofits	3,000.00	100,000.00
Redfield basin retrofit (1)	1,500.00	50,000.00
Summer Hill Road basin retrofit (1)	1,500.00	50,000.00
Old Oak Road basin retrofit (1)	1,500.00	50,000.00
Grundy Road basin retrofit (1)	1,500.00	50,000.00
Total	**$962,900.00**	**$3,956,760.00**

SPECIFIC ISSUES FOUND IN THE PINE RUN SUB-WATERSHED

1. Shrine of Czestochowa

This site is located in New Britain Township and contains a large complex of buildings and grounds on top of hills with steep slopes. Surface runoff from the site is known to impact the Pine Run Community (localized flooding issues), located on Ferry Road in Doylestown Township, and downgradient of the Shrine site.

The site has an oval, elongated retention basin (Figure 2) that could be retrofitted by modifying the outlet structure and enhancing its ability to temporarily hold stormwater and associated pollutants for assimilation by some planted, native herbaceous and shrubby vegetation. In addition, the associated swales could be vegetated and installed with small check dams to enhance nutrient uptake. Near the buildings themselves, some of the existing stormwater infrastructure could be retrofitted with Manufactured Treatment Devices that would increase the ability to remove suspended solids from the stormwater. Finally, as both a stormwater and educational project, rain gardens at the Shrine are recommended.

Figure 2: Elongated detention basin at the Shrine of Czestochowa (July 2013)

Figure 3: Stormwater catch basin that could be retrofitted with a Manufactured Treatment Device at the Shrine of Czestochowa (July 2013)

In addition to retrofitting the existing detention basin, there are a series of standard stormwater catch basins throughout the site that convey stormwater to the detention basin (Figure 3). While these basins accomplish the goal of moving the stormwater off the roadways and into the detention basin, they do nothing for water quality improvements. Thus, it is recommended that at least two large, regional Manufactured Treatment Devices be installed at the site to focus primarily on reducing the suspended solid load leaving the property. In addition to the detention basin and catch basin retrofits, it is recommended that the existing swale leaving the property be modified to enhance its ability to treat the stormwater.

Combined, these projects are estimated to conservatively remove approximately 1,244 pounds of TSS per year. In addition, these stormwater projects would also contribute toward reducing the downstream impacts of small to moderately–sized storm events. These projects are estimated to cost between $88,000 and $280,000 for installation.

2. Segment #1: Bridgeview Park to Old Iron Hill Road

The assessment for Segment #1 started at Bridgeview Park in Chalfont Borough and ended along Old Iron Hill Road in New Britain Township (Figure 4). While the majority of the land along this segment is park, recreational and protected open space, a stretch of disturbed streambank at the confluence of the North Branch and Pine Run was identified as a result of some local construction activities. It should be noted that this site was inspected in May of 2013 and may look substantially different at present. The land was being cleared and mowed for some local purpose.

In addition to this problem site, additional stretches of eroding streambank were observed along Segment #1 and included vegetation hanging over severe bank cuts, falling trees, slope failures and the abundance of invasive species. An old low–lying dam was present as well as log / debris jams along the floodplain and some in–stream rock crossings.

Some limited streambank stabilization / riparian buffer restoration is recommended for this segment. The term "limited" was used for this particular location since large sections of Pine Run appear to be eroding and show evidence of being undercut. While some of these larger sections of streambank may be good candidates for restoration work, a substantial portion of them are located in high forested / wetland / floodplain areas. Thus, getting to some of these sites to conduct restoration and stabilization may impact the land and produce more TSS loads than what the original restoration project is trying to address.

Figure 4: Confluence of Pine Run and the North Branch (May 2013)

The area targeted for stabilization along this section of waterway (Figure 4) is estimated to be approximately 5,000 square feet in total area, and the TSS reduction expected through the implementation of this project is approximately 1,140 pounds per year. The implementation of this project is estimated to cost between $2,500 and $5,000 depending on the actual size of the project area and what type of equipment is needed for the earth moving and re–grading. Essentially, the site would require a minimal to moderate amount of re–grading and then planting with riparian and some upland native vegetation.

Maintenance for the site would be minimal, with site inspections once every 3 months to identify and remove any invasive species during the first post–restoration year. After at least one growing season, inspections could be limited to once in spring and once in fall to control any invasive species and address other issues that may arise such as the potential formation of erosional gullies.

Again, there are a number of potential projects that could be implemented along Segment #1 (additional streambank stabilization, dam and fallen tree / debris removal) and, therefore, this proposed site should be considered for implementation. Additional issues (property survey work, permitting, engineering design) would need to be addressed to pursue this or any of the other potential projects described above.

3. Segment #2: Old Iron Hill Road to Tributary #1

The assessment for Segment #2 started at Old Iron Hill Road right up to the outlet of the Pine Run Reservoir (Figure 5). Again, much of the land is park, recreational and protected open space, and much of the segment is forested. However, the site does exhibit some extreme bank erosion, foul odors and an exposed sewer manhole. Given these conditions, in addition to its close proximity to the reservoir, implementing restoration / stabilization projects in this segment, which would include the installation of access roads for long–term maintenance, is recommended in spite of the high amount of forested land.

Some streambank stabilization / riparian buffer restoration is recommended along this segment. In addition, there are a number of fallen trees, causing log jams in the streambed that should be removed. The proposed project is estimated to remove approximately 12,350 pounds of TSS per year and would cost between $5,280 and $26,400 for implementation.

Figure 5: Below Pine Run Reservoir (May 2013)

4. Tributary #2: Roadside Swale

This location is a roadside swale (Figure 6) which flows to Hagan Court and subsequently to the spillway of Pine Run Reservoir. The swale, located on Ferry Road, could be re–graded to function as a stabilized, vegetated (water quality) swale. After some re–grading work, small check dams could be installed along with a variety of grasses and herbaceous vegetation. This proposed swale project is estimated to remove approximately 3,047 pounds of TSS per year and is estimated to cost between $7,920 and $23,760 for implementation.

Figure 6: Roadside swale below Pine Run Reservoir (May 2013)

5. Hagan Court Subdivision Detention Basin

An existing detention basin is located in Hagan Court (Figure 7), a subdivision located in Doylestown Township. As is typical of many existing stormwater basins, these structures were designed primarily with peak rate stormwater runoff control in mind with little to no regard for water quality. However, most of these existing structures can be modified with a moderate amount of funds to enhance their ability to remove nonpoint source pollutants, including TSS, as well as moderately enhance their capacity to minimize local flooding impacts from small–to–moderately sized storms.

The proposed restoration recommendation for this basin is to remove the low flow concrete channel and replace the lawn area with low lying, native and attractive vegetation. In addition, a forebay can be designed at the basin's inlet pipes to enhance the settling of particulates. In turn, such retrofits would allow the basin to function more as a dry or occasionally wet extended detention basin. Such retrofitted basins are estimated to have a 60 percent removal rate of TSS (*PA Stormwater BMP Manual*, 2006).

This proposed detention basin retrofit project is estimated to remove at least 546 pounds of TSS per year and is estimated to cost between $1,500 and $50,000 for implementation.

Figure 7: Detention basin at Hagan Court Subdivision (May 2013)

6. Tributary #3: Roadside Ditch along Pine Run Road

This roadside ditch in Doylestown Township runs parallel with Pine Run Road and flows into Pine Run Creek (Figure 8). The proposed road–size swale stabilization project is estimated to remove between 1,479 to 1,878 pounds of TSS per year and is estimated to cost between $10,560 and $31,680 for implementation. Stabilization efforts should follow the guidelines provided in the State's Stormwater BMP Manual in retrofitting an existing road–side swale into a water quality control swale.

Figure 8: Roadside swale along Pine Run Road (May 2013)

7. Detention Basins Summer Hill/Summer Meadow Development

Four existing detention basins are located in the Summer Hill and Summer Meadow development, Plumstead Township. Two are located on the same side of Signature Drive but in close proximity to Old Easton Road; one is off Old Oak Road and another is off Dillon Road. As is typical of many existing stormwater basins, these structures were designed primarily with peak rate stormwater runoff control in mind with little to no regard for water quality. However, most of these existing structures can be modified with a moderate amount of funds to enhance their ability to remove nonpoint source pollution, including TSS, as well as moderately enhancing their capacity to minimize local flooding impacts from small to moderately sized storms.

Again, as is typical with this type of stormwater management structure, two of the basins have low flow channels and mowed basins (Figures 9 and 10). Beyond grass, little to no vegetation is present in the basins to enhance nonpoint source pollutant removal. The goal of this project is to retrofit these two basins to function more as dry or occasionally wet extended detention basins. Such retrofitted basins are estimated to have a 60 percent removal rate of TSS (*PA Stormwater BMP Manual*, 2006).

The objective of this project would be to remove the existing low flow channels, re–grade and, if possible, create a meandering flow path for incoming stormwater, and plant the basin with a variety of attractive and native vegetation. The primary goal of these retrofits is to increase the runoff's contact with the soil and vegetation. This will provide direct water quality benefits and also drastically increase the volume control provided by the basin, especially for smaller storm events. In their current conditions the basins provide little to no volume attenuation (infiltration) due to the existence of the concrete low flow channel and the frequently mown turf grass vegetation. The retrofit grading will be designed in a manner to provide large, flat and shallow areas for runoff to be temporarily stored and infiltrated.

If the two basins were retrofitted with an upgraded outlet structure, re–graded and re–planted with native vegetation, each BMP is estimated to remove approximately 375 pounds per year, for a total of 750 pounds. The implementation of these retrofit projects is estimated to cost between $28,000 and $52,000 per basin, depending on the existing condition of the outfall structures and the extent of required earth–moving and re–grading. While there will be some degree of maintenance associated with the retrofitted basins, once the vegetation is established, maintenance will be less than the current program of routine mowing and associated landscaping. While some monitoring and removal of invasive species (if they appear) will be required, the amount of such activities tends to decline as the native vegetation becomes well established. After that (approximately 1–2 growing seasons), vegetation may need to be mowed only once or twice a year (at least in the fall) as opposed to a routine mowing schedule.

Figure 9: One of two basins off of Signature Drive, Summer Hill/Summer Meadow Development (July 2013)

Figure 10: Second of two basins that could be retrofitted at Summer Hill/Summer Meadow Development (July 2013)

8. Detention Basin along Redfield Road

This site is located along Redfield Road in Buckingham Township and has an extremely large detention basin with a considerable amount of trash, excess sediment, grass clippings, debris and deer and pet waste (Figures 11 and 12). The basin also has low flow concrete channels and a huge outfall pipe.

Given the size of the basin and its outfall pipe, as well as its current state, it is strongly recommended that this basin be retrofitted to function more as a dry extended detention basin. Such a retrofit would require modification to detain stormwater runoff for an extended period of time, which would allow solids to settle out and the assimilation of nutrients and other pollutants by native low–lying vegetation to be planted in the basin. In order to successfully accomplish this, the low flow concrete channels will need to be removed and the outfall structure will require some degree of modification. In addition, given the amount of walking traffic associated with pet owners, signage should be put up to dissuade people from walking their dogs in the basin and, if they do, to pick up their pet's waste. Any vegetation selected for planting should have a low degree of palatability to deer and will require some netting or deer enclosures.

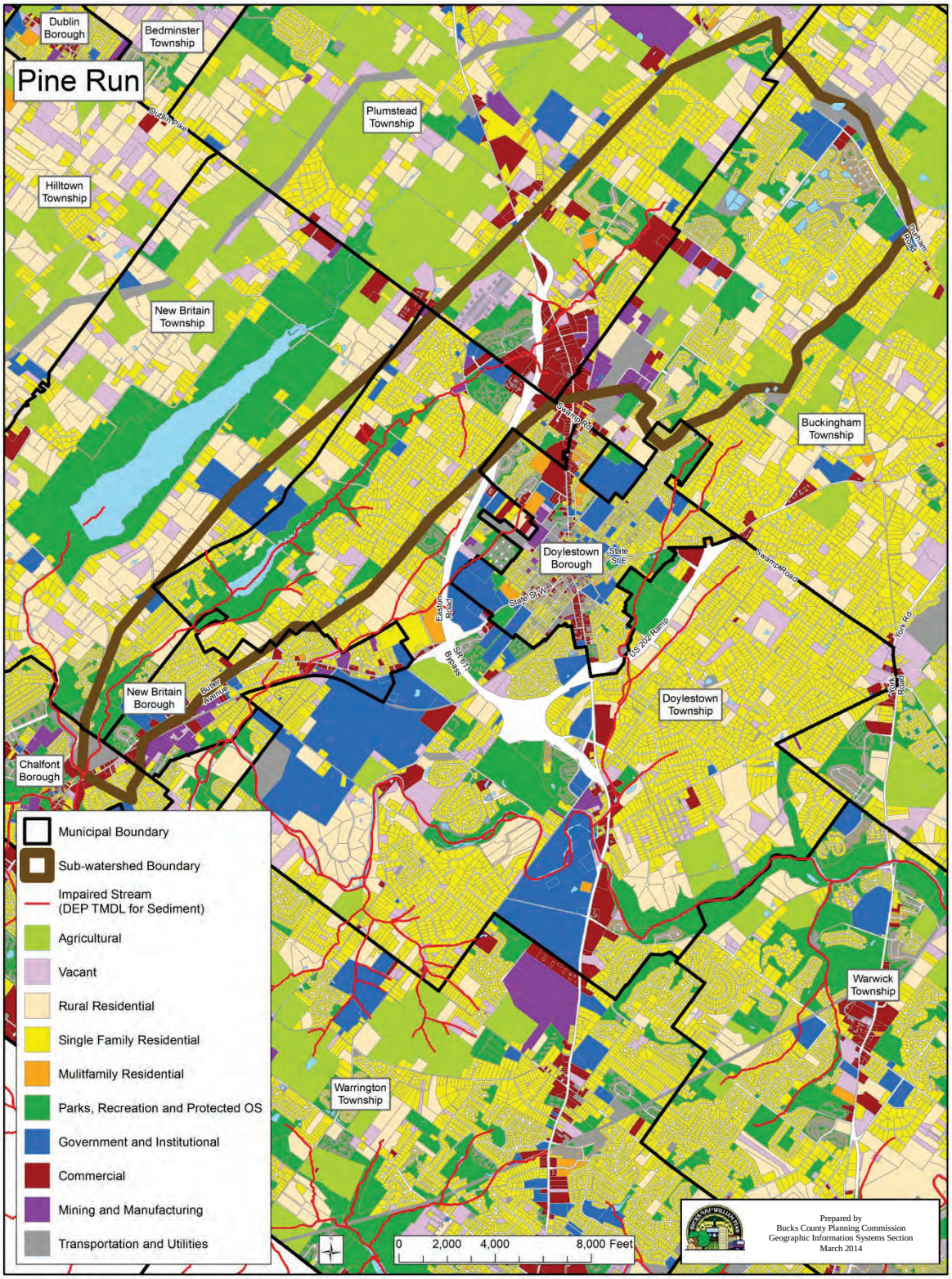
This basin more than likely has a larger drainage area than most of the other basins cited in this plan for restoration. Efforts to educate local property owners on the goals and objectives of any stormwater project, as well as getting them to "buy into" the project, will be particularly important for this project. The cost associated with this basin retrofit may be moderately higher relative to other basin projects.

This proposed detention basin retrofit project is estimated to remove at least 546 pounds of TSS per year and is estimated to cost between $1,500 and $50,000 for implementation.

Figure 11: Large outlet pipe for a basin along Redfield Road (July 2013)

Figure 12: Low flow concrete channel at bottom of basin along Redfield Road (July 2013)

Pine Run Sub-watershed Map



LITTLE NESHAMINY CREEK SUB–WATERSHED OF NESHAMINY CREEK

The Little Neshaminy sub–watershed is located in Bucks and Montgomery Counties and is about 43.2 square miles in size. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Bucks County part of the sub–watershed are Ivyland Borough, Northampton Township, Warminster Township, Warrington Township, and Warwick Township. The municipalities within the Montgomery County part of the sub–watershed are Horsham Township, Lower Gwynedd Township, Montgomery Township, and Upper Dublin Township.

Its portion of the Neshaminy Creek TMDL applies to approximately 47.2 miles of the main stem of Little Neshaminy, its tributary Park Creek and several unnamed tributaries. The TMDL for the Little Neshaminy sub–watershed is based on the comparison of simulated TSS loads, comparing loads when the stream attained its designed use (1992) to a time when it was identified as impaired (2000).

The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 1,432,129 pounds of TSS per year (Table 1), making it the third largest existing and targeted reduction of TSS for the Neshaminy Creek watershed.

The dominant land uses within the Little Neshaminy sub–watershed were agriculture (35 percent), forested (32 percent) and developed lands (28 percent). The largest existing TSS loads originate from streambank erosion (6.3 million pounds per year) and cropland (1.05 million pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 6 is estimated to remove approximately 1,542,025 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 109,896 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between about $4 million and $14 million dollars (Table 7). Estimated long–term maintenance costs are provided in Appendix 2.

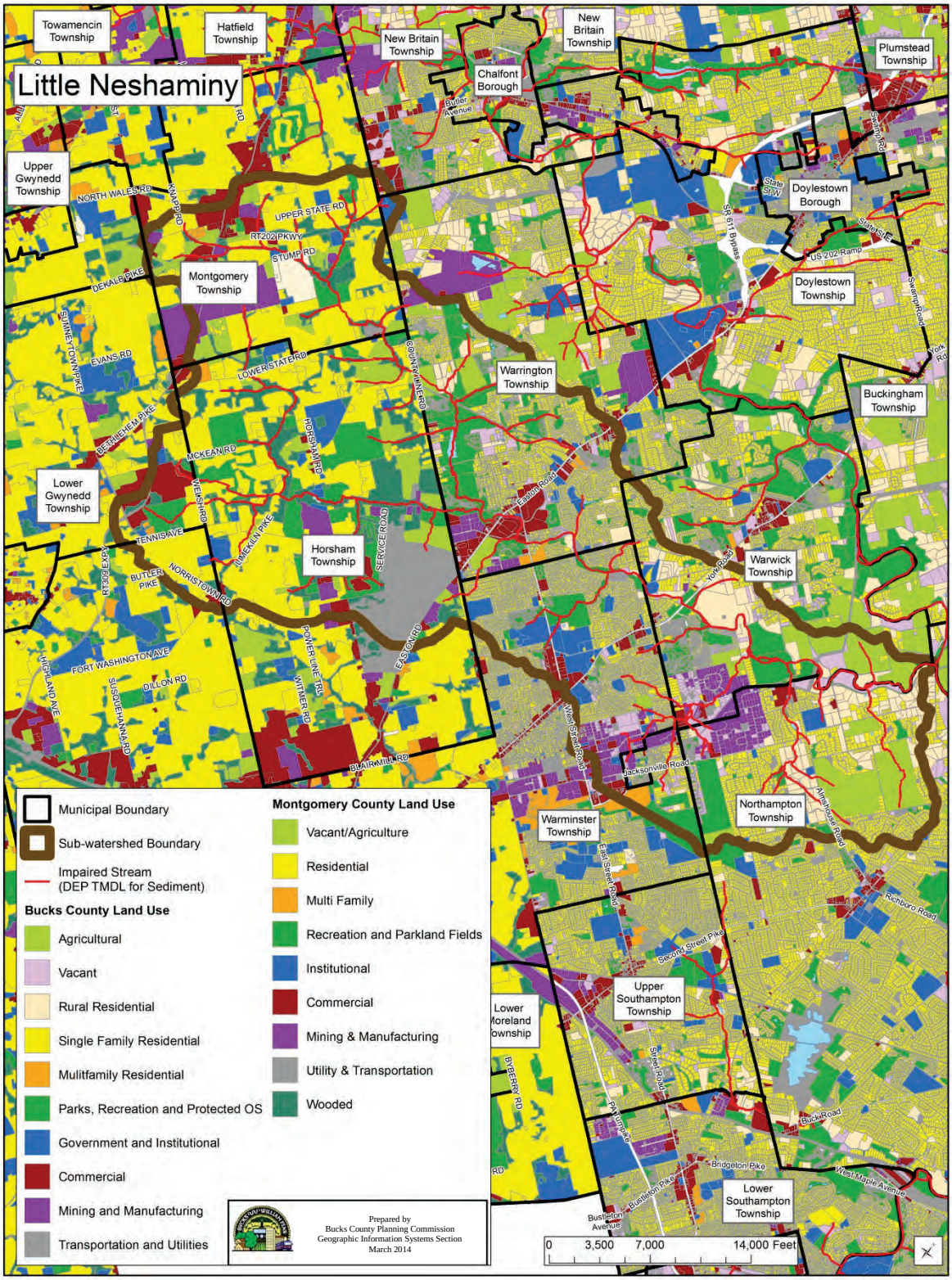
Table 6
Proposed TSS Reduction for the Little Neshaminy Creek Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 9.1 miles of the 47.2 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	479,741
Streambank restoration – Developed Lands focuses on 7.3 miles of the 47.2 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	383,793
Streambank restoration – Transitional Lands focuses on 1.0 miles of the 47.2 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	54,828
Riparian Buffers focuses on 8.7 miles of the 47.2 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	374,603
Constructed Wetland BMP Jarrett Nature Center (TSS removal rate of 85% as per PA BMP Manual)	489
Retrofit Basin Demonstration project: Cedar Hill Road Park, Horsham Township (TSS removal rate of 60% as per PA BMP Manual)	345
Retrofit Basins – Residential Development Approximately 59 basins in low intensity development and 18 basins in high density development (TSS removal rate of 60% as per PA BMP Manual)	20,386 4,600
Retrofit Basins – Agricultural Lands Approximately 26 basins in hay / pasture and 35 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	6,554 78,956
Retrofit Basins – Transitional Lands Approximately 12 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	123,923
Manufactured Treatment Devices Approximately 59 MTDs in low intensity development and 36 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	9,513 4,294
Total Amount of TSS Removed	**1,542,025**

Table 7
Cost Estimates for Project Implementation in the Little Neshaminy Creek Sub–watershed

Project	Low Estimate	High Estimate
Streambank restoration – agricultural lands (9.1 miles)	$240,240.00	$960,960.00
Streambank restoration – developed lands (7.3 miles)	192,720.00	770,880.00
Streambank restoration – transitional lands (1.0 miles)	26,400.00	105,600.00
Riparian buffers – forested lands (1.5 miles)	0.00	689,040.00
Constructed Wetland at Jarrett Nature Center	37,000.00	400,000.00
Cedar Hill residential basin retrofit	1,500.00	50,000.00
Retrofit residential basins (77 basins)	115,500.00	3,850,000.00
Retrofit agricultural basins (61 basins)	91,500.00	1,525,000.00
Retrofit transitional regional basins (12 basins)	18,000.00	600,000.00
MTDs (95 units)	3,325,000.00	5,225,000.00
Total	**$4,047,860.00**	**$14,176,480.00**

Little Neshaminy Creek Sub-watershed Map



NESHAMINY CREEK SOUTH #1 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek South #1 sub–watershed is located in Bucks County and is about 7.6 square miles in size. Neshaminy Creek South #1 is a portion of the main stem of the lower portion of Neshaminy Creek; it also includes several small tributaries. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Neshaminy Creek South #1 sub–watershed are Bensalem Township, Lower Southampton Township, Middletown Township, Langhorne Borough, and Langhorne Manor Borough.

Its portion of the Neshaminy Creek TMDL applies to 7.6 miles of waterways within this sub–watershed. With the reference watershed approach, a TMDL was established for the Neshaminy Creek South #1 sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 918,390 pounds of TSS per year (Table 1), making it the fourth largest existing and targeted reduction of TSS for the Neshaminy Creek watershed.

The dominant land uses within the Neshaminy Creek South #1 sub–watershed were developed lands (65 percent), forested (26 percent) and transitional (3 percent). Agricultural lands account for only approximately 6 percent of the sub–watershed's land use. The largest existing TSS loads originate from streambank erosion (2.5 million pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 8 is estimated to remove approximately 931,199 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 12,809 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $2.4 million and $7.3 million (Table 9). Estimated long–term maintenance costs are provided in Appendix 2.

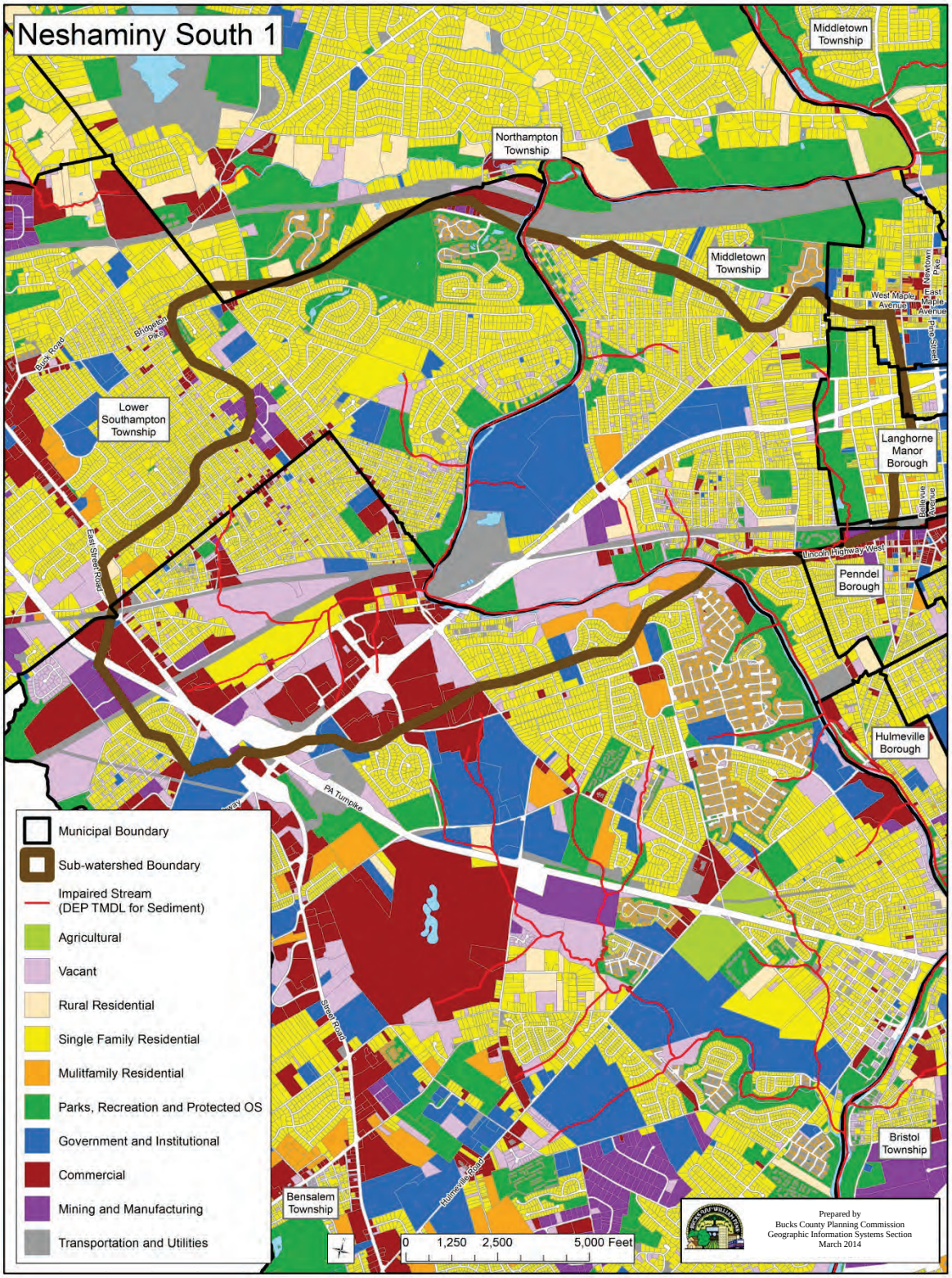
Table 8
Proposed TSS Reduction for the Neshaminy Creek South #1 Sub-watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 0.3 miles of the 7.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	59,710
Streambank restoration – Developed Lands focuses on 2.7 miles of the 7.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	355,775
Streambank restoration – Transitional Lands focuses on 0.3 miles of the 7.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	39,283
Riparian Buffers focuses on 1.3 miles of the 7.6 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 55% as per PA BMP Manual)	281,386
Retrofit Basins – Residential Development Approximately 47 basins in low intensity development and 15 basins in high density development (TSS removal rate of 60% as per PA BMP Manual)	45,923 5,639
Retrofit Basins – Agricultural Lands Approximately 2 basins in hay / pasture and 4 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	1,823 70,158
Retrofit Basins – Transitional Lands Approximately 3 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	47,439
Manufactured Treatment Devices Approximately 47 MTDs in low intensity development and 15 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	21,431 2,632
Total Amount of TSS Removed	**931,199**

Table 9
Cost Estimates for Project Implementation in Neshaminy Creek South #1 Sub-watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$ 7,920.00	$ 31,680.00
Streambank restoration – developed lands (2.7 miles)	71,280.00	285,120.00
Streambank restoration – transitional lands (1.1 miles)	29,040.00	116,160.00
Riparian buffers – forested lands (1.3 miles)	0.00	102,960.00
Retrofit residential basins (62 basins)	93,000.00	3,100,000.00
Retrofit agricultural basins (6 basins)	9,000.00	150,000.00
Retrofit transitional regional basins (3 basins)	4,500.00	150,000.00
MTDs (62 units)	2,170,000.00	3,410,000.00
Total	**$2,384,740.00**	**$7,345,920.00**

Neshaminy Creek South #1 Sub-watershed Map



NESHAMINY CREEK TRIBUTARY #3 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek Tributary #3 sub–watershed is located entirely in Warwick Township, Bucks County and is about 2.9 square miles in size. Neshaminy Creek Tributary #3 is a series of tributaries of Neshaminy Creek with the main stem being known locally as Fish Creek. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 3.3 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Neshaminy Creek Tributary #3 sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 791,346 pounds of TSS per year (Table 1).

The dominant land uses within the Neshaminy Creek Tributary #3 sub–watershed were agricultural lands (36 percent), developed lands (23 percent) and forested (21 percent). The largest existing TSS loads originate from transitional land (870,839 pounds per year), followed by cropland (102,539 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 10 is estimated to remove approximately 620,160 pounds of TSS per year. For this sub–watershed, it was recommended that the entire 3.3 miles of impaired waterways be stabilized or restored. In spite of this, the total amount of TSS estimated to be removed is less than the amount targeted for removal. Thus, under this given scenario there is a deficit of 171,186 pounds of TSS that still requires to be removed to comply with the TMDL. The cost to implement all of these measures, as outlined in Table 10, is estimated between $622,000 and $3 million (Table 11). Estimated long–term maintenance costs are provided in Appendix 2.

It should be noted that some very simplified Unit Aerial Loading modeling was conducted to determine if the Neshaminy Creek Tributary #3 sub–watershed could be in compliance with its TMDL if more severe watershed–based measures were implemented. For example, based on this simplified modeling, even if all 531 acres of existing farmland were converted to forested lands, it would still not be sufficient to address the remaining 171,186 pounds of TSS. Obviously, converting all farmland into forested lands is not feasible and still would not bring the TMDL for this sub–watershed into compliance.

The Fish Creek (Neshaminy Creek Tributary #3) sub–watershed should be targeted as the next detailed study area to include a field inventory and assessment of specific problem areas such as was conducted for the Pine Run Sub–watershed during this study. In October 2013 a Coastal Zone Management grant application was submitted to the PADEP to conduct such a study as "Phase II" of the *Neshaminy Creek Watershed Sediment Reduction Plan*. If the grant application is approved, the Phase II study would begin in October 2014 and be completed by March 2016.

Figure 13: Detention basin that could be retrofitted along Route 263 (Fish Creek) (September 2013)

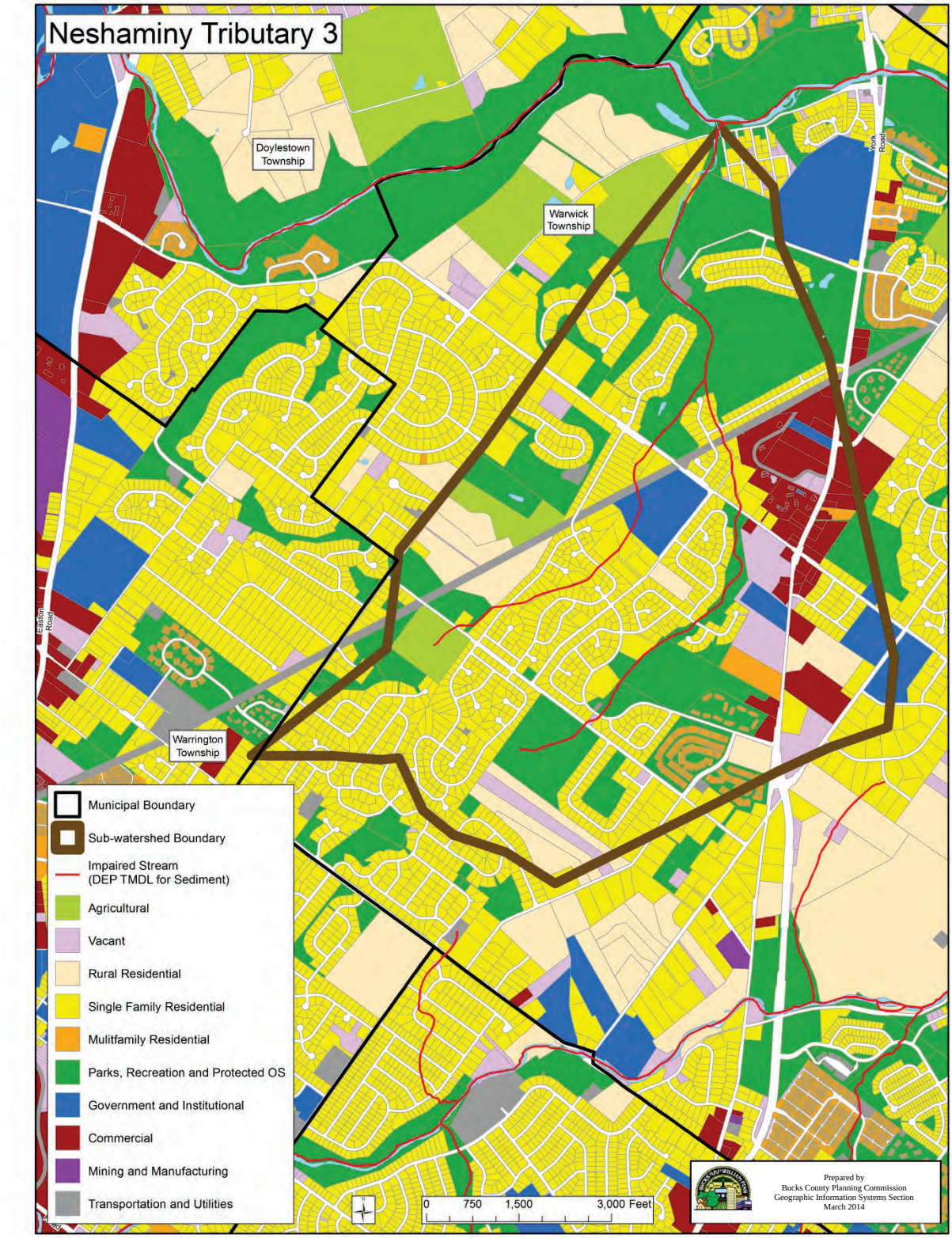
Table 10
Proposed TSS Reduction for the Neshaminy Creek Tributary #3 Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 1.0 miles of the 3.3 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	8,085
Streambank restoration – Developed Lands focuses on 0.2 miles of the 3.3 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	1,951
Streambank restoration – Transitional Lands focuses on 1.0 miles of the 3.3 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	8,642
Riparian Buffers focuses on 1.1 miles of the 3.3 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	7,550
Retrofit Basins – Residential Development Four (4) basins in low intensity development and Two (2) basins in high density development (TSS removal rate of 60% as per PA BMP Manual)	2,460 930
Retrofit Basins – Agricultural Lands Five (5) basins in hay / pasture and 16 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	2,774 61,620
Retrofit Basins – Transitional Lands Approximately 22 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	522,480
Manufactured Treatment Devices Nine (9) MTDs in low intensity development and Five (5) MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	2,583 1,085
Total Amount of TSS Removed	**620,160**

Table 11
Cost Estimates for Project Implementation in the Neshaminy Creek Tributary #3 Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.0 miles)	$ 26,400.00	$ 105,600.00
Streambank restoration – developed lands (0.2 miles)	5,280.00	21,120.00
Streambank restoration – transitional lands (1.0 miles)	26,400.00	105,600.00
Riparian buffers – forested lands (1.1 miles)	0.00	87,120.00
Retrofit residential basins (6 basins)	9,000.00	300,000.00
Retrofit agricultural basins (21 basins)	31,500.00	525,000.00
Retrofit transitional regional basins (22 basins)	33,000.00	1,100,000.00
MTDs (14 units)	490,000.00	770,000.00
Total	**$621,580.00**	**$3,014,440.00**

Neshaminy Creek Tributary #3 Sub-watershed Map



NESHAMINY CREEK SOUTH #2 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek South #2 sub–watershed is located in southern Bucks County and is about 5.4 square miles in size. This sub–watershed is entirely located in Bensalem Township and is a series of unnamed tributaries to Neshaminy Creek. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 9.9 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Neshaminy Creek South #2 sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 722,078 pounds of TSS per year (Table 1).

The dominant land uses within the Neshaminy Creek South #2 sub–watershed were developed lands (59 percent), agricultural lands (21 percent), forested (17 percent) and transitional (3 percent). The largest existing TSS loads originate from streambank erosion (1.4 million pounds per year), followed by cropland (283,509 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 12 is estimated to remove approximately 727,936 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 5,858 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $2.4 million and $7.7 million (Table 13). Estimated long–term maintenance costs are provided in Appendix 2.

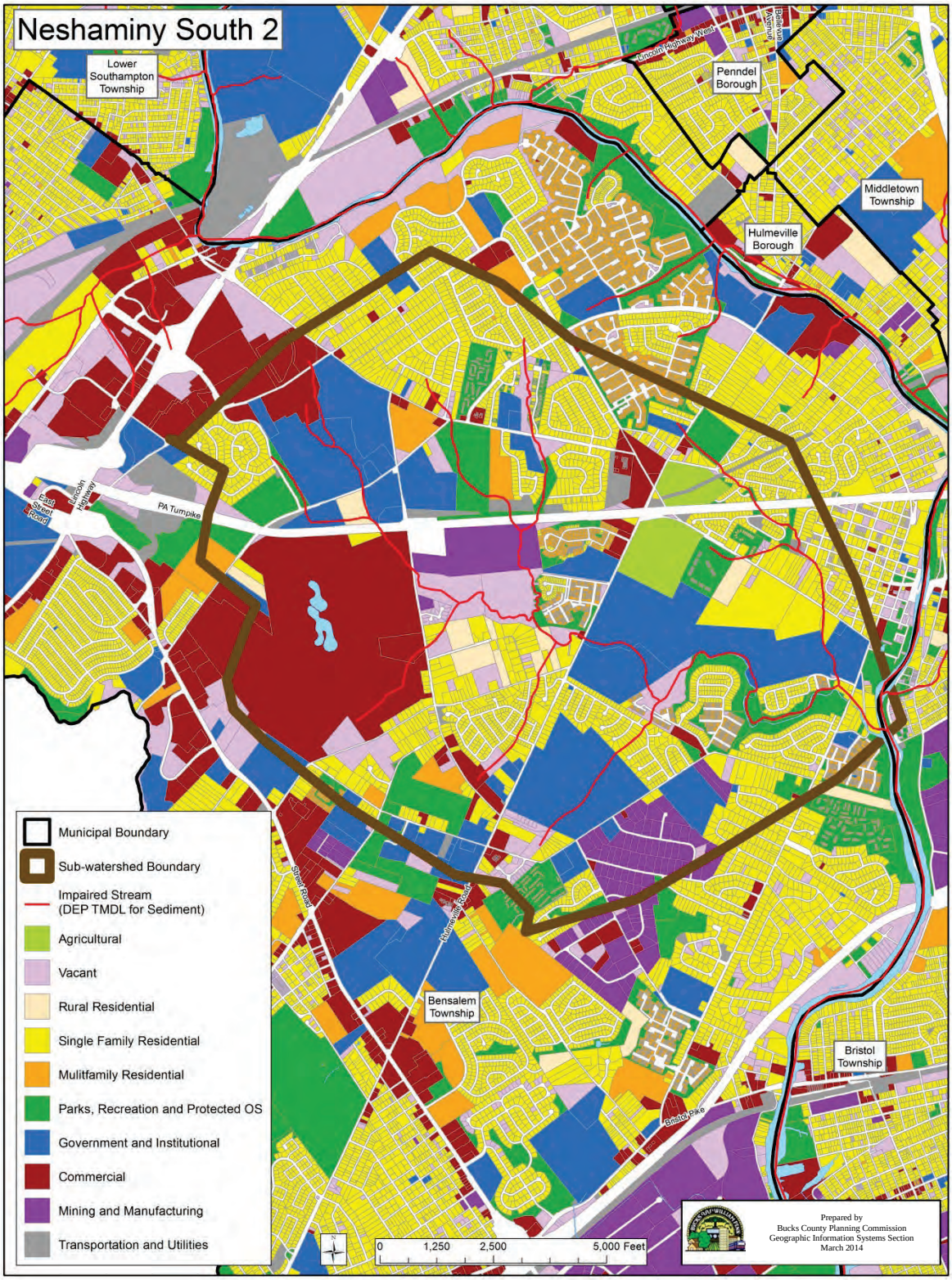
Table 12
Proposed TSS Reduction for the Neshaminy Creek South #2 Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 1.6 miles of the 9.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	88,915
Streambank restoration – Developed Lands focuses on 4.4 miles of the 9.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	249,808
Streambank restoration – Transitional Lands focuses on 0.2 miles of the 9.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	16,936
Riparian Buffers focuses on 1.5 miles of the 9.9 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	137,606
Retrofit Basins – Residential Development Approximately 47 basins in low intensity development and 15 basins in high density development (TSS removal rate of 60% as per PA BMP Manual)	11,571 5,229
Retrofit Basins – Agricultural Lands Approximately 2 basins in hay / pasture and 9 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	2,930 170,035
Retrofit Basins – Transitional Lands Approximately 3 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	33,930
Manufactured Treatment Devices Approximately 47 MTDs in low intensity development and 15 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	7,560 3,416
Total Amount of TSS Removed	**727,936**

Table 13
Cost Estimates for Project Implementation in the Neshaminy Creek South #2 Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.6 miles)	$ 42,240.00	$ 168,960.00
Streambank restoration – developed lands (4.4 miles)	116,160.00	464,640.00
Streambank restoration – transitional lands (0.2 miles)	5,280.00	21,120.00
Riparian buffers – forested lands (1.5 miles)	0.00	118,800.00
Retrofit residential basins (62 basins)	93,000.00	3,100,000.00
Retrofit agricultural basins (11 basins)	16,500.00	275,000.00
Retrofit transitional regional basins (3 basins)	4,500.00	150,000.00
MTDs (62 units)	2,170,000.00	3,410,000.00
Total	**$2,447,680.00**	**$7,708,520.00**

Neshaminy Creek South #2 Sub-watershed Map



MILL CREEK SUB–WATERSHED OF NESHAMINY CREEK

The Mill Creek sub–watershed is located in Bucks County and is about 4.7 square miles in size. Mill Creek is a tributary to Neshaminy Creek. Its protected uses are for water supply, recreation and aquatic life and its aquatic use is cold water fishes and migratory fishes. The Bucks County municipalities within the Mill Creek sub–watershed are Doylestown Township, New Britain Township and Warrington Township. There is a very small portion of the sub–watershed located in Montgomery Township, Montgomery County.

Its portion of the Neshaminy Creek TMDL applies to 8.7 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Mill Creek sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 619,346 pounds of TSS per year (Table 1).

The dominant land uses within the Mill Creek sub–watershed were agricultural lands (62 percent), forested (20 percent) and developed lands (11 percent). The largest existing TSS loads originate from croplands (1.4 million pounds per year), followed by streambank erosion (562,720 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 14 is estimated to remove approximately 636,660 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 17,314 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $657,000 and $3.2 million (Table 15). Estimated long–term maintenance costs are provided in Appendix 2.

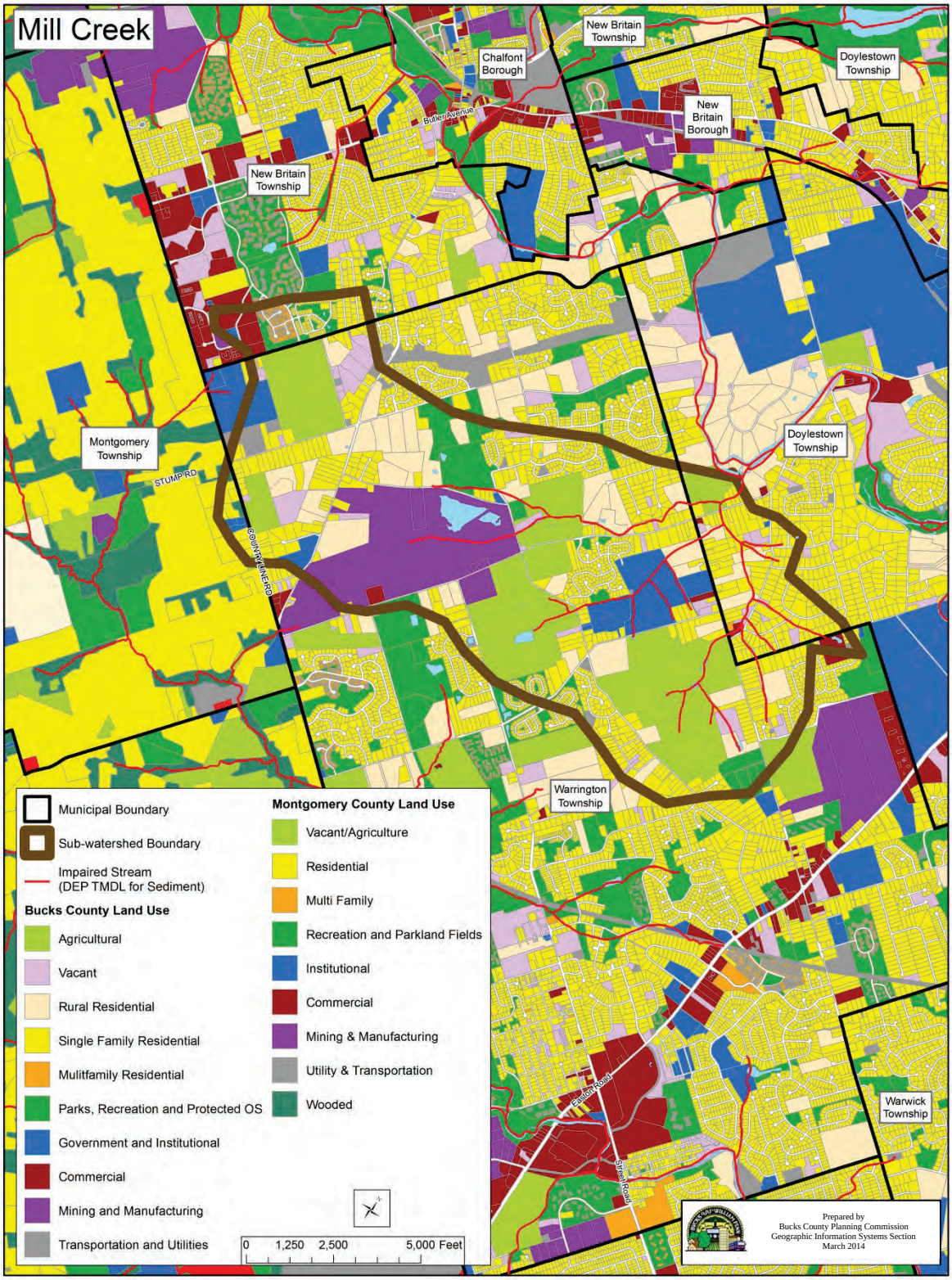
Table 14
Proposed TSS Reduction for the Mill Creek Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 3.0 miles of the 8.7 miles of waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	75,188
Streambank restoration – Developed Lands focuses on 0.5 miles of the 8.7 miles of waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	13,340
Streambank restoration – Transitional Lands focuses on 0.2 miles of the 8.7 miles of waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	7,276
Riparian Buffers focuses on 1.0 miles of the 8.7 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	43,037
Retrofit Basins – Residential Development Approximately 13 basins in low intensity development (TSS removal rate of 60% as per PA BMP Manual)	3,751
Retrofit Basins – Agricultural Lands Approximately 17 basins in hay / pasture and 29 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	13,097 428,161
Retrofit Basins – Transitional Lands Approximately 4 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	45,036
Retrofit Basins – Quarry 1 regional basin to address runoff from the quarry (TSS removal rate of 60% as per PA BMP Manual)	6,024
Manufactured Treatment Devices Approximately 13 MTDs in low intensity development	1,750
Total Amount of TSS Removed	**636,660**

Table 15
Cost Estimates for Project Implementation in the Mill Creek Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (3.0 miles)	$ 79,200.00	$ 316,800.00
Streambank restoration – developed lands (0.5 miles)	13,200.00	52,800.00
Streambank restoration – transitional lands (1.0 miles)	5,280.00	21,120.00
Riparian buffers – forested lands (1.0 miles)	0.00	79,200.00
Retrofit residential basins (13 basins)	19,500.00	650,000.00
Retrofit agricultural basins (46 basins)	69,000.00	1,150,000.00
Retrofit transitional regional basins (4 basins)	6,000.00	200,000.00
Regional basin at the Quarry (1 basin)	10,000.00	50,000.00
MTDs (62 units)	455,000.00	715,000.00
Total	**$657,180.00**	**$3,234,920.00**

Mill Creek Sub-watershed Map



NESHAMINY CREEK SOUTH #3 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek South #3 sub–watershed is located in Bucks County and is about 4.6 square miles in size. Neshaminy Creek South #3 is located in the lower part of the main stem of Neshaminy Creek; several small tributaries also flow into it. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Neshaminy Creek South #3 sub–watershed are Hulmeville Borough, Penndel Borough, Bensalem Township and Middletown Township.

Its portion of the Neshaminy Creek TMDL applies to 5.4 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Neshaminy Creek South #3 sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 514,517 pounds of TSS per year (Table 1).

The dominant land use within the Neshaminy Creek South #3 sub–watershed is developed lands (70 percent). Agricultural lands account for 8 percent of the land use, while forested land accounts for 20 percent of the land use within this sub–watershed. The largest existing TSS loads originate from streambank erosion (1.3 million pounds per year), followed by cropland (44,320 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 16 is estimated to remove approximately 519,350 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 4,833 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $1.5 and $5.2 million (Table 17). Estimated long–term maintenance costs are provided in Appendix 2.

Table 16
Proposed TSS Reduction for the Neshaminy Creek South #3 Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 0.4 miles of the 5.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	41,970
Streambank restoration – Developed Lands focuses on 3.8 miles of the 5.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	275,426
Streambank restoration – Transitional Lands focuses on 0.1 miles of the 5.4 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	10,492
Riparian Buffers focuses on 1.0 miles of the 5.4 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	150,042
Retrofit Basins – Residential Development Approximately 32 basins in low intensity development and 15 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	10,351 741
Retrofit Basins – Agricultural Lands Approximately 2 basins in hay / pasture and 5 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	566 19,028
Retrofit Basins – Transitional Lands 1 regional basin to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	5,558
Manufactured Treatment Devices Approximately 13 MTDs in low intensity development and 7 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	4,830 346
Total Amount of TSS Removed	**519,350**

Table 17
Cost Estimates for Project Implementation in the Neshaminy Creek South #3 Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.4 miles)	$ 10,560.00	$ 42,240.00
Streambank restoration – developed lands (3.8 miles)	100,320.00	401,280.00
Streambank restoration – transitional lands (0.1 miles)	2,640.00	10,560.00
Riparian buffers – forested lands (1.0 miles)	0.00	79,200.00
Retrofit residential basins (47 basins)	70,500.00	2,350,000.00
Retrofit agricultural basins (7 basins)	10,500.00	175,000.00
Retrofit transitional regional basins (1 basin)	1,500.00	50,000.00
MTDs (38 units)	1,330,000.00	2,090,000.00
Total	**$1,526,020.00**	**$5,198,280.00**

Neshaminy Creek South #3 Sub-watershed Map

NESHAMINY CREEK TRIBUTARY #1 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek Tributary #1 sub–watershed is entirely located in Northampton Township, Bucks County, and is about 2.1 square miles in size. Neshaminy Creek Tributary #1 is a tributary of Neshaminy Creek and its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 4.6 miles of waterways within this sub–watershed. The TMDL for Neshaminy Creek Tributary #1 is based on the comparison of simulated TSS loads, comparing loads when the stream attained its designed use (1992) to a time when it was identified as impaired (2000). The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 511,672 pounds of TSS per year (Table 1).

The dominant land uses within the Neshaminy Creek Tributary #1 sub–watershed were agriculture (36 percent), developed lands (23 percent), forested (21 percent) and transitional (2%). However, the largest existing TSS loads originate from transitional lands (524,901 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 18 is estimated to remove approximately 426,528 pounds of TSS per year. For this sub–watershed, it was recommended that the entire 4.6 miles of impaired waterways be stabilized or restored. In spite of this, the total amount of TSS estimated to be removed is less than the amount targeted for removal. Thus, under this given scenario there is a deficit of 79,373 pounds of TSS that is still required to be removed to comply with the TMDL. The cost to implement all of these measures, as outlined in Table 18, is estimated between $608,000 and $2.5 million (Table 19). Estimated long–term maintenance costs are provided in Appendix 2.

Simplified Unit Aerial Loading modeling was conducted to determine if the Neshaminy Creek Tributary #1 sub–watershed could be in compliance with its TMDL if more severe watershed–based measures were implemented. Based on the modeling efforts, if approximately 76 percent of the existing farmland was converted into forested lands, this sub–watershed would attain its targeted reduction in TSS. However, the feasibility of such a drastic management measure is extremely low and not desirable.

Table 18
Proposed TSS Reduction for the Neshaminy Creek Tributary #1 Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 1.7 miles of the 4.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	10,492
Streambank restoration – Developed Lands focuses on 1.1 miles of the 4.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	6,703
Streambank restoration – Transitional Lands focuses on 0.9 miles of the 4.6 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	6,121
Riparian Buffers focuses on 1.5 miles of the 4.6 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	9,472
Retrofit Basins – Residential Development Approximately 11 basins in low intensity development and 2 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	9,346 731
Retrofit Basins – Agricultural Lands Approximately 8 basins in hay / pasture and 11 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	6,209 57,829
Retrofit Basins – Transitional Lands Approximately 3 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	314,923
Manufactured Treatment Devices Approximately 11 MTDs in low intensity development and 2 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	4,361 341
Total Amount of TSS Removed	**426,528**

Table 19
Cost Estimates for Project Implementation in the Neshaminy Creek Tributary #1 Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.7 miles)	$ 44,880.00	$ 179,520.00
Streambank restoration – developed lands (1.1 miles)	29,040.00	116,160.00
Streambank restoration – transitional lands (1.0 miles)	26,400.00	105,600.00
Riparian buffers – forested lands (0.9 miles)	0.00	71,280.00
Retrofit residential basins (13 basins)	19,500.00	650,000.00
Retrofit agricultural basins (19 basins)	28,500.00	475,000.00
Retrofit transitional regional basins (3 basins)	4,500.00	150,000.00
MTDs (13 units)	455,000.00	715,000.00
Total	**$607,820.00**	**$2,462,560.00**

Neshaminy Creek Tributary #1 Sub-watershed Map

SUB–BASIN #3 WEST BRANCH OF NESHAMINY CREEK

The Sub–basin #3 West Branch is located in Bucks County and is about 4.0 square miles in size. The Sub–basin #3 West Branch sub–watershed is a tributary of the West Branch of Neshaminy Creek and is known locally as Reading Creek. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Sub–basin #3 West Branch sub–watershed are Hilltown Township, New Britain Township and New Britain Borough.

Its portion of the Neshaminy Creek TMDL applies to 8.5 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Sub–basin #3 West Branch sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 483,430 pounds of TSS per year (Table 1).

The dominant land uses within the Sub–basin #3 West Branch sub–watershed are agricultural lands (49 percent) and forested lands (44 percent). Developed lands account for 7 percent of the land use within this sub–watershed. The largest existing TSS loads originate from croplands (706,203 pounds per year), followed by streambank erosion (205,077 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 20 is estimated to remove approximately 305,308 pounds of TSS per year. For this sub–watershed, it was recommended that the entire 8.5 miles of impaired waterways be stabilized or restored. In spite of this, the total amount of TSS estimated to be removed is less than the amount targeted for removal. Thus, under this given scenario there is a deficit of 178,122 pounds of TSS that is still required to be removed to comply with the TMDL. The cost to implement all of these measures, as outlined in Table 20, is estimated between $0.5 million and $3 million (Table 21). Estimated long–term maintenance costs are provided in Appendix 2.

Simplified Unit Aerial Loading modeling was conducted to determine if the Sub–basin #3 West Branch sub–watershed could be in compliance with its TMDL if more severe watershed–based measures were implemented. Based on the modeling efforts, if approximately 26 percent of the existing farmland was converted into forested lands, this sub–watershed would attain its targeted reduction in TSS. The feasibility of such a drastic management measure is low and not desirable.

The Reading Creek (West Branch Sub–basin #3) sub–watershed should be targeted as the next detailed study area to include a field inventory and assessment of specific problem areas such as was conducted for the Pine Run sub–watershed during this study. In October 2013 a Coastal Zone Management grant application was submitted to the PADEP to conduct such a study as "Phase II" of the *Neshaminy Creek Watershed Sediment Reduction Plan for Municipal Implementation.* If the grant application is approved, the Phase II study would begin in October 2014 and be completed by March 2016.

Figure 14: Conventional stormwater basin located along Township Line Road (May 2013)

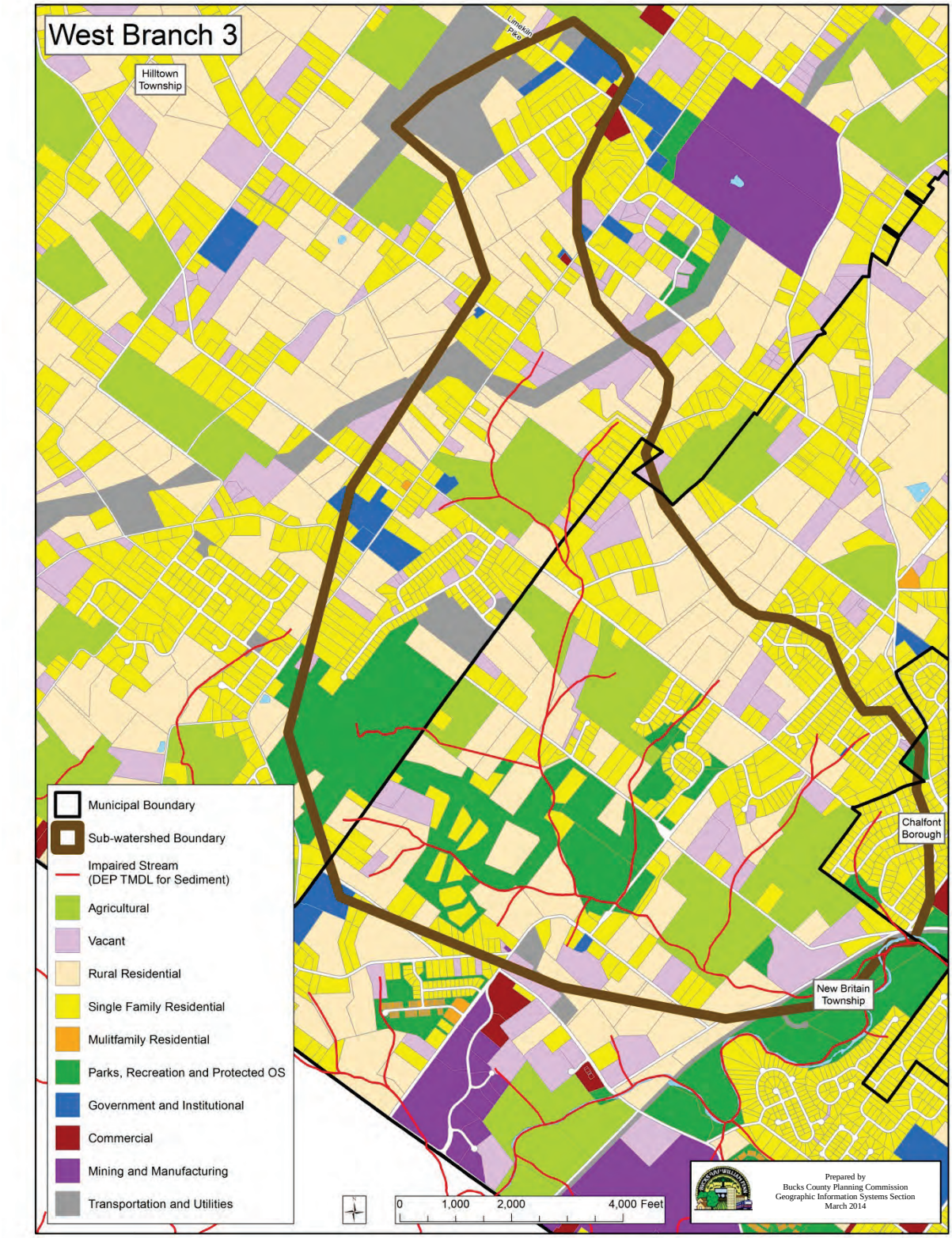
Table 20
Proposed TSS Reduction for the Sub–basin #3 West Branch

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 4.2 miles of the 8.5 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	43,982
Streambank restoration – Developed Lands focuses on 0.6 miles of the 8.5 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	6,283
Streambank restoration – Transitional Lands focuses on 0.03 miles of the 8.5 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	269
Riparian Buffers focuses on 3.7 miles of the 8.5 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	64,178
Retrofit Basins – Residential Development Approximately 3 basins in low intensity development and 5 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	2,918 3,764
Retrofit Basins – Agricultural Lands Approximately 8 basins in hay / pasture and 44 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	4,200 142,441
Retrofit Basins – Transitional Lands 1 regional basin to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	34,155
Manufactured Treatment Devices Approximately 3 MTDs in low intensity development and 5 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	1,362 1,756
Total Amount of TSS Removed	**305,308**

Table 21
Cost Estimates for Project Implementation in the Sub–basin #3 West Branch

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (4.2 miles)	$110,880.00	$ 443,520.00
Streambank restoration – developed lands (0.6 miles)	15,840.00	63,360.00
Streambank restoration – transitional lands (0.03 miles)	2,640.00	10,560.00
Riparian buffers – forested lands (3.7 miles)	0.00	293,040.00
Retrofit residential basins (8 basins)	12,000.00	400,000.00
Retrofit agricultural basins (52 basins)	78,000.00	1,300,000.00
Retrofit transitional regional basins (1 basin)	1,500.00	50,000.00
MTDs (8 units)	280,000.00	440,000.00
Total	**$500,860.00**	**$3,000,480.00**

Sub-basin #3 West Branch Map



CORE CREEK SUB–WATERSHED OF NESHAMINY CREEK

The Core Creek sub–watershed is located in Bucks County and is about 9.9 square miles in size. The Core Creek is a tributary that drains into the main stem of Neshaminy Creek. Its protected uses are for water supply, recreation and aquatic life. Aquatic uses include cold water fishes in the upper part of the stream, warm water fishes in the lower part of the stream, and migratory fishes throughout. The municipalities within the Core Creek sub–watershed are Lower Makefield Township, Middletown Township and Newtown Township.

The Core Creek portion of the Neshaminy Creek TMDL applies to 15.8 miles of streams within the sub–watershed. With the reference watershed approach, a TMDL was established for the Core Creek sub–watershed. The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 448,730 pounds of TSS per year (Table 1).

The dominant land uses within the Core Creek sub–watershed are agricultural lands (50 percent) and developed lands (42 percent). Forested lands account for 8 percent of the land use within this sub–watershed. The largest existing TSS loads originate from croplands (1.14 million pounds per year), followed by streambank erosion (571,523 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 22 is estimated to remove approximately 764,000 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 315,270 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $1.3 and $5.0 million (Table 23). Estimated long–term maintenance costs are provided in Appendix 2.

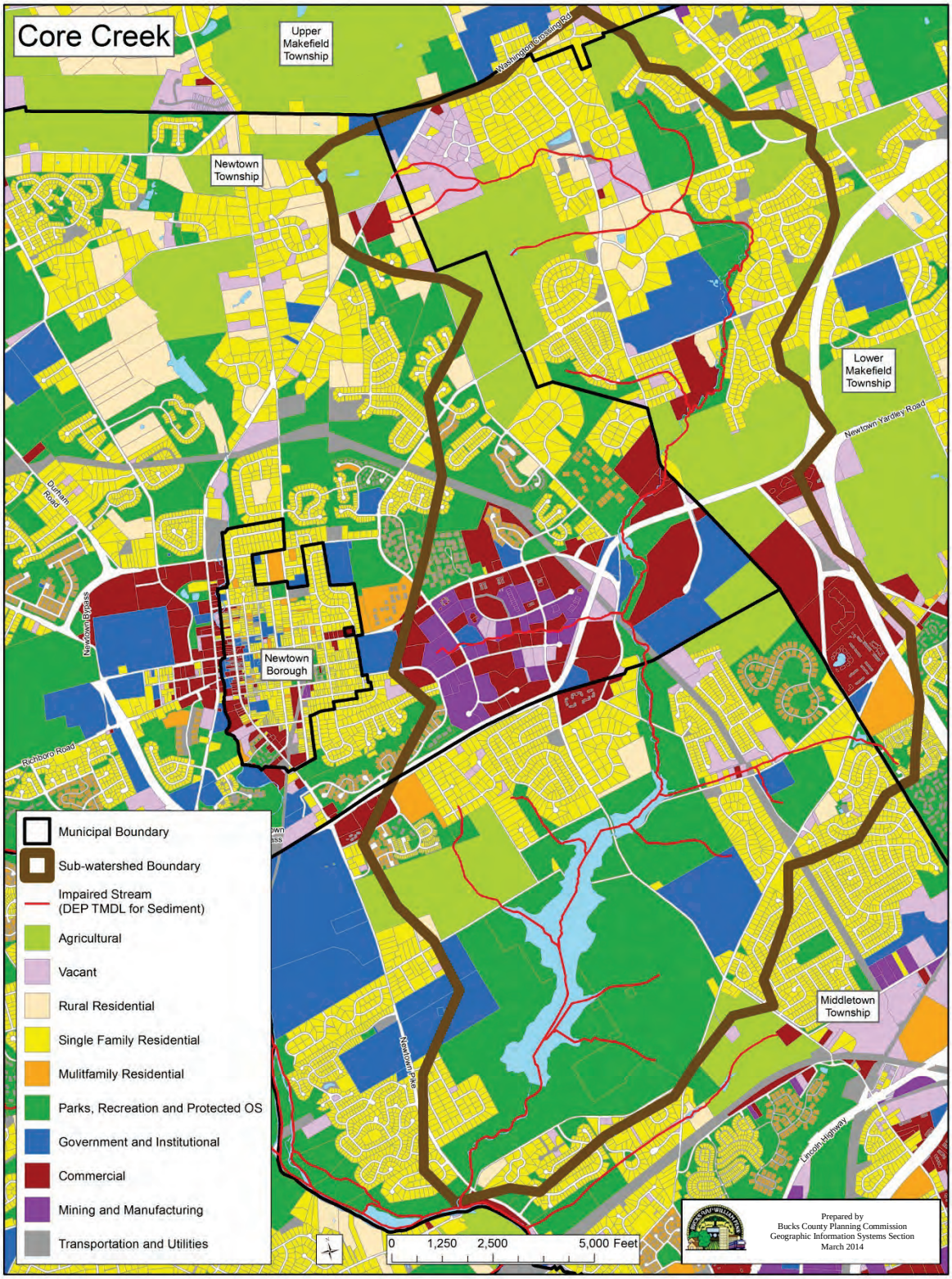
Table 22
Proposed TSS Reduction for the Core Creek Sub–watershed

Identified Watershed Actions, BMPs or MTDs	**TSS removed (pounds / year)**
Maintenance dredging of Conservation Pool at Lake Luxembourg (conservatively ascribed TSS removal rate of 55%; 15% lower than PA BMP Manual)	579,019
Streambank restoration – Agricultural Lands focuses on 5.0 miles of the 15.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	73,230
Streambank restoration – Developed Lands focuses on 3.6 miles of the 15.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	53,959
Streambank restoration – Transitional Lands focuses on 0.3 miles of the 15.8 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	21,840
Riparian Buffers focuses on 0.1miles of the 15.8 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	1,888
Retrofit Basins – Residential Development Approximately 22 basins in low intensity development and 6 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	9,492 2,020
Retrofit Basins – Agricultural Lands Approximately 2 basins in hay / pasture and 2 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	774 16,211
Retrofit Basins – Transitional Lands Approximately 20 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	613
Manufactured Treatment Devices Approximately 22 MTDs in low intensity development and 6 MTDs in high intensity development (TSS removal rate of 70% as per US EPA)	4,429 525
Total Amount of TSS Removed	**746,000**

Table 23
Cost Estimates for Project Implementation in the Core Creek Sub–watershed

Projects	Low Estimate	High Estimate
Dredging of Conservation Pool	$1,400,000.00	$3,100,000.00
Streambank restoration – agricultural lands (5.0 miles)	132,000.00	528,000.00
Streambank restoration – developed lands (3.6 miles)	95,040.00	380,160.00
Streambank restoration – transitional lands (0.03 miles)	7,920.00	31,680.00
Riparian buffers – forested lands (0.1 miles)	0.00	7,920.00
Retrofit residential basins (28 basins)	42,000.00	1,400,000.00
Retrofit agricultural basins (4 basins)	6,000.00	100,000.00
Retrofit transitional regional basins (20 basins)	30,000.00	1,000,000.00
MTDs (28 units)	980,000.00	1,540,000.00
Total	**$2,692,960.00**	**$8,087,760.00**

Core Creek Sub-watershed Map



SUB–BASIN #2 WEST BRANCH NESHAMINY CREEK

The Sub–basin #2 West Branch sub–watershed is located in Montgomery County and is about 4.0 square miles in size. Sub–basin #2 West Branch is a tributary of Neshaminy Creek and its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Sub–basin #2 West Branch sub–watershed are Hatfield Borough, Lansdale Borough and Montgomery Township.

Its portion of the Neshaminy Creek TMDL applies to 4.9 miles of waterways within this sub–watershed. The TMDL for Sub–basin #2 West Branch is based on the comparison of simulated TSS loads, comparing loads when the stream attained it designed use (1992) to a time when it was identified as impaired (2000). The waste load allocation with a 10% margin of safety was established, resulting in a targeted reduction of 386,490 pounds of TSS per year (Table 1).

The dominant land uses within the Sub–basin #2 West Branch sub–watershed were developed lands (55 percent) and forested (29 percent). Agricultural lands accounted for approximately 8 percent and transitional lands accounted for approximately 7 percent of the land use within the Sub–basin #2 West Branch sub–watershed. The largest existing TSS loads originate from transitional lands (425,717 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 24 is estimated to remove approximately 397,637 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 11,147 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $2.1 and $6.8 million (Table 25). Estimated long–term maintenance costs are provided in Appendix 2.

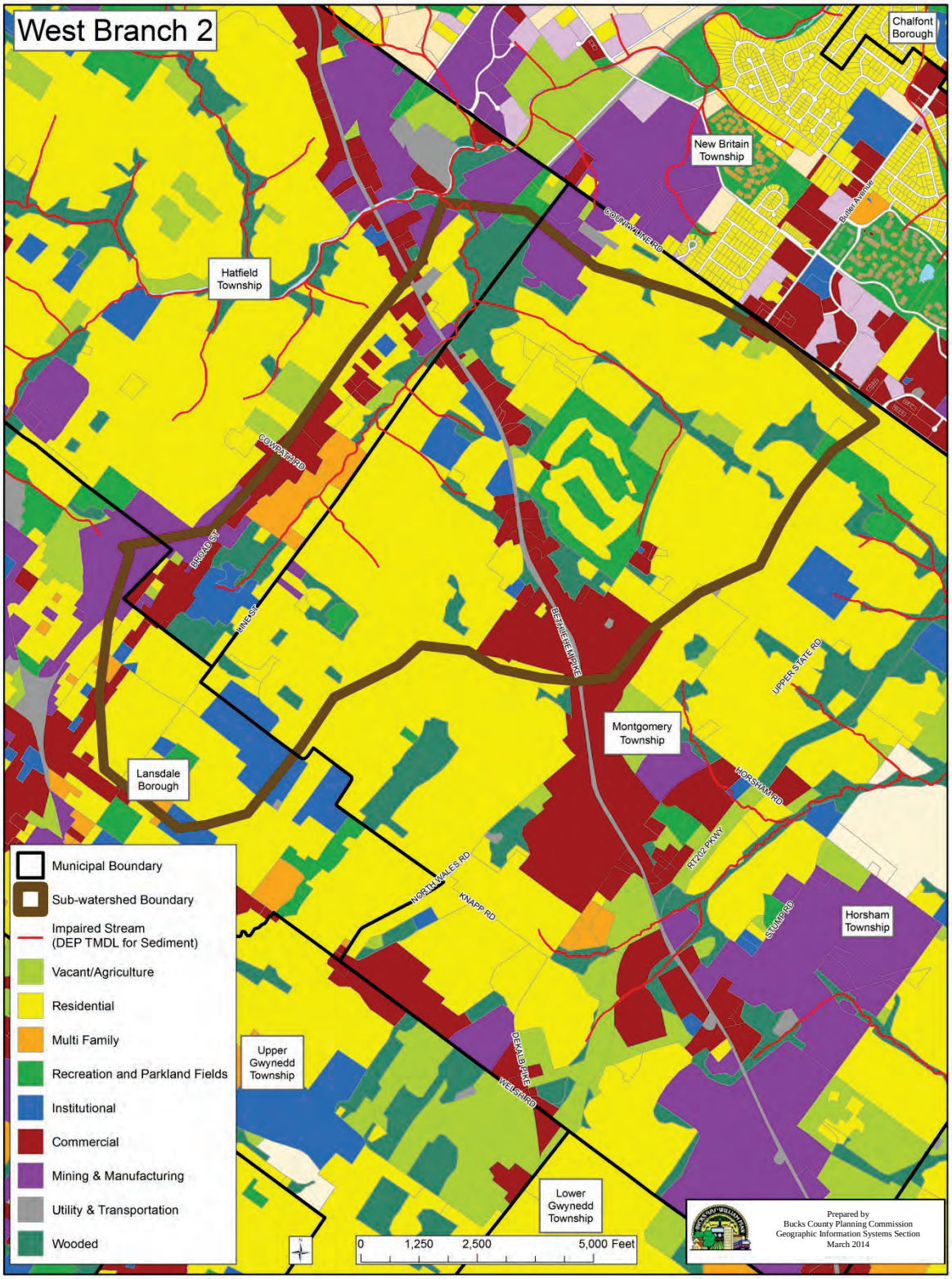
Table 24
Proposed TSS Reduction for the Sub–basin #2 West Branch

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 0.3 miles of the 4.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	3,105
Streambank restoration – Developed Lands focuses on 2.0 miles of the 4.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	21,344
Streambank restoration – Transitional Lands focuses on 0.3 miles of the 4.9 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	3,622
Riparian Buffers focuses on 1.3 miles of the 4.9 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	22,823
Retrofit Basins – Residential Development Approximately 44 basins in low intensity development and 12 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	49,750 9,364
Retrofit Basins – Agricultural Lands Approximately 4 basins in hay / pasture and 5 basins in croplands (TSS removal rate of 60% as per PA BMP Manual)	1,869 14,911
Retrofit Basins – Transitional Lands Approximately 7 regional basins to address transitional lands (TSS removal rate of 60% as per PA BMP Manual)	255,479
Manufactured Treatment Devices Approximately 44 MTDs in low intensity development and 12 MTDs in high intensity development (TSS removal rate of 39% as per US EPA)	12,935 2,435
Total Amount of TSS Removed	**397,637**

Table 25
Cost Estimates for Project Implementation in the Sub–basin #2 West Branch

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$ 7,920.00	$31,680.00
Streambank restoration – developed lands (2.0 miles)	52,800.00	211,200.00
Streambank restoration – transitional lands (0.3 miles)	7,920.00	31,680.00
Riparian buffers – forested lands (1.3 miles)	0.00	102,960.00
Retrofit residential basins (56 basins)	84,000.00	2,800,000.00
Retrofit agricultural basins (9 basins)	13,500.00	225,000.00
Retrofit transitional regional basins (7 basins)	10,500.00	350,000.00
MTDs (56 units)	1,960,000.00	3,080,000.00
Total	**$2,136,640.00**	**$6,832,520.00**

Sub-basin #2 West Branch Map



NESHAMINY CREEK TRIBUTARY #2 SUB–WATERSHED OF NESHAMINY CREEK

The Neshaminy Creek Tributary #2 sub–watershed is entirely located in Middletown Township, Bucks County, and is about one square mile in size. Neshaminy Creek Tributary #2 is a tributary of the main stem of Neshaminy Creek. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes.

Its portion of the Neshaminy Creek TMDL applies to 1.5 miles of waterways within this sub–watershed. The TMDL for Neshaminy Creek Tributary #2 is based on the comparison of simulated TSS loads; comparing loads when the stream attained it designed use (1992) to a time when it was identified as impaired (2000). The waste load allocation (WLA) with a 10 percent margin of safety was established, resulting in a targeted reduction of 109,417 pounds of TSS per year (Table 1).

The dominant land uses within the Neshaminy Creek Tributary #2 sub–watershed were forested (40 percent), residential lands (37 percent) and agricultural lands (23 percent). However, the largest existing TSS loads originate from transitional lands (524,901 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 26 is estimated to remove approximately 34,413 pounds of TSS per year. For this sub–watershed, it was recommended that the entire 1.5 miles of impaired waterways be stabilized or restored. In spite of this, the total amount of TSS estimated to be removed is less than the amount targeted for removal. Thus, under this given scenario there is a deficit of 75,004 pounds of TSS that is still required to be removed to comply with the TMDL. The cost to implement all of these measures, as outlined in Table 26, is estimated between $728,000.00 and $4.45 million dollars (Table 27). Estimated long–term maintenance costs are provided in Appendix 2.

Simplified Unit Aerial Loading modeling was conducted to determine if the Neshaminy Creek Tributary #2 sub–watershed could be in compliance with its TMDL if more severe watershed–based measures were implemented. For example, based on this simplified modeling, even if all 520 acres of existing farmland were converted to forested lands, it would still not be sufficient to address the remaining 75,004 pounds of TSS. Converting all farmland into forested lands is not feasible and would not bring the TMDL for this sub–watershed into compliance.

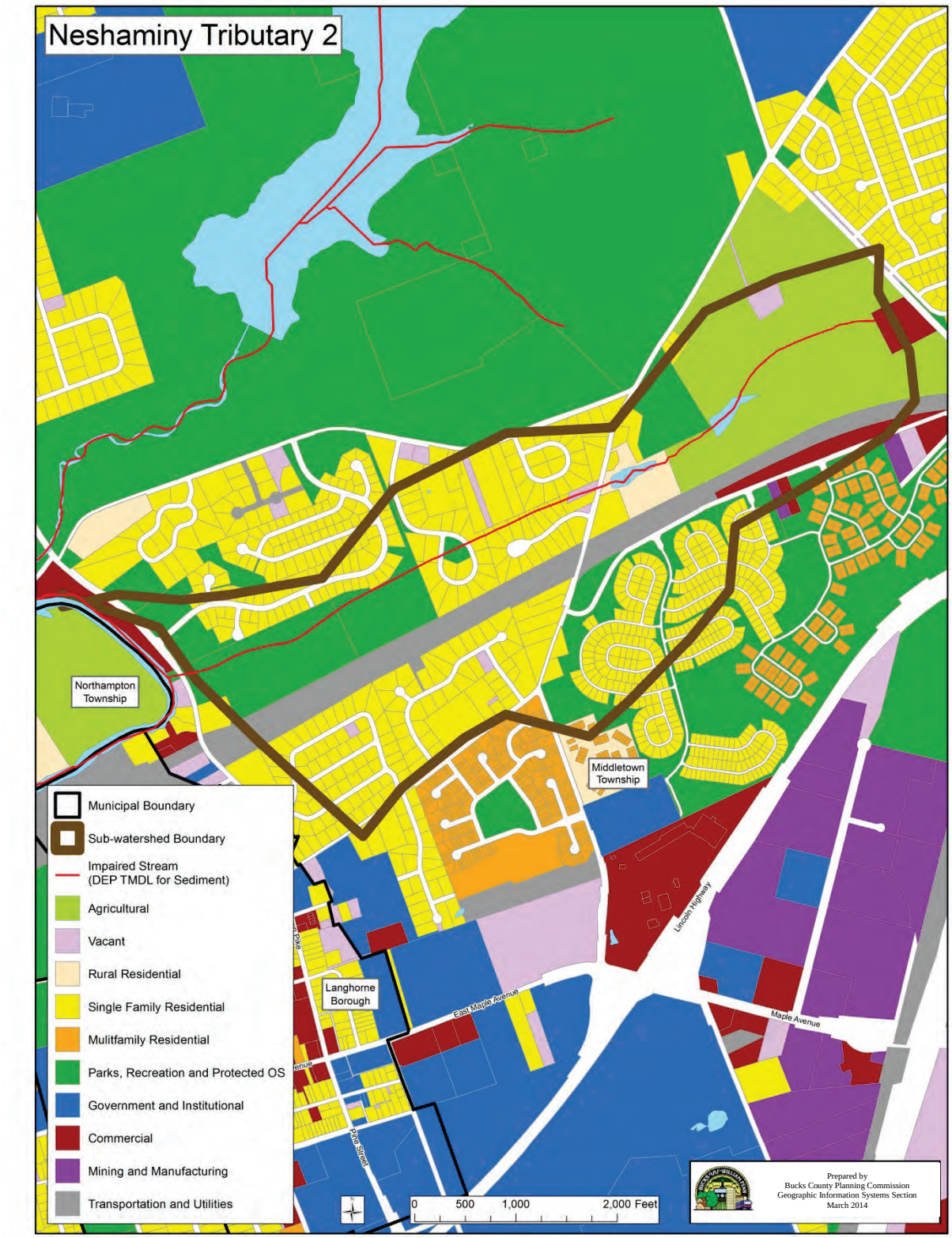
Table 26
Proposed TSS Reduction for the Neshaminy Creek Tributary #2 Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands	
focuses on 0.3 miles of the 1.5 miles of impaired waterways	1,457
(TSS removal rate of 40%; modified from the PA BMP Manual)	
Streambank restoration – Developed Lands	
focuses on 0.6 miles of the 1.5 miles of impaired waterways	2,344
(TSS removal rate of 40%; modified from the PA BMP Manual)	
Riparian Buffers	
focuses on 0.6 miles of the 1.5 miles of waterways	4,118
excluding agricultural and developed streambank restoration projects	
(TSS removal rate of 65% as per PA BMP Manual)	
Retrofit Basins – Residential Development	
Approximately 47 basins in low intensity development and	6,523
15 basins in high intensity development	495
(TSS removal rate of 60% as per PA BMP Manual)	
Retrofit Basins – Agricultural Lands	
Approximately 2 basins in hay / pasture and	240
9 basins in croplands	11,233
(TSS removal rate of 60% as per PA BMP Manual)	
Manufactured Treatment Devices	
Approximately 15 MTDs in low intensity development and	7,610
2 MTDs in high intensity development	393
(TSS removal rate of 70% as per US EPA)	
Total Amount of TSS Removed	**34,413**

Table 27
Cost Estimates for Project Implementation in the Neshaminy Creek Tributary #2 Sub–watershed

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$ 7,920.00	$31,680.00
Streambank restoration – developed lands (0.6 miles)	15,840.00	63,360.00
Riparian buffers – forested lands (0.6 miles)	0.00	47,520.00
Retrofit residential basins (62 basins)	93,000.00	3,100,000.00
Retrofit agricultural basins (11 basins)	16,500.00	275,000.00
MTDs (17 units)	595,000.00	935,000.00
Total	**$728,260.00**	**$4,452,560.00**

Neshaminy Creek Tributary #2 Sub-watershed Map



SUB–BASIN #1 WEST BRANCH NESHAMINY CREEK

The Sub–basin #1 West Branch is located in Montgomery County and is about 2.5 square miles in size. Sub–basin #1 West Branch is a tributary of the West Branch of Neshaminy Creek. Its protected uses are for water supply, recreation and aquatic life, and its aquatic use is warm water fishes and migratory fishes. The municipalities within the Sub–basin #1 West Branch sub–watershed are Hatfield Borough, Lansdale Borough and Hatfield Township.

Its portion of the Neshaminy Creek TMDL applies to 3.5 miles of waterways within this sub–watershed. The TMDL for Sub–basin #1 West Branch is based on the comparison of simulated TSS loads, comparing loads when the stream attained it designed use (1992) to a time when it was identified as impaired (2000). The waste load allocation with a 10 percent margin of safety was established, resulting in a targeted reduction of 25,356 pounds of TSS per year (Table 1).

The dominant land use within the Sub–basin #1 West Branch sub–watershed is developed lands (77 percent). Forested and agricultural lands account for 17 percent and 6 percent of the land use area within the Sub–basin #1 West Branch sub–watershed, respectively. The largest existing TSS loads originate from streambank erosion (71,523 pounds per year) followed by low–intensity development (38,933 pounds per year) (PA DEP, 2003).

Implementing all of the recommended watershed management measures outlined in Table 28 is estimated to remove approximately 40,919 pounds of TSS per year. Comparing this to the amount of TSS targeted for removal, this would result in an additional 15,563 pounds of TSS removed, beyond the targeted load. The cost to implement all of these measures is estimated between $0.5 million and $2.1 million (Table 29). Estimated long–term maintenance costs are provided in Appendix 2.

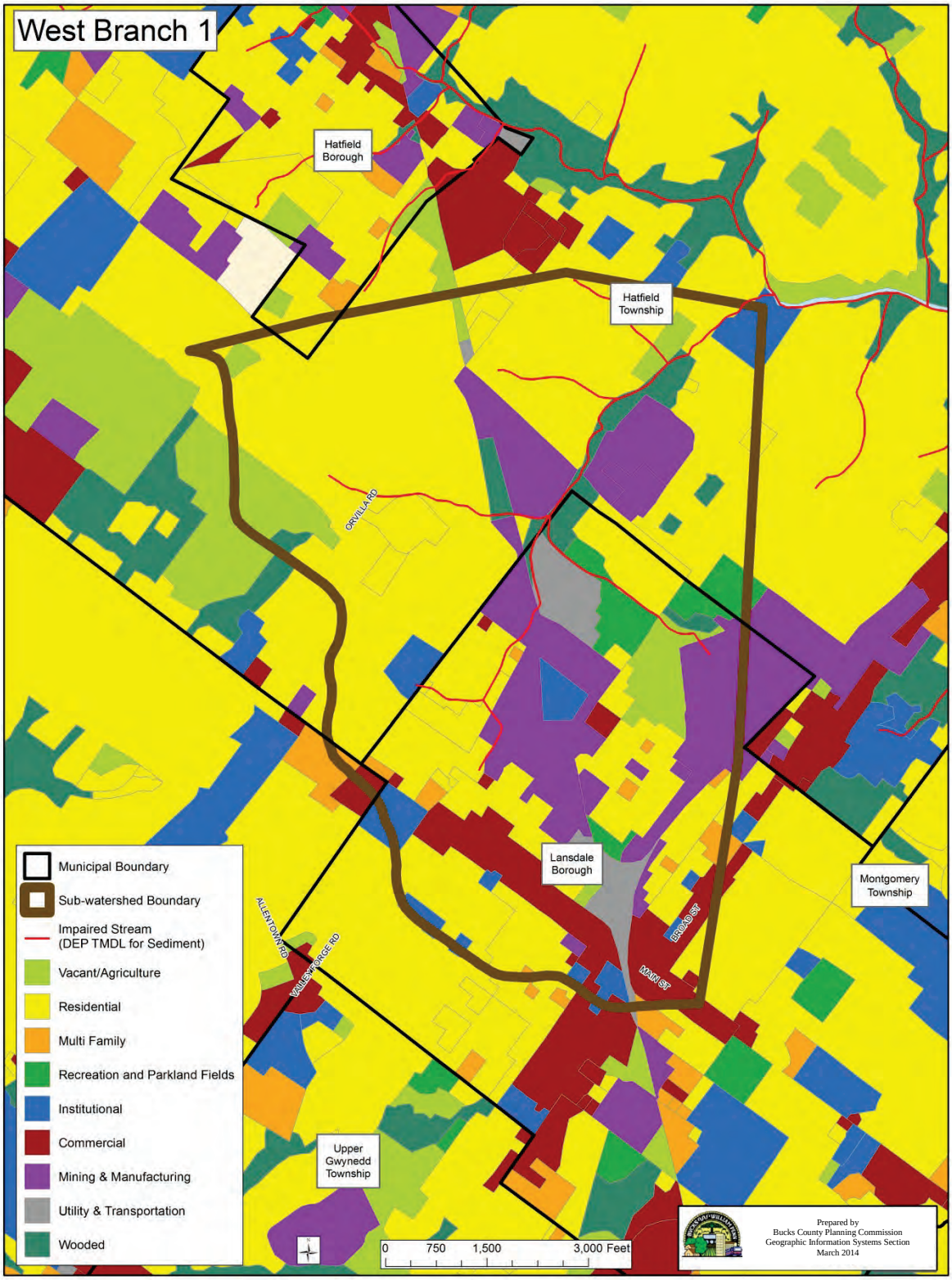
Table 28
Proposed TSS Reduction for the Sub–basin #1 West Branch

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year)
Streambank restoration – Agricultural Lands focuses on 0.1 miles of the 3.5 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	976
Streambank restoration – Developed Lands focuses on 1.5 miles of the 3.5 miles of impaired waterways (TSS removal rate of 40%; modified from the PA BMP Manual)	12,522
Riparian Buffers focuses on 0.1 miles of the 3.5 miles of waterways excluding agricultural and developed streambank restoration projects (TSS removal rate of 65% as per PA BMP Manual)	1,716
Retrofit Basins – Residential Development Approximately 16 basins in low intensity development and 9 basins in high intensity development (TSS removal rate of 60% as per PA BMP Manual)	11,595 5,805
Retrofit Basins – Agricultural Lands 1 basin in hay / pasture and 1 basin in croplands (TSS removal rate of 60% as per PA BMP Manual)	442 3,802
Manufactured Treatment Devices Approximately 8 MTDs in low intensity development and 4 MTDs in high intensity development (TSS removal rate of 39% as per US EPA)	2,706 1,355
Total Amount of TSS Removed	**40,919**

Table 29
Cost Estimates for Project Implementation in the Sub–basin #1 West Branch

Projects	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.1miles)	$ 2,640.00	$10,560.00
Streambank restoration – developed lands (1.5 miles)	39,600.00	158,400.00
Riparian buffers – forested lands (0.1 miles)	0.00	7,920.00
Retrofit residential basins (25 basins)	37,500.00	1,250,000.00
Retrofit agricultural basins (2 basins)	3,000.00	50,000.00
MTDs (12 units)	420,000.00	660,000.00
Total	**$502,740.00**	**$2,136,880.00**

Sub-basin #1 West Branch Map



SUMMARY OF THE TMDL–BASED SEDIMENT REDUCTION PLAN FOR THE NESHAMINY CREEK WATERSHED

The long–term goal of developing this Sediment Reduction Plan is to have a "blue–print" that all participating watershed stakeholders can use to guide the implementation of projects to reduce the sediment (TSS) load and eventually take impaired stream segments off the 303(d) list. PADEP's 2003 report, *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania* identified the required reductions, while this Sediment Reduction Plan serves as a guidance document on how to attain this goal. As shown in the TMDL requirements (Figure A1, Appendix 1), there are 14 sub–watersheds within the Neshaminy Creek watershed with impaired waterways as designated by DEP's 2003 report. Thus, this Plan provides small, "mini–plans" for each sub–watershed.

Table 1 summarized the existing TSS loads, the established (desired) TSS loads and targeted reductions, which were ranked from highest to lowest targeted reduction. Sub–basin #4 West Branch has the highest targeted reduction at a little over 5 million pounds of TSS, while Sub–basin #1 West Branch has the lowest at 25,356 pounds of TSS.

Now that the mini–plans have been developed, the 14 sub–watershed numbers were once again compiled, providing information on the targeted reductions (from Table 1), the predicted reductions outlined in the mini–plans, and the net difference between the targeted and predicted TSS loads (Table 30). As shown in Table 30, ten of the fourteen sub–watersheds have predicted TSS reductions that are higher than the targeted reductions (a surplus of TMDL credit). In contrast, four of the fourteen have predicted TSS reductions that are lower than the targeted reductions (a deficit of TMDL credit). However, when all fourteen sub–watersheds are compiled, the net outcome is that the total predicted TSS load is 108,629 pounds greater reduction than the targeted (desired) reduction for the entire watershed. Thus, if implemented, the watershed as a whole would be in compliance with DEP's TMDL requirements.

Table 30
Summary of TSS Removal Analysis
for Neshaminy Creek Watershed Sediment Reduction Plan.
Summary of Neshaminy Creek TMDL for TSS (pounds per year)

Sub–watershed	Targeted Reduction	Predicted Reduction	Net Difference between Targeted & Predicted
Sub–basin #4 West Branch	5,030,760	5,127,388	96,628
Pine Run	2,145,386	2,174,153	28,767
Little Neshaminy Creek	1,432,129	1,542,025	109,896
Neshaminy Creek South #1	918,390	931,199	12,809
Neshaminy Creek Tributary #3	791,346	620,160	–171,186
Neshaminy Creek South #2	722,078	727,936	5,858
Mill Creek	619,346	636,660	17,314
Neshaminy Creek South #3	514,517	519,350	4,833
Neshaminy Creek Tributary #1	511,672	426,528	–85,144
Sub–basin #3 West Branch	483,430	305,308	–178,122
Core Creek	448,730	764,000	315,270
Sub–basin #2 West Branch	386,490	397,637	11,147
Neshaminy Creek Tributary #2	109,417	34,413	–75,004
Sub–basin #1 West Branch	25,356	40,919	15,563
Total	**14,139,047**	**14,247,676**	**108,629**

TECHNICAL / FINANCIAL ASSISTANCE

Initiating the implementation of this *Neshaminy Creek Sediment Reduction Plan for Municipal Implementation* will require an organization or agency to serve as the "steward" for the Neshaminy Creek watershed. It is not recommended to create a new agency to serve in this capacity. Instead, if possible, an existing organization or agency should serve as the steward for the watershed and oversee the implementation of the Plan. Since the watershed covers two counties and 41 municipalities, it is recommended that an agency at the County or State level should serve as the watershed steward. Specifically, it is recommended that a County–level agency function as the steward. Such agencies are effective serving as the conduit and mediator between the local stakeholders (e.g. municipalities, homeowner groups) and funding / regulatory agencies (e.g. PA DEP and US EPA).

Since the majority of the watershed (approximately 86 percent) is in Bucks County with the remaining lands (approximately 14 percent) being in Montgomery County, it is recommended that Bucks County serve as the steward of the watershed. However, Montgomery County should be the primary partner in this stewardship. This partnership should be well established in moving the Plan forward. While Montgomery County may account for only 14 percent of the watershed, all of the waterways in that County are impaired (Figure A1, Appendix 1) and a large number of these waterways are headwaters. Montgomery County must be an active participant and the primary partner with Bucks County in implementing the Plan as the stewards of the Neshaminy Creek watershed.

It is recommended that either the Bucks County Planning Commission or the Bucks County Conservation District serve as the steward of the Neshaminy Creek watershed Plan. Either agency could serve as the primary steward of the watershed. The role of the steward would include:

1. **Education / Public Outreach** – Educate all watershed stakeholders on what should be done to minimize the generation of nonpoint source pollution throughout the watershed; promote the implementation of projects; distribute information on completed projects and oversee watershed tours that include visits to demonstration projects; provide technical assistance in water quality monitoring and watershed field assessments; and notify stakeholders of potential sources of funding for the implementation of projects.

2. **Implementation** – It is hoped that all stakeholders at various levels will contribute toward the implementation and completion of the various management measures listed in this Plan. For example, municipalities can focus on passing ordinances to protect and stabilize riparian buffers while they could also focus on retrofitting or naturalizing their existing dry detention basins. However, certain projects, due to their complexity or size,

will require a County–based lead. Such large–scale projects may include retrofitting the large conservation pools of Lake Luxembourg and Pine Run Reservoir.

In addition to large–scale projects, the steward may also want to implement a series of demonstration projects that can then be used to show others throughout the watershed how such projects can be completed. Such demonstration projects may include retrofitting an existing dry detention basin, conducting streambank stabilization measures and the installation of a stormwater BMP (such as a bioretention system) or Manufactured Treatment Device (such as a multi–chambered baffle box).

3. **Oversight of the TMDL** – In order for all of the watershed stakeholders to receive credit, both on a sub–watershed basis and on a whole, the status of the TMDL and the associated reductions in TSS must be tracked and documented. The steward will be responsible for this; however, similar to other watershed plans, a large portion of this oversight could be at least partially covered through the implementation of grant–funded projects. In other words, each project designed, installed and completed should include a monitoring / modeling component that quantifies in some manner the amount of TSS it will remove per year.

Time and funds need to be dedicated to conduct such steward–based responsibilities. However, many of the tasks outlined above are already being conducted through other programs such as MS4 permits or the Act 167 Plan. Thus, public education material developed under a municipality's MS4 permit can also be used, and modified if needed, to educate stakeholders throughout the watershed to implement measures to reduce existing TSS loads. In addition, other components, such as conducting water quality monitoring, on–site field assessments and the design / implementation of various projects, could be funded through grants or others sources.

In terms of financial assistance for the design and implementation of the recommended projects, a number of potential avenues of funding should be considered and possibly pursued such as:

- Federal and/or State grants, loans or technical assistance. Example programs include the State's Non–Point Source 319(h) program, Federal and State Environmental Education grants, USEPA's Source Reduction Assistance (SRA) Grant Program, and other sources such as US Army Corps of Engineers and possibly the United States Department of Agriculture (USDA).

- Strictly State–based grants, such as the Growing Greener grant program, may be another potential source of funding.

- Small–scale County or municipal grants, such as WREN Water Resources Education Grant, TreeVitalize, or projects that fund the planting of native vegetation.

- Establishment of unique agreements such as the creation of wetlands as part of a Mitigation Bank to compensate for the loss of wetlands associated with development within the watershed.

- Integrating required MS4 permit actions into the Plan; many of the basin retrofit projects and development of riparian–related ordinances could be addressed through such municipal – county – State agreements

- Cooperative agreements between private property owners (i.e. residential developments, golf courses) and local / county agencies to implement stabilization and vegetation–based projects.

- Other modes of funding such as private, non–profit sources, land or tax credit incentives and municipal agreements for future development or establishment of open space lands.

Local stakeholders such as municipalities and private land owners or associations may be eligible for potential sources of funding to design and implement many of the projects listed in this Plan. However, larger, more complex projects, particularly those that may encompass land from multiple land owners or agencies, may be more appropriately implemented by the Plan's steward.

PUBLIC INFORMATION AND OUTREACH

One of the ways the Plan will garner public support for its overall implementation is to identify a few select projects within the Neshaminy Creek watershed, successfully complete these projects and quantify the amount of TSS that were removed on an annual basis. The strategy of the public information and outreach part of the Plan should be to convey such information to the stakeholders throughout the municipalities. Such an approach is logical, since the local communities have a vested interest in protecting the water quality of their local resources; at the same time this aids the municipalities in complying with their MS4 permits and possibly their part of the Act 167 Plan.

It is recommended that a "Neshaminy Creek Watershed Sediment Reduction Plan Committee" be formed. This committee, staffed by the steward (described above), would meet 2–4 times per year in order to provide all participating stakeholders with progress reports on the implementation of the Plan and share local experiences on the reduction of TSS. Specifically, stakeholders could be provided with the following information:

- What watershed–based activities or updates have occurred since the last meeting;

- What projects are currently under review or being implemented;

- What projects are scheduled for implementation in the near future (up to a year), particularly within the context of securing sources of funding; and

- Other issues, including the long–term implementation of projects, progress on complying with the TMDL and future sources of funding.

Bucks County Planning Commission or the Bucks County Conservation District could serve as the steward of the watershed and thus coordinate these meetings. The participating stakeholders who attend the meetings can then go to their constituents and provide information and outreach material on how to proceed with implementing the identified management measures.

Representatives from State agencies (e.g. PA DEP and others when appropriate), the Counties (Bucks and Montgomery Counties) and associated agencies (e.g. Parks and Recreation), the local municipalities and other stakeholders should all be invited to participate in these watershed–wide meetings. Again, a key stakeholder must be identified that will manage the overall implementation of the Plan and oversee these project meetings, and it is recommended that this stakeholder be an agency within Bucks County, with an agency within Montgomery County serving as the primary partner.

SCHEDULE AND MILESTONES

NESHAMINY CREEK WATERSHED SEDIMENT REDUCTION PLAN LONG–TERM AND INTERIM MILESTONES

Based on the progressive results from other watershed–based implementation plans underway, as well as the limited amount of funds available for the implementation of projects, it is estimated that it will take between 20 to 30 years for the entire Neshaminy Creek watershed to be 100 percent in compliance with the TMDL and thus for all impaired waterways to be off the 303(d) list. A series of long–term project milestones has been integrated into the implementation schedule, along with interim milestones. These are based on a number of criteria, including the percentage of projects completed and the percentage of the TSS load targeted for reduction that has been addressed. While the implementation schedule sets out the proposed timeline in completing the identified projects, the interim milestones are proposed and listed in five year increments below.

The term **stabilize** specifically refers to reducing the sediment load from any area or piece of land where soils are exposed. Stabilization often refers to streambanks where the goal is to prevent further erosion of the streambank due to exposed areas and high storm flows. The action is to stabilize the streambanks using either structural or vegetative means, or a combination of, to reduce the generated TSS load through implementation of various BMPs. In turn, these actions contribute toward complying with the TMDL

Restoration can include stabilization but it refers to a general improvement in overall conditions that is typically linked to mimicking pre–development conditions. From a stormwater perspective, “restoring” a basin through retrofitting means to hold or retain the water longer to allow for solids to settle. This process mimics pre–development conditions and therefore can contribute to restoring conditions.

From an ecological and technical standpoint implementation of the recommended actions listed in this Plan are considered rehabilitation (improving conditions). While restoration typically means going back to pre–development conditions (which obviously is not feasible). However, the term rehabilitation never took off in the general public so the term restoration is used.

2014 to 2018

- The municipalities have passed ordinances to preserve and protect all forested waterways through the creation of riparian buffers and/or have documented that such measures have already been completed

- Approximately 50 percent of the impaired waterways targeted for preservation and protection as a riparian buffer have been identified and documented
- Approximately 33 percent of the existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Approximately 20 percent of the proposed multi–chambered baffle boxes have been installed
- The three roadside swales in the Pine Run sub–watershed targeted for water quality upgrades have been retrofitted or upgraded
- Installation of a wetland basin in the Pine Run sub–watershed has been completed
- The conservation pool at Lake Luxembourg (Core Creek sub–watershed) has been dredged (partially or entirely) and restored to function as a large, regional BMP.

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 23 percent for this five-year period.

2019 to 2023

- The remaining 50 percent of the impaired waterways targeted for preservation and protection with riparian buffers have been identified and documented. Forest buffers along the identified impaired waterways are protected. By the end of 2023, all impaired waterways flowing through forested lands should be protected
- Approximately 33 percent of the impaired waterways flowing through agricultural lands have been stabilized / restored
- Approximately 10 percent of the impaired waterways flowing through residential lands have been stabilized / restored
- Approximately 20 percent of the impaired waterways flowing through transitional lands have been stabilized / restored
- Approximately 50 percent of the existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Approximately 40 percent of the proposed multi–chambered baffle boxes have been installed

- The upper reaches (conservation pool) of Pine Run Reservoir have been dredged (partially or entirely) and restored to function as a large, regional BMP.

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 56 percent for this five-year period.

2024 to 2028

- Approximately 66 percent of the impaired waterways flowing through agricultural lands have been stabilized / restored
- Approximately 25 percent of the impaired waterways flowing through residential lands have been stabilized / restored
- Approximately 50 percent of the impaired waterways flowing through transitional lands have been stabilized / restored
- Approximately 75 percent of the existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Approximately 60 percent of the proposed multi–chambered baffle boxes have been installed

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 73 percent for this five-year period.

2029 to 2033

- Approximately 90 percent of the impaired waterways flowing through agricultural lands have been stabilized / restored
- Approximately 50 percent of the impaired waterways flowing through residential lands have been stabilized / restored
- Approximately 75 percent of the impaired waterways flowing through transitional lands have been stabilized / restored
- Nearly all of the existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Approximately 80 percent of the proposed multi–chambered baffle boxes have been installed

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 90 percent for this five-year period.

2034 to 2038

- Nearly all of the impaired waterways flowing through agricultural lands have been stabilized / restored
- Approximately 75 percent of the impaired waterways flowing through residential lands have been stabilized / restored
- Nearly all of the impaired waterways flowing through transitional lands have been stabilized / restored
- Nearly all of the existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Nearly all of the proposed multi–chambered baffle boxes have been installed

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 96 percent for this five-year period.

2039 to 2042

- Nearly all waterways identified as impaired have been stabilized / restored
- Nearly all of existing dry detention basins have been retrofitted in some capacity to enhance pollutant removal
- Nearly all of the proposed multi–chambered baffle boxes have been installed
- Any other watershed–based problems associated with TSS that have developed in recent years have been addressed

Note: The implementation of the measures outlined above should result in a total reduction of approximately 14.1 million pounds of TSS targeted for reduction by approximately 100 percent for this five-year period.

- Final revised assessment and confirmation that the watershed is in compliance with the targeted TSS loads and mean concentrations, following State Water Quality Standards, has been completed

CRITERIA TO DETERMINE WHETHER LOADING REDUCTIONS ARE BEING ACHIEVED OVER TIME

The criteria that will be used to determine if loading reductions associated with the recommended projects are being achieved will be four–fold. First, tributary and in–stream water quality sampling will be conducted, specifically for TSS to determine if the State's Water Quality Standard designated for Neshaminy Creek is being met. Specifically, the mean TSS concentration should be less than or equal to 40 mg/L.

Second, limited but site–specific stormwater sampling will be conducted at project sites as funds allow. Sampling would be conducted both prior to and after a specific project is installed to quantify how it contributes toward reducing the TSS loads. Post–installation stormwater monitoring would entail collecting samples immediately upgradient and downgradient of the installed project to calculate its pollutant removal efficiency.

Third, given the costs associated with the collection and analysis of samples for TSS, some simplified, watershed–based pollutant models should be utilized to quantify the project–related, estimated TSS reductions. Such simplified mass balance or unit aerial loading models, coupled with the percent reductions in TSS established in the PA Stormwater BMP Manual, can be a cost–effective means of quantifying TSS reductions. In addition, such analyses can be conducted as part of most State and Federal grants.

Fourth, photo–documentation of projects can be an important means of documenting their completion. This is particularly the case for sections of waterways that have been stabilized or the creation of riparian buffers. In addition, using "before" and "after" photographs to document the naturalization or retrofitting of an existing basin can also be effective.

To conclude, these four methods, baseline TSS monitoring, stormwater sampling to quantify project specific reduction efficiencies, simplified watershed–based pollutant modeling and photo–documentation, will be used to determine if the Plan needs to be revised and document the progress being made in reducing the TSS loads and attaining the desired mean TSS concentration.

MONITORING TO EVALUATE THE EFFECTIVENESS OF THE IMPLEMENTATION EFFORTS

This last element of the Plan outlines the specific monitoring methodology that should be used to determine if the load and concentration reductions are being achieved over time. While at this point no stable source of funding exists to develop such a long–term monitoring program, the following recommendations are made to identify the bare minimum that should be done to provide some means of monitoring the effectiveness of the implementation efforts. More data would be preferred to conduct more rigorous statistical analysis in evaluating project progress, particularly relative to storm–based sampling. However, at a minimum:

- At least ten monitoring stations should be established throughout the watershed, one for each of the major drainage areas throughout the watershed as shown in the TMDL (Figure A1, Appendix 1). One of these stations should be the Water Quality Network (WQN)[6] Station.

- At least four samples should be collected at each station per year, two during baseline (non–storm) and two during storm event conditions for the analysis of TSS. This would generate a total of 40 data points per year.

- If possible, *in–situ* data (temperature, dissolved oxygen, pH, turbidity and conductivity) should also be collected at the sites, at least during the baseline (non–storm event) conditions.

The proposed, yet very minimal, monitoring plan should generate enough TSS data to develop a long–term and statistically sound inter–annual database for the 232 square mile Neshaminy Creek Watershed. Obviously, such a monitoring program should be formally developed in a Quality Assurance Protection Plan (QAPP) and submitted to PA DEP for review, comment and approval. The QAPP is a document that outlines the procedures to be taken by those who conduct a monitoring project to ensure that the data they collect and analyze meets project and State requirements. This document is designed to encourage and facilitate the development of volunteer QAPPs by providing explanations and examples.

The TSS data collected under this proposed monitoring program could be used to determine if watershed management efforts are contributing toward long–term, inter–annual reductions in the TSS.

[6] The WQN is a long term network of approximately 150 fixed monitoring stations on rivers, streams and lakes throughout the state. It is the backbone of the state's efforts to monitor conditions on a broad scale (PADEP).

ELEMENTS OF A WATERSHED IMPLEMENTATION PLAN

Under PA DEP's Non–Point Source Management Program, the Commonwealth of Pennsylvania has identified a series of nine elements that are absolutely essential to a successful and feasible Watershed Implementation Plan. While many of the components of these nine elements have been discussed throughout this Plan for the Neshaminy Creek watershed, this section of the document explicitly addresses each one. In addition, the nine elements are summarized in Table 31.

ELEMENT 1 – IDENTIFICATION OF POLLUTION SOURCES

Address TMDL and other problems / goals in the watershed

A total suspended solids TMDL was developed, revised and approved in 2003 for the Neshaminy Creek watershed. Additionally, targeted reductions in the TSS load focused on the fourteen sub–watersheds that have been identified as having impaired stream segments for sediment (Figure A1, Appendix 1).

For this TMDL–based Sediment Reduction Plan, the focus is on those waterways listed on the State's 303(d) list as being impaired with suspended solids. However, other pollutants, such as the nutrient phosphorus, are recognized as impairing the Neshaminy Creek watershed. The primary water use not being met is the protection of aquatic life, although each sub–watershed "mini–plan" specifically identifies its own particular impairment.

As shown in Table 1, the annual TSS load is 36.25 million pounds and needs to be reduced by 14.14 million pounds in order to attain the targeted load of 22.11 million pounds. Collectively, the fourteen sub–watershed "mini–plans" predicted reductions in TSS will reach the targeted reduction with a surplus of approximately 108,629 pounds (Table 30).

Include applicable water quality standards

Pennsylvania does not currently have state–wide criteria for sediments or total suspended solids. However, the narrative statement for sediments states "water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life."

Typically, a high level of water quality protection can be realized when the mean baseline (non–storm event) TSS concentration is equal to or less than 25 mg/L. In addition, TSS concentrations greater than 25 mg/L typically produce a "turbid" or muddy appearance, which is generally perceived by the layperson as being a water quality problem.

Quantify and map by category

For the sake of this Sediment Reduction Plan, the annual TSS load throughout the Neshaminy Creek watershed was quantified and categorized based on sub–watershed boundaries (see Table 1 and Figure A1, Appendix 1). In addition, the sub–watersheds in Table 1 were listed and prioritized from the highest to the lowest in their required reductions in TSS. With the limited resources associated with the CZM grant for this project, it was decided to focus any limited field assessment work to the Pine Run sub–watershed, which has the second highest required TSS reduction, and is located entirely within Bucks County.

Refer to TMDL narratives and previous studies

This Sediment Reduction Plan is based on PADEP's 2003 report, *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania*. The Plan developed a set of "mini–plans" for the fourteen sub–watersheds identified in the DEP assessment targeted for TSS reductions due to the presence of impaired waterways (Figure A1, Appendix 1).

Prioritized based on impact on designated uses, feasibility / affordability of remediation, local concerns, etc.

The TSS load throughout the Neshaminy Creek watershed was divided based on sub–watershed areas and then prioritized and ranked based on the magnitude of their respective required reductions in TSS. Proposed stormwater projects in those sub–watersheds which had higher required reductions will be prioritized over other projects with lower required reductions. This protocol provides a means of prioritizing stormwater projects based on their relative watershed impacts to improve water quality conditions and to address the impairments of the waterways within the Neshaminy Creek watershed.

ELEMENT 2 – POLLUTANT LOAD REDUCTIONS REQUIRED TO MEET TMDLS

Specified in TMDL narratives

A detailed narrative of the TSS TMDL for the Neshaminy Creek watershed can be found on both the PA DEP and US EPA websites. The document is titled *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania* (PA DEP, 2003)

Break out by category (delineated in Step 1)

The original TMDL broke down the TSS loads for the Neshaminy Creek watershed on a sub–watershed basis. Those sub–watersheds with documented impaired waterways were targeted for TSS reductions (Figure A1, Appendix 1).

Consider impacts on downstream waters

Twelve of the fourteen sub–watersheds listed in the Neshaminy Creek watershed TMDL are classified as warm–water fishery and migratory fish's habitat (WWF–MF). The exceptions to this are the Pine Run sub–watershed, which is trout stocking–migratory fishes habitat (TS–MF) and the Mill Creek sub–watershed, which is cold–water fishery and migratory fish's habitat (CWF–MF). Neshaminy Creek eventually discharges into the Delaware River. Thus, the municipalities within the Neshaminy Creek watershed (in both Bucks and Montgomery Counties) need to be cognizant of impacts the water quality of Neshaminy Creek has on the Delaware River.

ELEMENT 3 – MANAGEMENT MEASURES REQUIRED TO ACHIEVE PRESCRIBED LOAD REDUCTIONS

Document Best Management Practices (BMPs) already implemented or planned in the watershed and assess their effectiveness

Wherever possible, specific watershed projects were identified in the mini–plans (e.g. stormwater projects in the Pine Run and Little Neshaminy Creek sub–watersheds and the maintenance dredging of the conservation pool at Lake Luxembourg in the Core Creek sub–watershed). A summary of potential stormwater BMP sites are also listed in Appendix 4. In addition, other watershed–based actions that have been implemented (such as street sweeping, cleaning–out catch basins, development of streambank / riparian buffer ordinances) are listed in Appendix 4. A series of BMPs planned for the sub–watersheds are presented in this document as a series of "mini–plans."

Designate and map target areas for additional controls

A series of site–specific projects were identified for the Pine Run sub–watershed. Due to the limitation of funds, the site–specific assessments needed for such detail were only conducted for the Pine Run sub–watershed. While selected BMPs were still identified for the other thirteen sub–watersheds via desk–top analyses, the Bucks County Planning Commission will continue to seek additional funds to conduct similar field site assessments for the other sub–watersheds in both Bucks and Montgomery Counties.

Select appropriate BMPs based on nature and magnitude of the pollutant, nature and location of the source, engineering feasibility, cost effectiveness, etc.

Information on the selected and identified BMPs was based on site–specific information, including the amount of impaired waterways and the various land types. Other site–specific measures, such as the presence of large reservoirs with conservation pools, were also included in the analysis.

The selected BMPs were also based on those technologies that are well established in the State's Stormwater BMP Manual or other sources (e.g., US EPA). In addition, the recommended Manufactured Treatment Devices, multi–chambered baffle boxes, is a technology approved by both PA DEP and US EPA as a means of reducing TSS loads in areas where space is extremely limited (e.g. more urbanized areas). The advantage of such technologies is that they do not have the requirement of large land areas, as needed by more conventional BMPs.

Model performance of selected BMPs to estimate operational efficiencies, load reductions achieved, maintenance requirements, etc. (DEP will assist)

Operational efficiencies of the selected BMPs and MTDs will be estimated by using percent removal rates provided by DEP's Stormwater BMP Manual, US EPA or Princeton Hydro's project experience associated with field–based, empirical monitoring of these structures, particularly MTDs. A fairly simple pollutant reducing analysis is conducted; hydrologic loads are combined with measured TSS concentrations to estimate storm loads entering and exiting a BMP, or a unit aerial loading (UAL) model is coupled with the documented pollutant removal rates to determine the annual reductions in TSS. More than likely, the modeled approach will be used most of the time since funds for large–scale and detailed stormwater monitoring programs are not readily available. However, whenever possible, stormwater sampling will be conducted to validate or calibrate the use of the simple models in quantifying the TSS removed by the BMPs and MTDs.

ELEMENT 4 – TECHNICAL AND FINANCIAL ASSISTANCE NEEDED TO IMPLEMENT BMPS

Estimate costs of design, installation and maintenance

Costs for the design, installation and maintenance of each proposed stormwater structure are provided in this document and Appendix 2.

Evaluate sources of funding for plan implementation

A few stormwater projects have been implemented to date in the Neshaminy Creek watershed with variable sources of funding, such as: private homeowners and groups, the State's Growing Greener Program and the Non–Point Source Program (Section 319 of the Clean Water Act). The Counties and municipalities will continue to seek funding through these and other programs to implement the recommended BMPs; however, all information will be provided to the watershed steward so there is an appropriate amount of documentation for the TMDL.

Address shortfalls identified

Each BMP and MTD will require some degree of operational, long–term maintenance. Land owners (municipality, county, private) will be responsible for the long–term maintenance of any installed or retrofitted BMP.

ELEMENT 5 – PUBLIC INFORMATION AND PARTICIPATION

Identify stakeholders and sources of information and influence in the watershed

A total of 41 municipalities are located within the fourteen sub–watersheds, which encompass portions of two Counties of the Neshaminy Creek watershed.

Designate a watershed advisory group from those identified to sponsor projects, review planning products, set priorities, gain landowner cooperation and secure funding for implementation

It is strongly recommended that a Bucks County–based agency continue to serve as the steward of the Neshaminy Creek watershed. In addition, it was already described how a "Neshaminy Creek Watershed Sediment Reduction Plan Committee" (or advisory group) will meet 2–4 times a year to discuss the progress stakeholders have made with complying with the TMDL. This will include reviewing projects (implemented, on–going and planned), establishing priorities and goals and discussing opportunities for funding. In addition, while municipalities, private landowners and other groups are more than welcome to pursue sources of funding and implement projects on their own, the steward will continue to seek and secure funding for project implementation. However, the steward's focus will be on the more complex and large–scale BMP projects (e.g. maintenance dredging and retrofitting the conservation pool at Lake Luxembourg and Pine Run Reservoir to function as a large, regional BMP).

Outline a strategy for informing citizens about watershed issues and soliciting their involvement in plan development and implementation (e.g. press releases, web site presentation and public meetings)

The "Neshaminy Creek Watershed Sediment Reduction Plan Committee" will employ a four point strategy to inform citizens and local stakeholders on the issues of concern and projects that are underway in the Neshaminy Creek watershed:

1. Committee meetings 2–4 times per year. These committee meetings will be open to all stakeholders and the public. All of the issues associated with the development of the Plan as well as pre– and post–Plan projects will be presented and discussed at these meetings.

2. Provide literature and articles on the implementation of the Plan to the watershed stakeholders (e.g. municipalities) at least once a year.

3. Occasional press releases to local and regional newspapers; such press releases will be issued after a project milestone is complete.

4. Assisting in the sponsorship of local environmental watershed–based training and education seminars.

ELEMENT 6 – IMPLEMENTATION SCHEDULE AND EVALUATION

Develop milestones for the sub–watersheds and aggregate for watershed as a whole

Each sub–watershed has a set of proposed BMPs to be implemented. The milestones set for each sub–watershed will be the completion of each recommended BMP, or the determination that the recommended BMP cannot be implemented for some site specific logistical reason, or the implementation of a BMP project that was not originally described in this Implementation Plan. In addition, from a long–term perspective, each sub–watershed will be tracked based on the percent of projects completed once a year and every five years.

The milestones for the watershed as a whole will be the completion of a specific project or projects, the estimated amount of TSS removed on an annual basis, and comparison of this removed annual load to the targeted load reduction as outlined in the TMDL.

Include funding, construction and maintenance activities

Funds for the design and implementation for the recommended BMPs will be sought through a variety of private and public sources, with an emphasis on State and Federal programs such as Growing Greener and the Non–Point Source Pollution Programs (Section 319). However, the recommended–to–be–formed "Neshaminy Creek Watershed Sediment Reduction Plan Committee," as well as other stakeholders, will continue to seek alternative sources of funding for the implementation of the identified BMPs as well as other actions that will preserve and protect the water quality of Neshaminy Creek.

Any installed BMP will require some degree of maintenance, and grant funds will only be spent on projects where the stakeholder (e.g. municipality) or landowner can guarantee in writing that they will be responsible for the long–term maintenance of the installed structure. In addition to preserving and protecting the water quality and recreational value of Neshaminy Creek, it is recognized that these actions aid in compliance with local MS4 permits and Act 167 actions. However, it is also recognized that any Federal funds (319)(h) that are used to aid in complying with the TMDL cannot be credited toward a municipality's MS4 permit. In contrast, State–based, Growing Greener funds can be accounted for in a municipality's MS4 permit.

Identify parties responsible for meeting implementation milestones

A Bucks County–based agency should continue to be the "steward" of Neshaminy Creek, which includes oversight of the design and implementation of many of the watershed BMP projects. As part of their responsibilities, the steward, in conjunction with the "Neshaminy Creek Watershed Sediment Reduction Plan Committee" will ensure that project milestones are met by completing the projects, documenting the pollutant load removals, and comparing them to the existing sub–watershed TSS loads.

Consider local priorities for restoration, availability of funding, personnel, equipment, seasonal weather conditions, coordination opportunities, etc.

Many of the issues associated with local priorities, availability of resources, seasonal weather conditions and coordination of opportunities have already been worked through with past investigations and plans (e.g. revised TMDL document, Act 167 Plan). A series of meetings (May and November 2013 and February 2014) took place for the development of this Sediment Reduction Plan to advance a coordinated approach as the Plan moves into the Implementation Phase.

Indicate schedule and parties responsible for monitoring and reporting progress

The schedule of implementation of the Sediment Reduction Plan for the Neshaminy Creek watershed is dependent primarily on the availability of funding for the design and installation of the recommended BMPs. Local stakeholders will need to demonstrate a commitment toward the long–term maintenance and cleaning out of all installed structures if they are to receive any grant–based funding for the implementation of BMPs.

A substantial component of the funding for the implementation of BMPs will originate from grant programs (Federal, State or local). Thus, it is difficult to develop a detailed schedule for the completion of the Plan. However, based on the progress made to date in other watersheds and assuming the rate of progress will be relatively constant, it is estimated that it will take between 20 and 30 years, depending on how much funding is available at any one time, to attain the targeted reductions in TSS in the fourteen sub–watersheds.

ELEMENT 7 – INTERIM, MEASUREABLE MILESTONES

The proposed Long–Term and Interim Milestones schedule was outlined in a previous section of this report (Schedule and Milestones page 83).

ELEMENT 8 – IDENTIFY CRITERIA FOR JUDGING RESULTS OF IMPLEMENTATION AND WATER QUALITY MONITORING AGAINST PRESCRIBED MILESTONES

Since the goal of the Sediment Reduction Plan is to attain the targeted sub–watershed–based TSS loads in accordance with the TMDL, the prescribed milestones will focus on the cumulative amount of TSS that is removed on an annual basis as a result of the installed BMPs. These milestones are outlined above.

Provide for reevaluation of implementation efforts, project milestones, restoration measures and TMDLs if progress is less than expected

Progress on the TMDL is re–evaluated on a regular basis as part of each project that is awarded funding for a specific structural BMP. As part of the project reports associated with each BMP implementation, project milestones (annual TSS load removed and how it contributed toward

attaining the targeted TMDL both within the sub–watershed as well as for the entire Neshaminy Creek watershed), identification of additional benefits (removal of other pollutants such as total phosphorus) and progress on attaining the TMDL is always provided. These reports document both relative successes as well as problems that arose during project implementation.

ELEMENT 9 – WATER QUALITY MONITORING AND EVALUATION

Develop milestones for pollutant load and water quality leading to achievement of DEP standards for water quality and recommended use

The goal of the TMDL designated for the Neshaminy Creek watershed is to reduce the existing annual TSS by approximately 14.1 million pounds per year to comply with the TMDL and attain desirable water quality improvements. This will include taking many of the impaired waterways off the 303(d) list. The targeted reductions have been allocated to the fourteen sub–watersheds recognized as having impaired waterways (Table 1). If completely implemented, the Plan will achieve this reduction over the entire Neshaminy Creek watershed (Table 30).

Tailor milestones to the character and magnitude of impairments in each sub–watershed, specifying parameters, location and frequency of sampling

With the implementation of any watershed–based project, some degree of stormwater monitoring and pollutant load modeling will be conducted to quantify the TSS reduction. Where stormwater monitoring is conducted, the frequency of sampling will be a minimum of three pre– and three post–installation sampling events; however, some of the larger BMPs may be monitored over several years to obtain a better, inter–annual estimate of their pollutant removal rates. Any monitoring to assess progress on the TMDL is tied to stormwater monitoring or pollutant modeling within each sub–watershed.

Stream monitoring is also conducted to gauge how Neshaminy Creek and its associated waterways are responding to the reductions in the TSS loads. Such large–scale, watershed based monitoring should be conducted at the ten proposed sampling stations previously described. This provides an ever increasing inter–annual database to identify long–term changes or trends in water quality. In addition to the collection of samples for TSS analysis, *in–situ* (dissolved oxygen, temperature, pH, turbidity and conductivity) sampling should also be conducted.

Consider local priorities for implementation, availability of funding, personnel, analytic capability, seasonal weather conditions, coordination with existing monitoring programs, etc.

Bucks and Montgomery Counties, as well as the associated municipalities, are and have been committed to the long–term care and maintenance of the BMPs that have been installed to date and will continue in this long–term commitment with any additional structures that are installed in the future. The counties and municipal public works departments will continue to coordinate operations in the maintenance and care of all structural BMPs installed in their respective governmental boundaries of their sub–watershed(s).

Whenever possible, the watershed steward will team with other organizations and agencies to further enhance the implementation of the Plan. For example, Neshaminy Creek contains some headwater systems that eventually flow into the Delaware River. Such watershed–based relationships could aid in fostering larger, regionally based agreements and projects to improve the water quality of both Neshaminy Creek and the Delaware River.

Indicate schedule and parties responsible for monitoring and reporting progress

The recognized Bucks County–based steward (proposed) will be responsible for managing and documenting the monitoring and progress reports on both specific projects completed, as well as the overall progress toward complying with the TMDL on a watershed and sub–watershed basis. The steward will work with technical and scientific organizations to collect monitoring data, conduct on–site assessments within each sub–watershed, and document progress on the TMDL

REMEDIAL ACTIONS

Identify criteria for judging results of implementation and water quality monitoring against prescribed milestones

Since the goal of the Sediment Reduction Plan is to attain the targeted annual TSS load in accordance with the TMDL, the prescribed milestones focus on the cumulative amount of TSS that is removed in five year blocks as a result of the installed BMPs. For example, by the end of 2018, approximately 23 percent of the annual TSS load targeted for removal under the TMDL should be removed. The percent reduction relative to the TSS targeted for removal should be the criteria for assessing milestone progress. However, a database of in–stream, mean TSS concentrations at key locations throughout the watershed should also be developed to serve as another means of assessing progress.

Provide for re–evaluation of implementation efforts, project milestones, restoration measures and TMDLs if progress is less than expected

Progress on the TMDL should be re–evaluated on a regular basis as part of each project that is awarded funding for a specific structural BMP. With the completion of any project, particularly those associated with grant funding, project reports need to be completed. Project milestones need to be documented (e.g., the annual TSS load removed through the completion of the project and how it contributes toward reducing TSS loads both in its sub–watershed and the entire watershed), additional benefits associated with the project should be identified (removal of other pollutants such as nutrients) and progress on attaining the TMDL should be provided. These reports document both relative successes as well as problems that arose during project implementation. Milestones should also include a re–evaluation of the TMDL as a whole every five years.

Table 31
Watershed Work Elements for the Neshaminy Creek Watershed

Watershed Plan Elements for Neshaminy Creek Sediment Reduction Plan	Resulting Work Product (Section and page number where applicable)
1. Identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in this watershed–based restoration plan.	TMDL Assessment for Neshaminy Creek Watershed (Revised 2003)
2. An estimate of the load reductions needed to be achieved from management measures.	Tables 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28
3. Description of the NPS management measures that will need to be implemented to achieve necessary load reductions and identification of critical areas in which those measures will be needed to implement the plan.	Identified in the Tables listed above as well as the Figure found in Appendix A
4. Estimate the amounts of technical and financial assistance needed, associated costs, and the sources and authorities that will be relied upon to implement the plan.	Tables 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29. Also see text for participating municipalities / counties
5. 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.	Technical and Financial Assistance section of this Plan
6. A reasonably expeditious schedule for implementing the NPS management measures identified in the plan	Outlined in previous section of report
7. Description of interim, measureable milestones for determining whether NPS management measures or other control actions are being implemented.	Outlined in previous section of report
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining desired water quality standards. If not attained, criteria for determining if the watershed–based plan needs to be revised.	Schedule and Milestones
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time. The criteria in Element 8 above were measured again.	Schedule and Milestones

SUMMATION

The Neshaminy Creek watershed encompasses 232 square miles and is located in Bucks and Montgomery counties, Pennsylvania. In response to the State–identified water quality impairments associated with sediments, measured as total suspended solids (TSS), a Total Maximum Daily Load (TMDL) analysis was conducted by PA DEP and completed in December 2003. This report identifies fourteen sub–watersheds where runoff from urbanized and developing areas has caused impairments and as a result has generated known impaired waterways. The identified reductions in TSS outlined in the TMDL for the Neshaminy Creek watershed focuses on these fourteen impaired sub–watersheds.

Incorporating a 10 percent margin of safety, the existing, annual TSS load of the Neshaminy Creek watershed is approximately 36.25 million pounds of TSS. The targeted (desired) annual TSS load is 22.11 million pounds of TSS, representing a 39 percent reduction. Thus, the existing TSS load needs to be reduced by approximately 14.14 million pounds of TSS per year. Of the fourteen sub–watersheds that have been identified with impairments, three account for over 60 percent of the targeted reduction (Sub–basin #4 West Branch, Pine Run and Little Neshaminy Creek).

In October, 2012, the Bucks County Commissioners were awarded a Coastal Zone Management (CZM) grant (FY 2012.PD.05) for development of the *Neshaminy Creek Sediment Reduction Plan for Municipal Implementation* (this document). The CZM grant was used to develop a Sediment Reduction Plan that provides specific recommendations for each sub–watershed to comply with its respective TMDL, as well as comply with the PA DEP and US EPA requirements of addressing the nine elements of an approved Watershed Implementation Plan (WIP). This document is to serve as a flexible 'blue–print" for municipalities, counties and other stakeholders to move the Neshaminy Creek watershed into TMDL compliance. In addition, the document also serves to provide baseline information to assist watershed stakeholders in seeking and obtaining grants from various sources to help in funding these projects.

While the resources and budget associated with the CZM grant were limited, the Bucks County Planning Commission (BCPC) wanted to obtain the largest amount and highest quality information in the development of the Plan. The BCPC contributed a substantial amount of its own in–kind time in the associated field work and in the development of the Plan. Princeton Hydro (Exton, PA) assisted in developing the technical components of the Plan and in assisting in some of the field work.

It was decided that some site–specific field work was required for at least one of the sub–watersheds to serve as a template for other sub–watershed field assessments in the future. The goal of the field work was to identify both sections of waterways in need of stabilization,

restoration and protection, as well as existing stormwater infrastructure that could use upgrades or retrofits to enhance their ability to remove TSS. From late May through early July, staff of the BCPC, with some assistance from Princeton Hydro, conducted this field work.

The sub–watershed of focus was Pine Run since it was relatively easy to assess with the limited funds, accounted for the second largest targeted reduction in TSS, and to date has received little attention when compared to the other sub–watersheds. In addition, it is completely located within Bucks County, which slightly reduced the complexity in conducting the field work. A series of projects were identified throughout the sub–watershed based on the field work. Recommendations were also made which included streambank restoration, the establishment of riparian buffers, retrofitting existing dry detention basins and the installation of Manufactured Treatment Devices (MTDs such as multi–chambered baffle boxes). Each sub–watershed was provided a list of recommended projects. Where appropriate, more specific BMPs were recommended, such as the development of stormwater wetlands or the dredging of large conservation pools.

Based on the miles of impaired waterway or the amount of acres covered by a particular land type, the number of BMPs that could be retrofitted or installed was estimated. In turn, TSS removal rates obtained through the *PA DEP Stormwater Management Manual* or other sources (e.g., US EPA) were used to estimate how much TSS would be removed through the implementation of each measure. This resulted in each sub–watershed having a list of projects to implement in order to comply with its particular, targeted reduction in TSS.

A modified and simplified version of the unit aerial loading (UAL) method was used to quantify the reduction values. The TSS loading coefficients that were selected for the analyses were both sub–watershed and land use specific and were derived from the actual TMDL for the Neshaminy Creek Watershed. This method, when coupled with estimated percent removal rates that originate from the State's BMP Manual or other sources (e.g., US EPA, manufactures of devices), calculated the estimated reductions in TSS loads associated with each installed BMP or project. This methodology is a very generalized approach in calculating the estimated reductions and do not depend on site–specific water quality data. However, both State and Federal agencies have found this methodology acceptable in tracking and documenting projects associated with a TMDL. If a stakeholder wishes to use more site specific information in calculating their removal rates associated with a specific project, such efforts would need to be clearly documented for State and Federal agencies to receive the due TSS credit.

The recommended BMPs were selected based on the existing land use and amount of impaired waterways within each sub–watershed. Professional judgment was used in selecting the most conservative and well documented BMPs or Manufactured Treatment Devices for implementation. A balance between associated costs for implementation and maintenance, as

well as anticipated amount of TSS removal and other associated benefits was also used as guidance in the selection of projects.

While some site–specific projects were identified as a result of field assessments (e.g., Pine Run sub–watershed) or past studies (e.g., Core Creek / Lake Luxembourg sub–watershed), many of the identified projects are based on existing land use and impaired waterways. However, it needs to be emphasized that this is a flexible, adaptive management plan. Any site–specific projects that appropriately address TSS loads can be considered for implementation in working toward compliance with the TMDL, even if it is not identified in the Plan.

Cost estimates to implement all of the recommended watershed measures, as well as their long–term maintenance, were also provided in the Plan. The cost estimate to get all 14 sub–watersheds in complete compliance with the TMDL is between $23.8 and $88.4 million dollars. A schedule with established 5–year blocks of milestones (e.g., percent reductions in the watershed–based TSS load) was also provided. While the schedule is obviously based on the amount of available funding and the amount of watershed–based participation and support, it is estimated that the watershed would be in complete compliance within 30 years.

APPENDICES

APPENDIX 1: SUPPLEMENTAL FIGURES

Figure A1
Neshaminy Creek Stormwater Management Plan Base Map

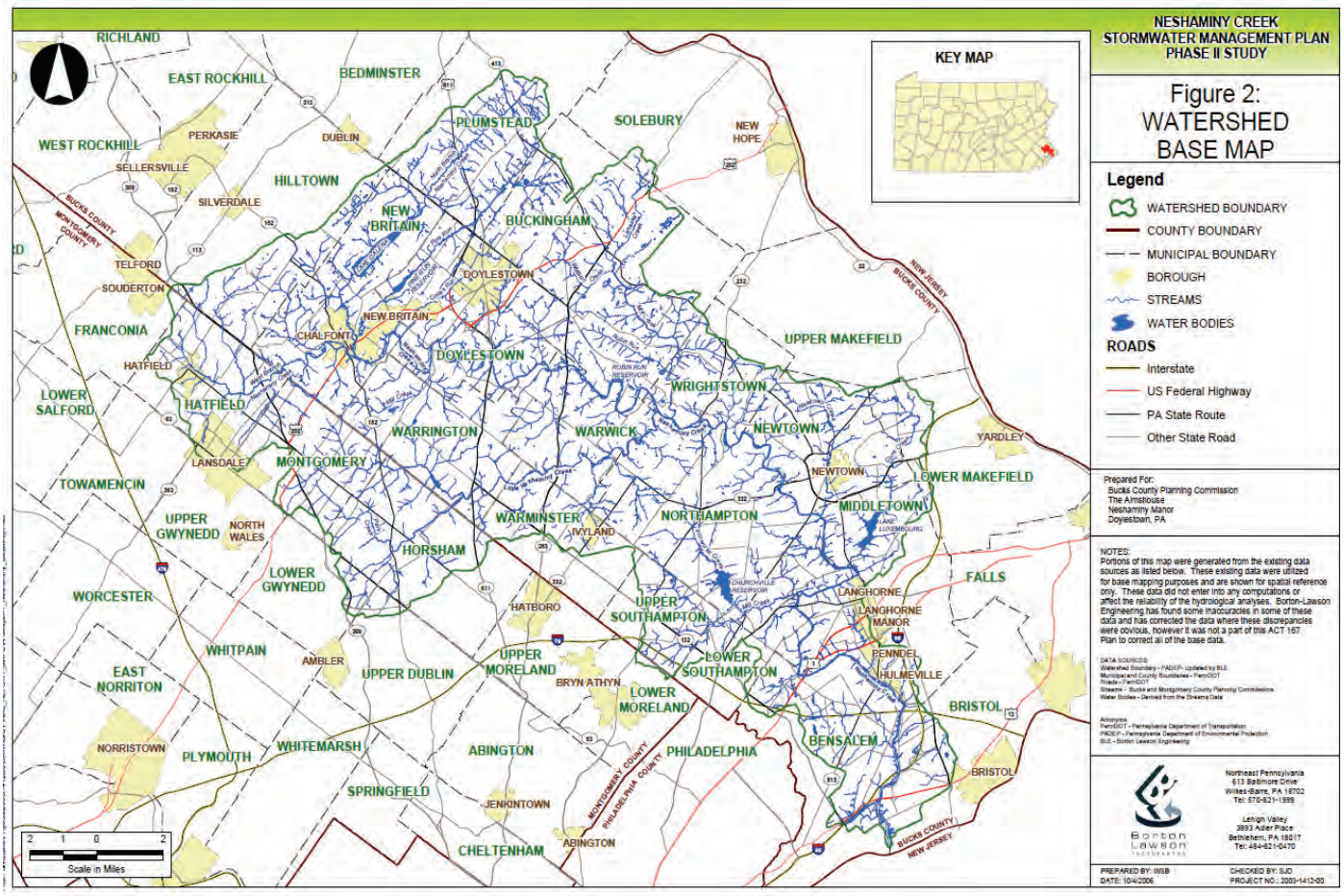
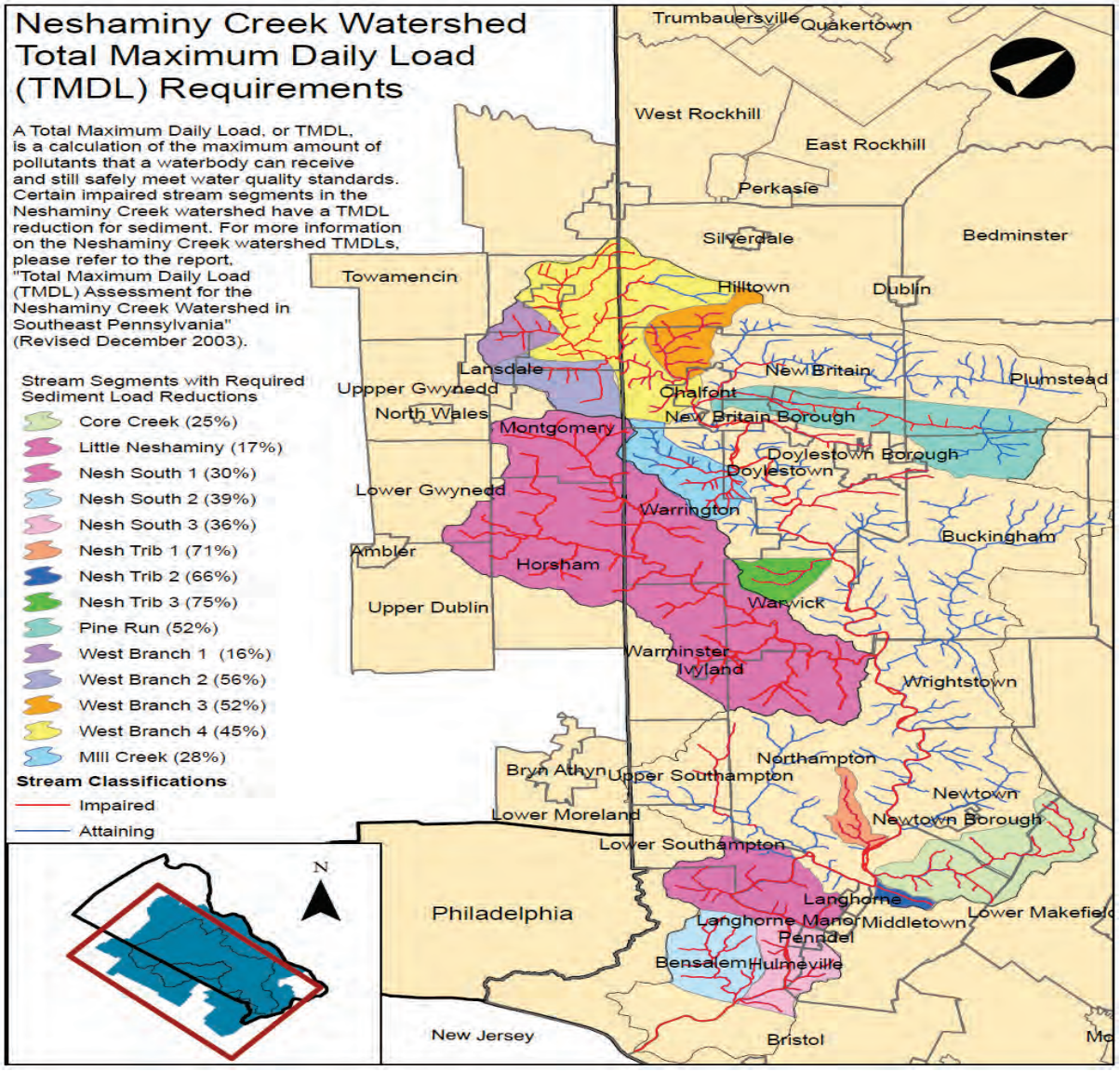


Figure A2
Neshaminy Creek Watershed Total Maximum Daily Load (TMDL) Map



APPENDIX 2: Estimates of Long-term Maintenance Costs by Sub–watershed

LONG–TERM MAINTENANCE COSTS

Any watershed or streambank restoration project designed to reduce sediment and other nonpoint source pollutants will require some degree of maintenance. Typically, many of these maintenance activities will be necessary on a routine basis, once or several times a year. In contrast, a few maintenance activities will be non–routine measures that focus on larger, more regional measures, such as dredging a large conservation pool. The estimated maintenance costs provided below includes both routine and non–routine activities, as described in the *PA Stormwater BMP Manual* (PA DEP, 2006).

Maintenance costs include a wide range of activities, many of which municipalities, homeowners and other land owners are already conducting such as mowing, harvesting of vegetation, cleaning out catch basins and other stormwater structures, and monitoring for nuisance or invasive species. Since the costs outlined below include such measures, the actual cost for implementation of the Plan–based maintenance activities is more than likely lower than estimated.

Additionally, the amount of money spent on maintenance may actually decline relative to current budgets. For example, more naturalized, retrofitted extended dry detention basins will be mowed less frequently than these basins in their existing state. Instead, the vegetation is typically cut and removed once a year, sometime during the end of the growing season. With lower amounts of routine labor, gas, equipment use, etc., the annual cost is lower than having a grass–lined basin.

The estimates for annual maintenance costs provided below include routine and non–routine activities as well as labor (monitoring, vegetation management, supplemental stabilization, pump–outs, clean–outs) and other associated costs (e.g., gas, equipment use, selective use of contractors). The annual cost for non–routine maintenance activities is based on taking the total cost for the specific activity and dividing it by the number of years between its implementation. For example, it is estimated that the upper end of Pine Run Reservoir would need to be dredged once every 25 years (Table A2.2), while the conservation pool for Lake Luxembourg would need to be dredged once every 20 years (Table A2.1).

Table A2.1
Annual Maintenance Costs – Sub–basin #4 West Branch

Watershed Control Measures	Low Estimate	High Estimate
Streambank restoration – agricultural lands (6.8 miles)	$36,036.00	$132,132.00
Streambank restoration – developed lands (6.2 miles)	32,472.00	119,064.00
Streambank restoration – transitional lands (1.1 miles)	4,356.00	15,972.00
Riparian buffers – forested lands (4.4 miles)	11,616.00	34,848.00
Retrofit residential basins (134 basins)	6,030.00	335,000.00
Retrofit agricultural basins (153 basins)	6,885.00	191,250.00
Retrofit transitional regional basin (18 basins)	810.00	45,000.00
MTDs (133 units)	59,850.00	73,150.00
Total	**$158,055.00**	**$946,416.00**

Table A2.2
Annual Maintenance Costs –Pine Run Sub–watershed

Watershed Control Measures	Low Estimate	High Estimate
Maintenance dredging of Pine Run Reservoir*	$16,264.00	$32,524.00
Streambank restoration – agricultural lands (1.7 miles)	3,150.00	11,550.00
Streambank restoration – developed lands (0.6 miles)	1,125.00	4,125.00
Streambank restoration – transitional lands (0.7 miles)	1,575.00	5,775.00
Riparian buffers – forested lands (0.8 miles)	1,200.00	3,600.00
Riparian zone below reservoir	450.00	1,050.00
Retrofit residential basins (20 basins)	900.00	50,000.00
Pine Run swale	675.00	2,475.00
Nottingham Way basins (7 basins)	315.00	17,500.00
Two road–side swales	900.00	3,300.00
Basin retrofits, swale upgrades, two MTDs and rain garden	1,350.00	2,750.00
Streambank stabilization – confluence site	225.00	825.00
Dillon Road Apartment Complex – three basin retrofits	135.00	7,500.00
Old Easton Road – two basin retrofits	90.00	5,000.00
Redfield basin retrofit (1)	45.00	2,500.00
Summer Hill Road basin retrofit (1)	45.00	2,500.00
Old Oak Road basin retrofit (1)	45.00	2,500.00
Grundy Road basin retrofit (1)	45.00	2,500.00
Total	**$28,534.00**	**$157,974.00**

*Very preliminary estimate; bathymetric assessment required. Maintenance dredging is estimated to be required once every 25 years. The cost for this maintenance activity is actually an annual breakdown for maintenance dredging, which is estimated to cost between $406,600.00 and $813,100.00 (once every 25 years).

Table A2.3
Annual Maintenance Costs – Little Neshaminy Sub–watershed

Watershed Control Measures	Low Estimate	High Estimate
Streambank restoration – agricultural lands (9.1 miles)	$36,036.00	$132,132.00
Streambank restoration – developed lands (7.3 miles)	28,908.00	105,996.00
Streambank restoration – transitional lands (1.0 miles)	3,960.00	14,520.00
Riparian buffers – forested lands (1.5 miles)	22,968.00	68,904.00
Constructed Wetland at Jarrett Nature Center	740.00	20,000.00
Cedar Hill residential basin retrofit	45.00	2,500.00
Retrofit residential basins (77 basins)	3,465.00	192,500.00
Retrofit agricultural basins (61 basins)	2,745.00	76,250.00
Retrofit transitional regional basins (12 basins)	540.00	30,000.00
MTDs (95 units)	42,750.00	52,250.00
Total	**$142,157.00**	**$695,052.00**

Table A2.4
Annual Maintenance Costs – Neshaminy South #1

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$ 1,188.00	$ 4,356.00
Streambank restoration – developed lands (2.7 miles)	10,692.00	39,204.00
Streambank restoration – transitional lands (1.1 miles)	4,356.00	15,972.00
Riparian buffers – forested lands (1.3 miles)	3,432.00	10,296.00
Retrofit residential basins (62 basins)	2,790.00	155,000.00
Retrofit agricultural basins (6 basins)	270.00	7,500.00
Retrofit transitional regional basins (3 basins)	135.00	7,500.00
MTDs (62 units)	27,900.00	34,100.00
Total	**$50,763.00**	**$273,928.00**

Table A2.5
Annual Maintenance Costs – Neshaminy Tributary #3

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.0 miles)	$ 3,960.00	$14,520.00
Streambank restoration – developed lands (0.2 miles)	792.00	2,904.00
Streambank restoration – transitional lands (1.0 miles)	3,960.00	14,520.00
Riparian buffers – forested lands (1.1 miles)	2,904.00	8,712.00
Retrofit residential basins (6 basins)	270.00	15,000.00
Retrofit agricultural basins (21 basins)	945.00	26,250.00
Retrofit transitional regional basins (22 basins)	990.00	55,000.00
MTDs (14 units)	6,300.00	7,700.00
Total	**$20,121.00**	**$144,606.00**

Table A2.6
Annual Maintenance Costs – Neshaminy South #2

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.6 miles)	$ 6,336.00	$ 23,232.00
Streambank restoration – developed lands (4.4 miles)	17,424.00	63,888.00
Streambank restoration – transitional lands (0.2 miles)	792.00	2,904.00
Riparian buffers – forested lands (1.5 miles)	3,960.00	11,880.00
Retrofit residential basins (62 basins)	2,790.00	155,000.00
Retrofit agricultural basins (11 basins)	495.00	13,750.00
Retrofit transitional regional basins (3 basins)	135.00	7,500.00
MTDs (62 units)	27,900.00	34,100.00
Total	**$59,832.00**	**$312,254.00**

Table A2.7
Annual Maintenance Costs – Mill Creek Sub–watershed

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (3.0 miles)	$ 11,880.00	$ 43,560.00
Streambank restoration – developed lands (0.5 miles)	1,980.00	7,260.00
Streambank restoration – transitional lands (1.0 miles)	792.00	2,904.00
Riparian buffers – forested lands (1.0 miles)	2,640.00	7,920.00
Retrofit residential basins (13 basins)	585.00	32,500.00
Retrofit agricultural basins (46 basins)	2,070.00	57,500.00
Retrofit transitional regional basins (4 basins)	180.00	10,000.00
Regional basin at the Quarry (1 basin)	300.00	2,500.00
MTDs (62 units)	5,850.00	7,150.00
Total	**$26,277.00**	**$171,294.00**

Table A2.8
Annual Maintenance Costs – Neshaminy South #3

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.4 miles)	$ 1,584.00	$ 5,808.00
Streambank restoration – developed lands (3.8 miles)	15,048.00	55,176.00
Streambank restoration – transitional lands (0.1 miles)	396.00	1,452.00
Riparian buffers – forested lands (1.0 miles)	2,640.00	7,920.00
Retrofit residential basins (47 basins)	2,115.00	117,500.00
Retrofit agricultural basins (7 basins)	315.00	8,750.00
Retrofit transitional regional basins (1 basin)	45.00	2,500.00
MTDs (38 units)	17,100.00	20,900.00
Total	**$39,243.00**	**$220,006.00**

Table A2.9
Annual Maintenance Costs – Neshaminy Tributary #1

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (1.7 miles)	$ 6,732.00	$ 24,684.00
Streambank restoration – developed lands (1.1 miles)	4,356.00	15,972.00
Streambank restoration – transitional lands (1.0 miles)	3,960.00	14,520.00
Riparian buffers – forested lands (0.9 miles)	2,376.00	7,128.00
Retrofit residential basins (13 basins)	585.00	32,500.00
Retrofit agricultural basins (19 basins)	855.00	23,750.00
Retrofit transitional regional basins (3 basins)	135.00	7,500.00
MTDs (13 units)	5,850.00	7,150.00
Total	**$24,849.00**	**$133,204.00**

Table A2.10
Annual Maintenance Costs – Sub-basin #3 West Branch

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (4.2 miles)	$ 16,632.00	$60,984.00
Streambank restoration – developed lands (0.6 miles)	2,376.00	8,712.00
Streambank restoration – transitional lands (0.03 miles)	396.00	1,452.00
Riparian buffers – forested lands (3.7 miles)	9,768.00	29,304.00
Retrofit residential basins (8 basins)	360.00	20,000.00
Retrofit agricultural basins (52 basins)	2,340.00	65,000.00
Retrofit transitional regional basins (1 basin)	45.00	2,500.00
MTDs (8 units)	3,600.00	4,400.00
Total	**$ 35,517.00**	**$192,352.00**

Table A2.11
Annual Maintenance Costs – Core Creek Sub-watershed

Watershed Control Measure	Low Estimate	High Estimate
Dredging of Conservation Pool*	$30,750.00	$43,250.00
Streambank restoration – agricultural lands (5.0 miles)	19,800.00	72,600.00
Streambank restoration – developed lands (3.6 miles)	14,256.00	52,272.00
Streambank restoration – transitional lands (0.03 miles)	1,188.00	4,356.00
Riparian buffers – forested lands (0.1 miles)	264.00	792.00
Retrofit residential basins (28 basins)	1,260.00	70,000.00
Retrofit agricultural basins (4 basins)	180.00	5,000.00
Retrofit transitional regional basins (20 basins)	900.00	50,000.00
MTDs (28 units)	12,600.00	15,400.00
Total	**$81,198.00**	**$313,670.00**

***Maintenance dredging is estimated to be required once every 20 years. The costs for this maintenance activity are actually an annual breakdown for maintenance dredging, which is estimated to cost between $615,000 and $865,000 (once every 20 years).

Table A2.12
Annual Maintenance Costs – Sub–basin #2 West Branch

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$ 1,188.00	$4,356.00
Streambank restoration – developed lands (2.0 miles)	7,920.00	29,040.00
Streambank restoration – transitional lands (0.3 miles)	1,188.00	4,356.00
Riparian buffers – forested lands (1.3 miles)	3,432.00	10,296.00
Retrofit residential basins (56 basins)	2,520.00	140,000.00
Retrofit agricultural basins (9 basins)	405.00	11,250.00
Retrofit transitional regional basins (7 basins)	315.00	17,500.00
MTDs (56 units)	25,200.00	30,800.00
Total	**$42,168.00**	**$247,598.00**

Table A2.13
Annual Maintenance Costs – Neshaminy Tributary #2

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.3 miles)	$1,188.00	$4,356.00
Streambank restoration – developed lands (0.6 miles)	2,376.00	8,712.00
Riparian buffers – forested lands (0.6 miles)	1,584.00	4,752.00
Retrofit residential basins (62 basins)	2,790.00	155,000.00
Retrofit agricultural basins (11 basins)	495.00	13,750.00
MTDs (17 units)	7,650.00	9,350.00
Total	**$16,083.00**	**$195,920.00**

Table A2.14
Annual Maintenance Costs – Sub–basin #1 West Branch

Watershed Control Measure	Low Estimate	High Estimate
Streambank restoration – agricultural lands (0.1miles)	$ 396.00	$ 1,452.00
Streambank restoration – developed lands (1.5 miles)	5,940.00	21,780.00
Riparian buffers – forested lands (0.1 miles)	264.00	792.00
Retrofit residential basins (25 basins)	1,125.00	62,500.00
Retrofit agricultural basins (2 basins)	90.00	2,500.00
MTDs (12 units)	5,400.00	6,600.00
Total	**$13,215.00**	**$95,624.00**

APPENDIX 3: LAKE GALENA SUB-WATERSHED

LAKE GALENA SUB–WATERSHED OF NESHAMINY CREEK

The Lake Galena sub–watershed is located in the upper end of the Neshaminy Creek watershed. The lake is comprised of 370 acres in Peace Valley Park. The sub–watershed is located in Bucks County and is approximately 9,798 acres. The lake and the North Branch of Neshaminy Creek is designated Trout Stocking, Migratory Fishes (TS, MF).

While the Lake Galena sub–watershed is identified in the Neshaminy Creek TMDL, the main focus of concern associated with this sub–watershed is to reduce the existing phosphorus loads to achieve a mesotrophic state (e.g., mean chlorophyll a concentration of 10 ug/L) to minimize water quality problems associated with nuisance algal blooms and aquatic vegetation. None of the waterways within the Lake Galena sub–watershed are identified as impaired (Figure A1, Appendix 1). Thus, the Lake Galena sub–watershed is not identified in this Sediment Reduction Plan as one of the sub–watersheds targeted for reductions in TSS.

With a 10 percent margin of safety, the amount of TSS targeted for reduction is 1,265 pounds per year. Relative to the other sub–watersheds, this is a relatively small amount of TSS targeted for reduction. Because this sub–watershed is not recognized as having impaired waterways, it is not included in the Sediment Reduction Plan. However, in response to an early draft of the Plan, the Bucks County Conservation District requested that the Lake Galena sub–watershed be considered in this analysis. This Appendix outlines a series of watershed projects that could address the targeted TSS load. For convenience, the amount of total phosphorus (TP) removed through the implementation of these watershed measures was also estimated. However, it should be emphasized that the development of a complete and holistic TP management control plan to bring Lake Galena into compliance (mesotrophic state of primary productivity) with that part of the TMDL was not part of this Sediment Reduction Plan.

In the Lake Galena sub–watershed it was estimated that through the 1990's the rate of development (conversion of farmland or forested land into residential development) was fairly high at approximately 247 acres per year (PA DEP, revised 2003). Thus, the watershed measures outlined below target both agricultural and residential land types. For the sake of this very simplified analysis, the land use types considered are cropland, low–intensity development and high–intensity development.

Simply retrofitting a few existing dry detention basins to enhance their abilities to assimilate nonpoint source pollution would address the 1,265 pounds per year of TSS targeted for removal. However, in order to reduce the existing TP load to attain the desired mesotrophic (moderate

level of primary productivity) condition within Lake Galena, a considerable amount of additional watershed control measures will need to be implemented.

Table A3.1
Projects Proposed for TSS Reduction in the Lake Galena Sub–watershed

Identified Watershed Actions, BMPs or MTDs	TSS removed (pounds / year) TP removed (pounds / year)
Retrofit Basins – Low Residential Development	
Two basins targeted for retrofitting	
(TSS removal rate of 60% as per PA BMP Manual)	1,666
(TP removal rate of 30% modified as per PA BMP Manual)	0.9
Retrofit Basins – High Residential Development	
One basin targeted for retrofitting	
(TSS removal rate of 60% as per PA BMP Manual)	833
(TP removal rate of 30% modified as per PA BMP Manual)	0.3
Retrofit Basins – Agricultural Lands – Croplands	
One basin targeted for retrofitting	
(TSS removal rate of 60% as per PA BMP Manual)	833
(TP removal rate of 30% modified as per PA BMP Manual)	9.3

Table A3.2
Initial Costs and Annual Maintenance Costs – Lake Galena Sub–watershed

Watershed Control Measures	Low Estimate	High Estimate
Retrofit Basins – Low Residential Development		
Initial costs for retrofitting two basins	$3,000.00	$100,000.00
Annual Maintenance costs	90.00	5,000.00
Retrofit Basins – High Residential Development		
Initial costs for retrofitting two basins	1,500.00	50,000.00
Annual Maintenance costs	45.00	2,500.00
Retrofit Basins – Agricultural Development		
Initial costs for retrofitting two basins	1,500.00	25,000.00
Annual Maintenance costs	45.00	1,250.00
Total	**$6,180.00**	**$183,750.00**

APPENDIX 4: SUPPLEMENTAL LIST OF POTENTIAL PROJECTS OR ACTIVITIES (COMPLETED OR PROPOSED)

This Appendix provides additional information and guidance on the measures and activities that can be implemented by municipalities, as well as other organizations, groups and agencies, to work toward compliance with the Neshaminy Creek TMDL. Some sub–watersheds and municipalities have more information on their existing waterways and stormwater infrastructure than others. Additionally, a number of projects have been implemented that can be credited against the TMDL, but such credit should be conducted on a sub–watershed basis.

The Bucks County Planning Commission conducted a considerable amount of field work in the Pine Run sub–watershed, with some limited assistance by Princeton Hydro. This field work was conducted to identify a series of streambank and stormwater infrastructure sites that could be targeted for restoration projects to reduce the TSS loads toward compliance with that sub–watershed's goal. Some sub–watersheds, such as Core Creek, already have a detailed set of recommendations in place. However, most of the sub–watersheds do not have such detailed information, so it is recommended that some degree of field work be conducted in some of the larger sub–watersheds to identify potential project sites.

While it is recommended that a County–level agency or agencies be responsible for the general oversight and documentation of the progress made in the implementation phase of the TMDL, municipalities should keep track of their own activities for the TMDL and for other purposes, such as their MS4 permit or participating in the Act 167 program. While participation in the TMDL is not mandatory, documenting such activities makes municipalities more eligible for State and Federal funding to implement many of these recommended activities. In order to obtain such funding, some degree of documentation is required. Municipalities and other organizations could develop an incentive program for private homeowners and groups to participate in such activities, particularly when associated with streambank stabilization and the establishment of riparian buffers. Below is a list of activities, projects, locations and recommendations that could be considered in more detail for implementation.

Street Sweeping

Street sweeping is a required BMP activity as identified in the MS4 permit. In order to quantify how current street sweeping activities contribute toward reducing the existing TSS loads, participating municipalities were asked to provide an estimate of the miles of road they street sweep. To calculate the amount of TSS removed through street sweeping, methodology developed by the Maryland Department of the Environment (2011) was employed. Since it was not stated otherwise, all street sweeping activities were assumed to be conducted using

mechanical technology. Table A4.1 provides a summary of the amount of TSS removed by the participating municipalities.

Since all street sweeping was assumed to be mechanical technology (and not regenerative vacuum technology), the associated TSS removal rate was established at 10%. Using the existing data on miles of road swept and the number of times conducted, the TSS removal rate for each municipality was calculated. Horsham Township stated it street sweeps but did not provide any estimates of miles or frequency**.** Upper Dublin Township sweeps all streets a minimum of twice a year, in the spring after the last snow, and near the end of the summer. Additionally, Lansdale provided its own estimate of how much TSS it has removed per year (510,968 pounds), using its own TSS loading coefficient of 193.5 tons / square mile (0.3 tons / acre), which is not far off from the coefficient provided in the Maryland study of (0.46 tons / acre).

Table A4.1
Calculated TSS Removal Rates for Street Sweeping

Municipality	**TSS removed (pounds / year)**
Bensalem Township	187,345
Buckingham Township	10,705
Chalfont Borough	3,988
Doylestown Borough	349,265
Doylestown Township	40,681
Franconia Township	19,805
Hilltown Township	1,579
Horsham Township*	——
Hulmeville Borough	1,071
Lansdale Borough**	510,968
Langhorne Manor Borough	268
Middletown Township	9,100
New Britain Borough	1,606
Penndel Borough	1,926
Plumstead Township	1,793
Upper Dublin Township	3,212
Warwick Township	46,569
Total Amount of TSS Removed	**1,189,881**

*Horsham Township states they do street sweep, but no miles were provided.
**Lansdale calculated their TSS removal rate per year.

To conclude, the estimated amount of TSS removed through street sweeping, as reported by the participating municipalities, is 1,186,401 pounds per year (Table A4.1). Thus, street sweeping is estimated to account for approximately 8.4 percent of the 14+ million pounds of TSS targeted for removal for compliance with the Neshaminy Creek TMDL.

Site-Specific Assessment of TSS Removal Associated with Two Existing Detention Basins

Plumstead Township, Bucks County, PA, located within the Pine Run Sub-Watershed, provided some site-specific information on two existing detentions basins identified for retrofitting to enhance their capacity to remove TSS. These two basins are along Signature Drive within the Summer Hill / Summer Meadow Development (Figures 9 and 10).

The site-specific information for Basin 1C (Figure 9) is that it has a total drainage area of 13.0 acres, which is comprised of 3.0 acres of streets (assumed to be paved), 8.1 acres of 7,500 square feet single family lots and 1.9 acres of open space (assumed to be primarily forested land). Using this information and loading coefficients based on the land use information provided in the TMDL, as well as an accepted TSS removal rate of 60%, it is estimated that retrofitting this basin would remove approximately 171 pounds of TSS per year. This is lower than the previously estimated TSS removal value of 375 pounds of TSS per year, primarily due to the estimated drainage area used in the generalized analysis being 25 acres.

The site-specific information for Basin 1A (Figure 10) is that it has a total drainage area of 19.3 acres, which is comprised of 3.9 acres of streets (assumed to be paved), 9.4 acres of 7,500 square feet single family lots, 2.0 acres of townhouses and 4.0 acres of open space (assumed to be primarily forested land). Using this information and loading coefficients based on the land use information provided in the TMDL, as well as an accepted TSS removal rate of 60%, it is estimated that retrofitting this basin would remove approximately 239 pounds of TSS per year. This is lower than the previously estimated TSS removal value of 375 pounds of TSS per year, primarily due to the estimated drainage area used in the generalized analysis being 25 acres.

Other Municipal–Based Control Measures

After the November 2013 public meeting, questions were forwarded to all municipalities to determine what additional watershed control measures are underway on a municipal level. Of the fifteen municipalities who responded to these questions, only three have active programs that provide funds or incentives for homeowners to use rain barrels or to install rain gardens. All of the municipalities clean out catch basins on a varying routine basis, about half have and maintain naturalized modified dry detention basins, and about half have identified specific, structural stormwater Best Management Practices that they have installed and maintain. In addition, about half of the municipalities either have or are working on some type of municipal–based ordinance for streambank stabilization or the establishment of riparian buffers.

Other Potential Project Sites to Consider

A large number of other watershed–based studies have been conducted throughout Neshaminy Creek over the past 10–20 years. In an effort to assist local municipalities in moving their contribution to the TMDL–based Sediment Reduction Plan forward, these documents were

reviewed for potential locations or projects that could be considered for design and implementation in the near future (within 1–5 years). For a sub–watershed or municipality looking for guidance in identifying projects for consideration, prior to any formal field assessment (e.g., Pine Run sub–watershed site assessments conducted as part of this Plan), this list of potential projects may be useful. The list provided below is by no means encompassing; there are numerous reports, documents and studies that have been conducted by various agencies and groups over the last 20 years on the Neshaminy Creek watershed. However, this list provides some suggestions on where a municipality should start, if such guidance is needed.

Little Neshaminy Creek River Conservation Plan (2007)

A variety of sites were identified in the Conservation Plan, with the majority located on public lands, thus being eligible for various sources of State and Federal funding.

1. One County–owned Park (Bradford Dam Park, located in Warrington Township, Bucks County)
2. One State Park (Graeme Park, located in Horsham Township. Montgomery Township)
3. 68 municipal parks and other public, recreational lands (Montgomery County: 22 in Horsham Township; 4 in Lower Gwynedd Township; 6 in Montgomery Township; 1 in Upper Dublin Township and Bucks County: 5 in Ivyland Borough; 1 in Northampton Township; 11 in Warminster Township; 16 in Warrington Township; 2 in Warwick Township)

Neshaminy Creek: Nonpoint source Pollution and Wetland Study, Volume 2 – Technical Support (1994)

This study conducted a series of on–site assessments of wetlands identified on the USGS National Wetland Inventory maps in the Coastal Zone Management study area. Many of these identified wetlands were associated with existing stormwater infrastructure (e.g., basins) and thus could be modified or retrofitted to enhance nonpoint source pollution uptake:

1. 34 sites throughout Bensalem Township, Bucks County, with one located in Neshaminy State Park.
2. At least 19 sites throughout Bristol Township, Bucks County
3. 1 site in Upper Southampton Township and 1 in Lower Southampton Township, Bucks County
4. 3 sites in Langhorne Borough and 2 in Langhorne Manor Borough, Bucks County
5. 1 site in Penndel Borough and 1 in Hulmeville Borough, Bucks County
6. 10 sites in Middletown Township, Bucks County

Little Neshaminy Creek Watershed Act 167 Storm Water Management Plan Data Generation & Model Set–Up – Progress Report No. 1 (1994)

This study provides a status report on progress made in the Act 167 Stormwater Management Plan. As part of the study, a series of field assessments were made of stream obstructions; many such obstructions are associated with eroded streambanks and other land–use activities that increase TSS loading:

1. 6 sites were identified throughout Ivyland Borough, Bucks County
2. 77 sites were identified throughout Northampton Township, Bucks County
3. 72 sites were identified throughout Warminster Township, Bucks County
4. 81 sites were identified throughout Warrington Township, Bucks County
5. 31 sites were identified throughout Warwick Township, Bucks County
6. 41 sites were identified throughout Horsham Township, Montgomery County
7. 54 sites were identified throughout Montgomery Township, Montgomery County

Little Neshaminy Creek Watershed Stormwater Management Plan Volume II (Technical Report) and Volume III (Technical Appendices) (1996)

These reports are a follow–up to the Act 167 Progress Report from 1994. Volume II includes two large maps that identify Significant Obstructions (Figure II–4) and Problem Areas, Stormwater Detention Basins, and Flood Control Facilities (Figure II–7). Volume III lists the stream obstructions identified in the 1994 report, as well as stormwater management facilities:

1. 49 sites were identified throughout Montgomery Township, Montgomery County
2. 20 sites were identified throughout Horsham Township, Montgomery County
3. 8 sites were identified throughout Upper Dublin Township, Montgomery County
4. 12 sites were identified throughout Warrington Township, Bucks County
5. 9 sites were identified throughout Warminster Township, Bucks County
6. 5 sites were identified throughout Warwick Township, Bucks County
7. 26 sites were identified throughout Northampton Township, Bucks County

Neshaminy Creek Watershed Stormwater Management Plan Volume III – Graphic Supplement (1992)

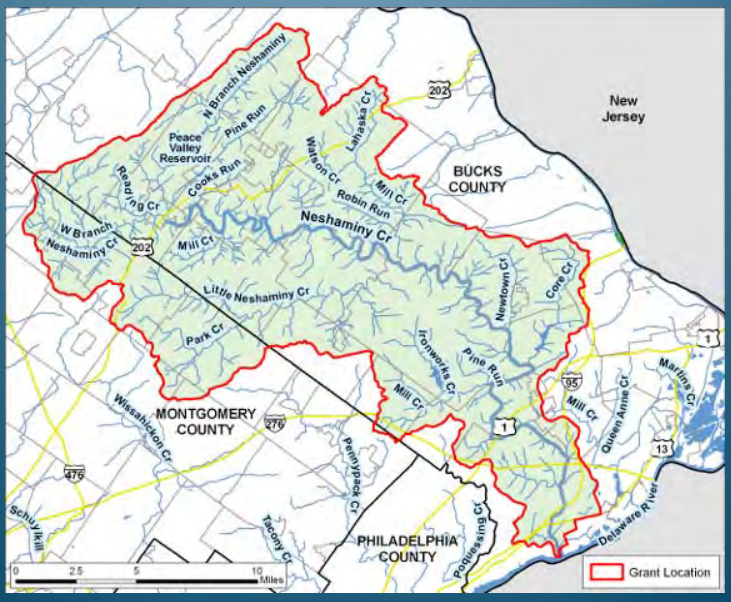
This supplement includes a series of large maps, which can be referenced. One such map (Map 3) identifies Stream Obstructions and Flooding Problems.

APPENDIX 5: WORKSHOP POWERPOINT PRESENTATIONS

Assisting the Bucks County Planning Commission in the Development of the Neshaminy Creek Sediment Reduction Plan

Fred S. Lubnow, Ph.D. and Clay Emerson, Ph.D., P.E.
Princeton Hydro, LLC

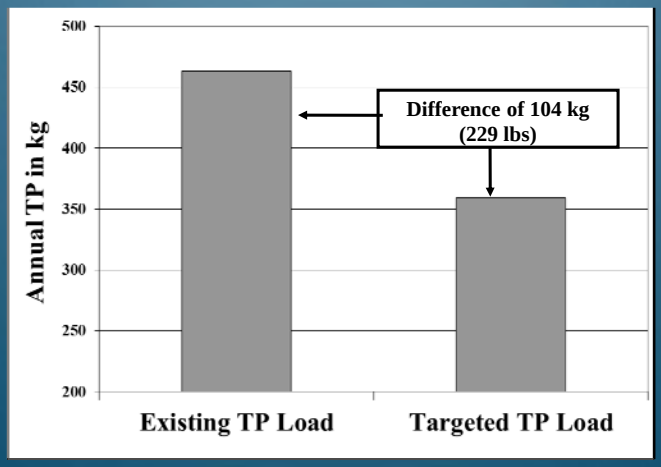
30th May 2013



Total Maximum Daily Load for Neshaminy Creek Watershed

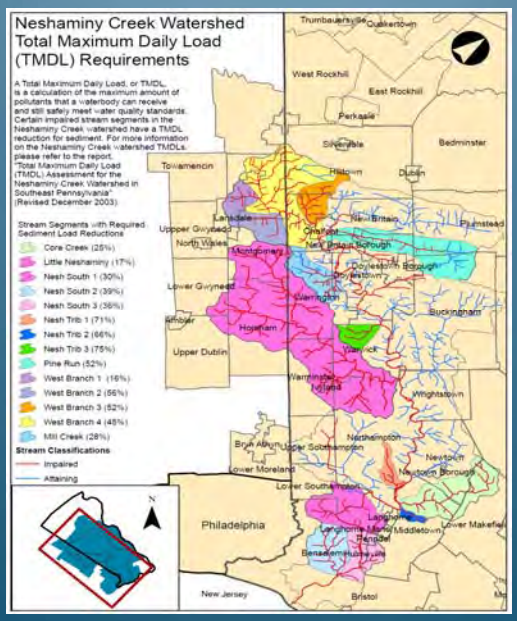
- Total maximum daily load (TMDL) is a calculation of the maximum amount of pollutants that a waterbody can receive and still attain State water quality standards.
- The primary pollutant of concern for this study of the Neshaminy Creek watershed is sediments (or total suspended solids – TSS) and will be reported as lbs per year.
- DEP revised the TMDL in December 2003.

Harveys Lake, Luzerne County, PA TMDL for Total Phosphorus



Neshaminy Creek Watershed TMDL

- TMDL's primary pollutant of concern is sediments or TSS.
- A series of 15 impaired sub-watersheds were identified that are required for sediment load reductions in order for the watershed to comply with its TMDL.
- Existing TSS load for the 15 sub-watersheds is approximately 36 million lbs/yr, while the targeted TSS load is approximately 25 million lbs/yr.
- Thus, a required reduction of approximately 11 million lbs/yr has been identified under the TMDL.

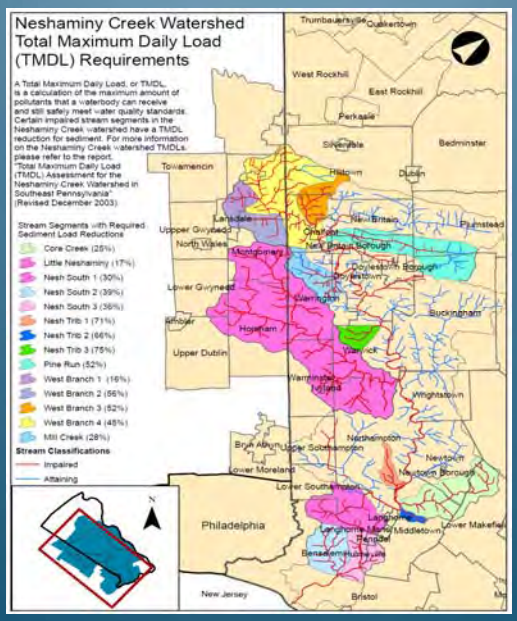


Neshaminy Creek Watershed TMDL

- DEP's TMDL identifies the existing and targeted loads (Point A and Point B).
- However, it does not identify how to get from Point A to Point B.
- Thus, the proposed municipal-based Management Plan will serve as a "blue-print" to attain the targeted TSS loads and comply with the TMDL.
- The Plan will also comply with the 9 elements of Watershed Implementation Plan (WIP).

Neshaminy Creek Watershed TMDL

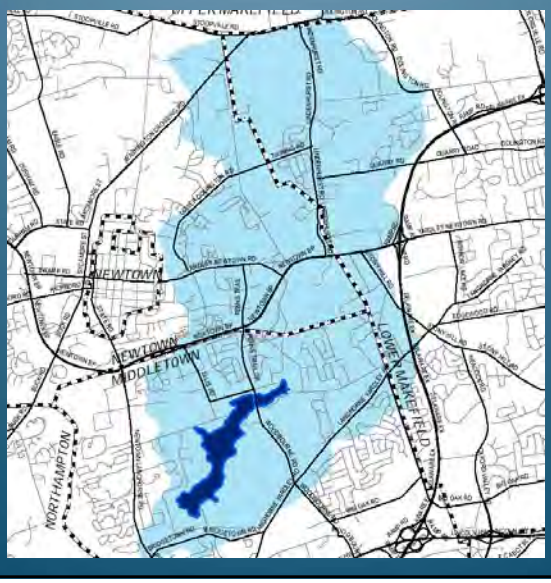
- The required reductions for each impaired sub-watershed were calculated and used to conduct a prioritization analysis, ranking the reductions from highest to lowest.
- The West Branch (#4) and Pine Run sub-watersheds had the highest and second highest required reductions, respectively.
- Combined, these two sub-watersheds account for 52.5% of the required reductions in TSS.



Neshaminy Creek Watershed TMDL

- Given the higher required TMDL reductions of these two sub-watersheds, in-kind field work under the current grant has focused almost exclusively on them.
- However, the County will be expanding the field work into the other sub-watersheds over time (hopefully with some grant support).
- Fortunately, many of the sub-watersheds already have existing Plans or are part of an existing Plan.
- Additionally, the County wants to work closely with the municipalities to identify and prioritize their sites of concern (i.e. the letter request).

Core Creek / Lake Luxembourg Watershed, Bucks County, PA



Core Creek / Lake Luxembourg Watershed, Bucks County, PA

- High nutrient and solid loads
- Phase I Diagnostic / Feasibility Study conducted in early 1990's (Bucks County Conservation District).
- Three 319 grants provided funds to reduce pollutant loads from agricultural / residential lands and shoreline erosion(1995-2008; BCCD)
- TMDL was revised / updated by US EPA in 2005
- Revised a Restoration / Management Plan in 2005, which was then expanded to a WIP and directly linked it to the TMDL in 2008
- Received funding under the SFY2011 319 program (fourth grant) to implement various residential BMPs, which will be completed this year

What the Neshaminy Creek Watershed Plan will provide to the Municipalities

- A series of structural and non-structural Best Management Practices (BMPs) that should be implemented to comply with the TMDL.
- The Plan will comply with the 9 elements of a WIP so projects can be eligible for State and Federal funding.
- Municipalities can incorporate their portion of the Plan into their MS4 permits.
- Also, credit will be provided to projects that have been implemented to reduce the TSS load.

BMPs that will be considered for the Neshaminy Creek Watershed Plan

- Riparian buffers / streambank and shoreline stabilization
- In-stream restoration measures / small dam removals
- Pocket wetlands / stormwater wetland treatment systems
- Rain gardens / bioretention swales
- Retrofit / upgrade existing detention / retention basins
- Various Manufactured Treatment Devices
- Others (street sweeping, rain barrels, maintenance measures).

Princeton Hydro

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

Stream Assessments

Stormwater Infrastructure Field Studies

Conducted: May 1-May 17, 2013

Rea Monaghan, Environmental Planner
Bucks County Planning Commission
remonaghan@co.bucks.pa.us

Stream Segment Assessments

- **Primary considerations:**
  - Public open space land /county or municipal-owned land
- **Assessments conducted thus far:**
  - Small portion of the West Branch: primarily stormwater facilities
    - Facilities assessed were those suggested by municipalities as having potential problems that could be contributing to sediment loads
  - Large portion of the Pine Run sub-watershed: primarily stream assessments
    - Assessment areas were broken down by stream segment and bridge crossings for ease of identification
    - Utilized Princeton Hydro's stream assessment and stormwater facilities infrastructure field sheets to document conditions
    - Mapped via GIS, segments and sub-watershed location/ Indentified longitude and latitude for beginning and ending points/Created pdfs of each mapped segment

Stream Visual Assessment

- **Stream Visual Assessment Scoring Sheet**
  - Vegetated Buffer Width
  - Vegetated Buffer Condition
  - Canopy Cover
  - Bank stability
  - Channel Condition
  - Hydrologic Alterations
  - Floodplain Encroachment
  - Aquatic Plant Community
  - Invertebrate Habitat
  - Instream Fish Cover
  - Barriers to Fish Movement
  - Velocity / Depth Variability
  - Manure Sources

Stream Assessment Consistencies Throughout Pine Run Sub-watershed

- **Vegetated Buffer Width:** Many segments range from 25-50 feet or > 50 feet (optimal).
- **Vegetated Buffer Condition:** Many segments have one habitat layer missing with scattered invasive species.
- **Canopy Cover:** Many segments have > 50% of the stream as shaded, or upstream poorly shaded, or 75% of water shaded and upstream well shaded. Some have canopy cover of 20-50%.
- **Bank Stability:** Vast majority of segments have unstable banks; some moderately unstable.
- **Channel Condition:** The majority of segments consist of natural channels. Several have mid-channel gravel bars and braided channels.
- **Hydrologic Alterations:** Several have evidence of hydrologic alterations (dams, channels or ditches).

Stream Assessment Consistencies Throughout Pine Run

- **Floodplain Encroachment:** The majority of segments have no evidence of floodplain encroachment or manmade structures.
  - Some have minor floodplain encroachment: fill materials, development, or manmade structures that may affect floodplain function.
- **Aquatic Plant Community:** The majority of stream segments have pea green or brown water throughout due to sediment/turbidity. Many segments have heavy siltation on stream bed and slow moving water.

Stream Assessment Consistencies Throughout Pine Run

- **Invertebrate Habitat and Instream Fish Cover:** Some stream segments have a diversity of habitat and fish cover present but show very little in the way of fish, invertebrates, turtles, frogs, etc. In those segments lacking fish and macroinvertebrates, the bottom of the stream segments were laden with silt, had few rocks or gravel and only a few riffles.
- **Velocity / Depth Variability:** Stream segments have, on average, 2-4 velocity/depth regimes present (4 being the most beneficial).
- This presentation will focus on problem areas but there are examples of segments having features that help to maintain water quality (e.g., no-mow/low-mow along stream; wetland areas; habitat diversity; and healthy riparian buffer areas).

Pine Run Stream Segments/Tributaries Assessed

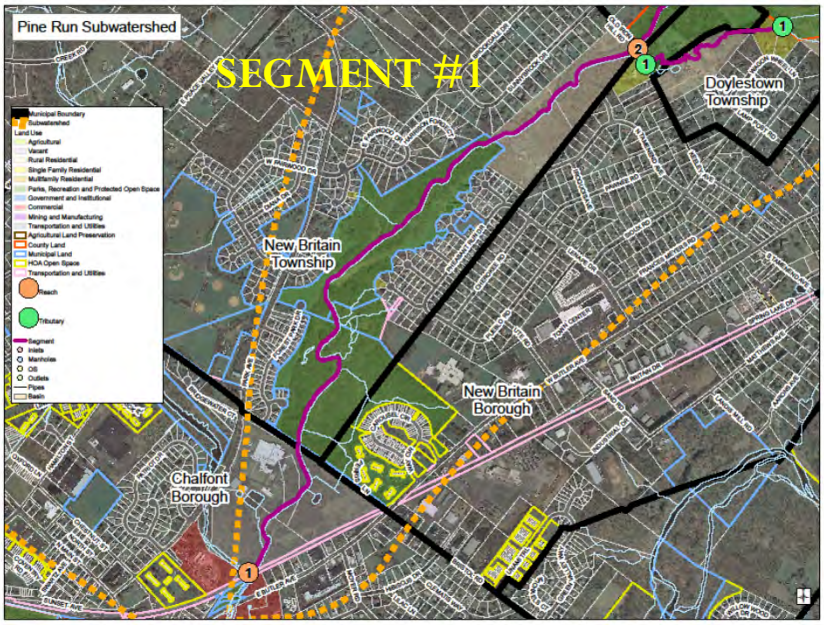
- Segment #1: (1 to 2) Bridgeview Park to Old Iron Hill Road
- Tributary #1 Old Iron Hill Road to Tributary Below Pine Run Reservoir
- Segment #2: (2 to 3) Old Iron Hill Road to end of Pine Run Reservoir
- Tributary #2 Ferry Road to Hagan Court to Dam Spillway
- Tributary #3: Ditch/Gulch on Pine Run Road to Pine Run
- Segment #3: (3 to 4) Dam Spillway and Forebay Area
- Segment #4: (4 to 5) Pine Run Forebay to Pine Run Road
- Segment #5: (5 to 6) Pine Run Road to Limekiln Road
- Segment #6: (6 to 7) Limekiln Road to Rickerts Road
- Segment #7: (7 to 8) Rickerts Road to Chapman Road

Pine Run Stream Segments/Tributaries Assessed

- Segment #8: (8 to 9) Chapman Road to Old Dublin Pike
- Segment #9: (9 to 10) Old Dublin Pike to Swamp Road
- Segment #10: (10 to 11) Swamp Road to Easton Road
- Segment #11: (11 to 12) Easton Road to North Easton
- Segment #12: (12 to 13) North Easton Road to Old Easton
- Segment #13: (13 to 14) Old Easton Road to Burnt House Hill Road
- Tributary #4 (below Segment #13) Old Easton Road to Landisville (conducted visual assessment of tributary from the road)
- Segment #14: (14 to 15) Burnt House Hill Road to Landisville Road (End of Impaired Stream Segments)
- Segment #15: (15 to 16): Landisville to Burnt House Hill Road (looped around)

Stream Assessment Segment #1

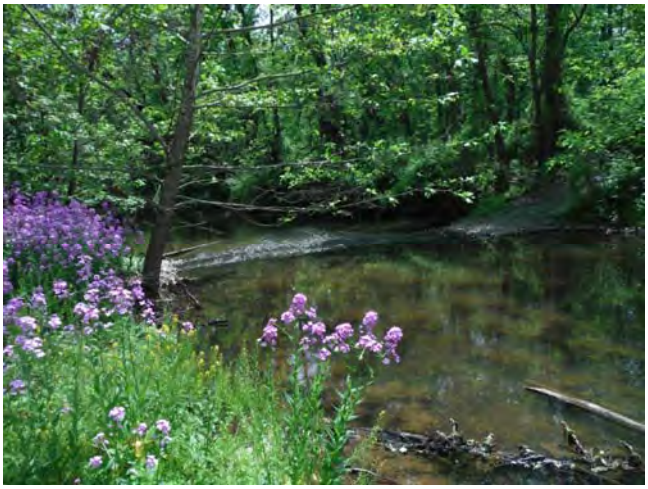
- **Bridgeview Park to Old Iron Hill Road:**
  - Assessment began at the confluence of the North Branch and Pine Run
  - Municipal location: Bridgeview Park in Chalfont Borough to Old Iron Hill Road in New Britain Township
  - Land Use: Park, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Construction at confluence of North Branch and Pine Run
  - Invasive species (e.g., Multiflora rose) dominate second tier habitat layer (bushes and shrubs)
  - Bank Stability: moderately unstable; outside bends are actively eroding (overhanging vegetation, falling trees, some slope failure)
  - Channel condition and Hydrologic Alterations: An abutment and dam are present
  - Log jams in the stream and debris all along floodplain
  - In-stream rock crossing for vehicle access



Segment #1 Bridgeview Park to Old Iron Hill Road
Confluence of Pine Run and North Branch

Segment #1 Bridgeview Park to Old Iron Hill Road
Construction at Confluence

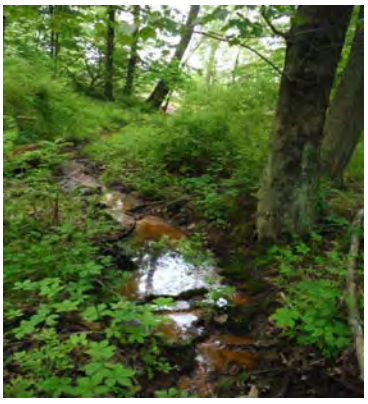
Segment #1 Bridgeview Park to Old Iron Hill Road Dam



Segment #1 Bridgeview Park to Old Iron Hill Road Abutment and Log Jam

Segment #1Bridgeview Park to Old Iron Hill Road
Remnants of a Bridge

Segment #1 Bridgeview Park to Old Iron Hill Road



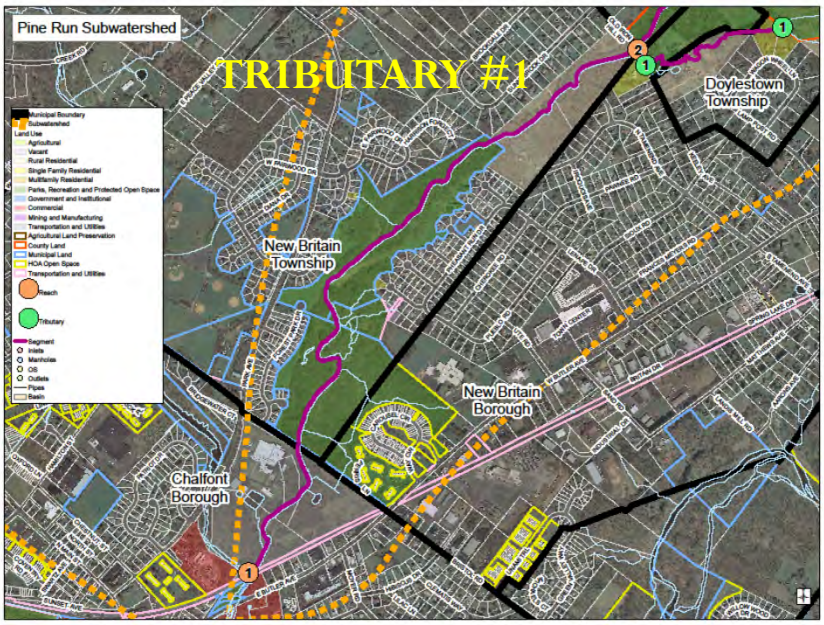
Orange runoff draining south from pond above
or seeping from ground

Stream Assessment Segment #1

- **Bridgeview Park to Old Iron Hill Road:**
  - **Potential Solutions:**
    - Consider removing log jams blocking water flow
    - Consider removal of dam/abutment
    - Consider alternate access across stream
    - Numerous opportunities for bank stabilization

Tributary #1 Old Iron Hill Road to Tributary Below Pine Run Reservoir

- **Old Iron Hill Road to Tributary Below Pine Run Reservoir:**
  - Municipal location: Doylestown Township. Below Segment #1
  - Land Use: Parks, Recreation and Protected Open Space and Rural Residential
  - Assessment: Good condition
- **Primary Problems Identified:**
  - Culvert under the bridge at the end of the Segment is shallow and many sunfish are trapped

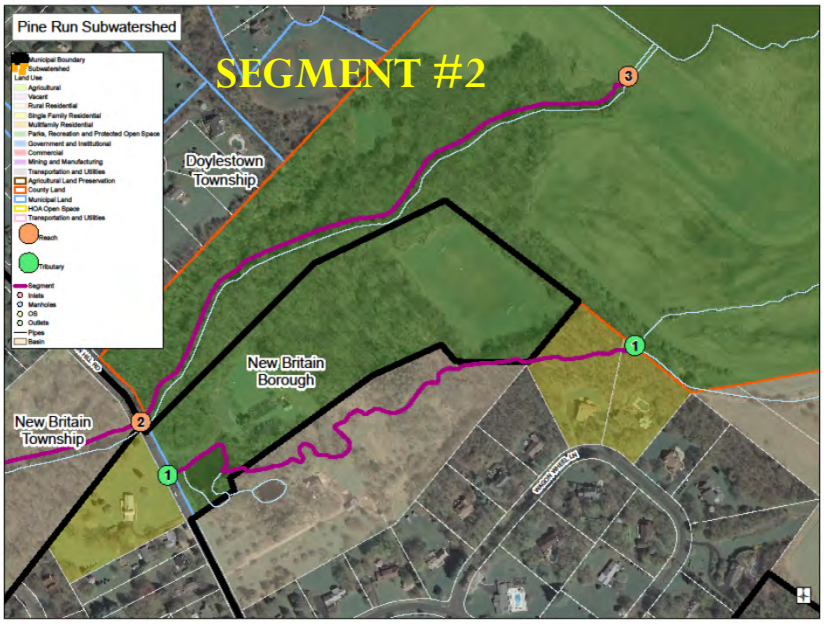


Tributary #1 Old Iron Hill Road to Tributary Below Pine Run Reservoir

Tributary #1 Old Iron Hill Road to Tributary Below Pine Run Reservoir

Segment #2 Old Iron Hill Road to the end of Pine Run Reservoir

- **Old Iron Hill Road to end of Pine Run Reservoir:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Extreme bank erosion and fallen trees. Numerous log jams
  - Many erosion channels to Pine Run
  - Limited wildlife/waterfowl
  - Foul odor /grey / green water in some areas
  - Sewer manholes along this segment



Segment #2 Old Iron Hill Road to End of Pine Run Reservoir: Log Jams

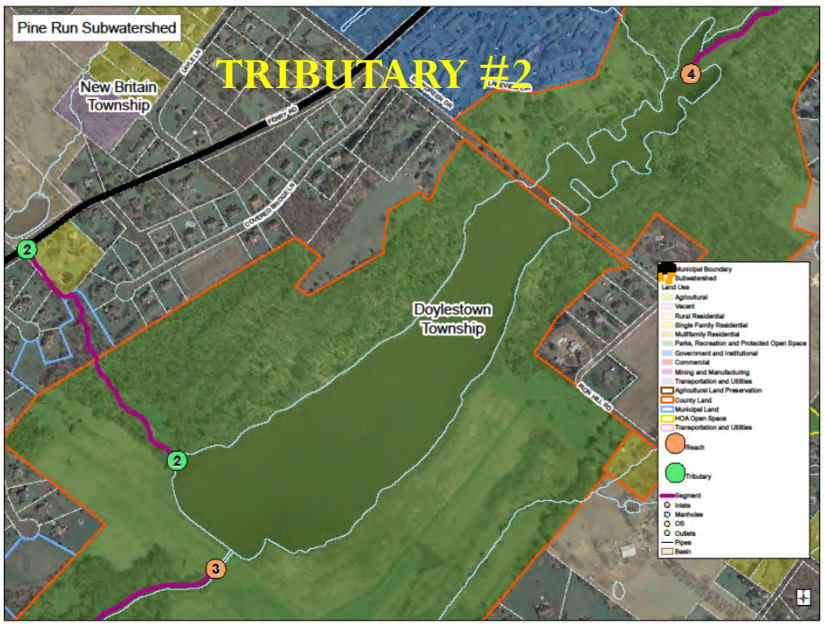
Segment #2 Old Iron Hill Road to End of Pine Run Reservoir: Erosion/Scouring

Segment #2 Old Iron Hill Road to the end of Pine Run Reservoir

- **Potential Solutions:**
  - Explore opportunities for stream bank stabilization
  - Water quality sampling

Tributary #2 Ferry Road to Hagan Court to the Dam Spillway

- **Ferry Road to Hagan Court to Dam Spillway:**
  - Municipal location: Doylestown Township
  - Land Use: Single Family Residential / Homeowner Open Space / Park, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - One pond with a dam, above Ferry Road, has a steep ditch leading under the road to the tributary that traverses through Hagan Court (subdivision)which drains to Pine Run
    - Orange-colored runoff draining diagonally to ditch
  - Hagan Court detention basin – low flow channel



Tributary #2 Ferry Road to Hagan Court to the Dam Spillway: Detention Basin

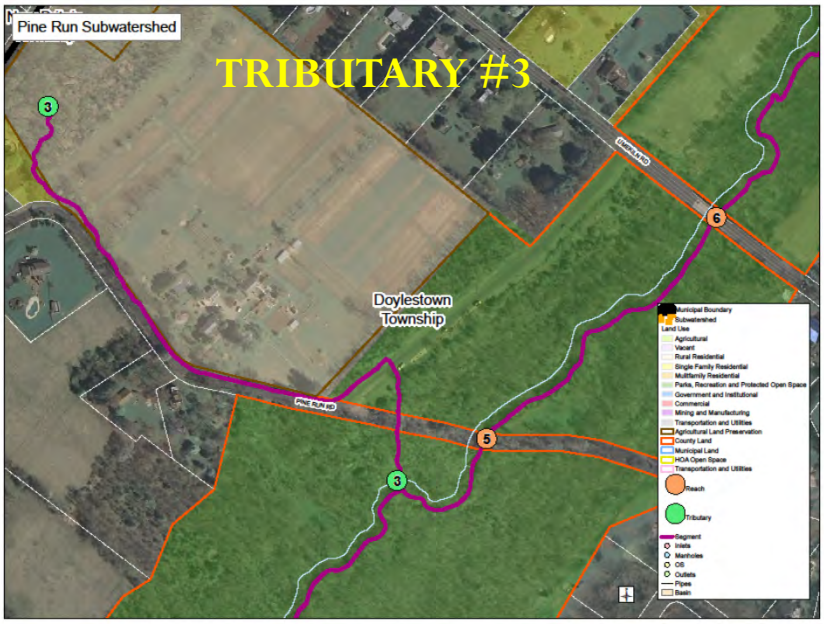
Tributary #2 Ferry Road to Hagan Court to the Dam Spillway: Ditch

Tributary #2 Ferry Road to Hagan Court to the Dam Spillway

- **Potential Solutions:**
  - Explore potential to naturalize detention basin in Hagan Court
  - Investigate origin of orange runoff (may be due to soil composition)

Tributary #3 Ditch/Gulch on Pine Run Road

- **Ditch/Gulch on Pine Run Road:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space, and Rural Residential
- **Primary Problems Identified:**
  - Gulch runs directly adjacent to Pine Run Road.
  - No buffer or canopy cover on the left bank of gulch
  - Extreme velocity during rain events
  - Tree limbs and cement blocks, etc., placed in ditch to slow velocity of runoff coming from Ferry Road



Tributary #3 Ditch/Gulch on Pine Run Road to Pine Run Creek

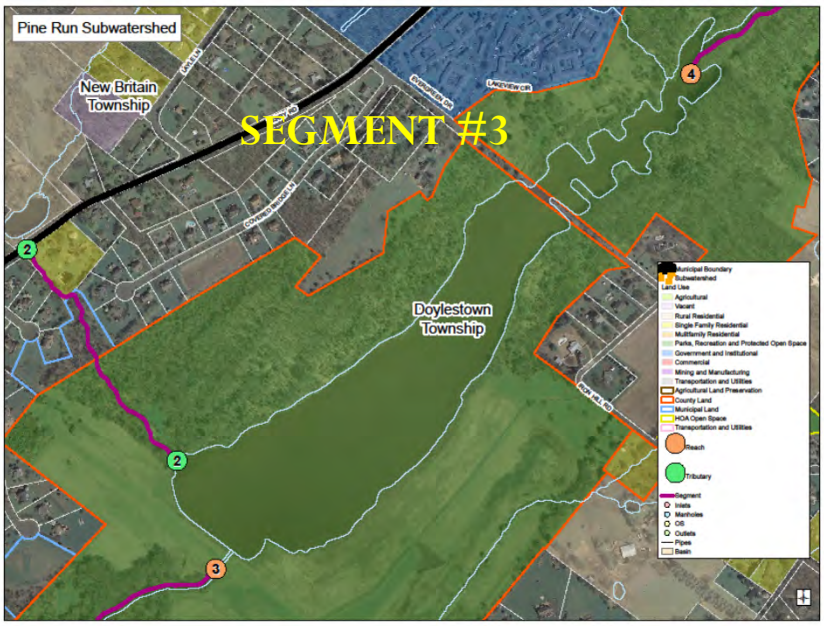
Tributary #3 Ditch/Gulch on Pine Run Road to Pine Run Creek

Tributary #3 Ditch/Gulch on Pine Run Road to Pine Run Creek

- **Ditch/Gulch on Pine Run Road:**
  - **Potential Solutions:**
    - Explore potential to utilize open space property for infiltration

Segment #3 Dam Spillway and Forebay Area

- **Dam Spillway and Forebay Area:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - We did not walk the stretch of the reservoir but rather made observations at the beginning /end of the reservoir
  - Water is chocolate brown throughout, high level of turbidity



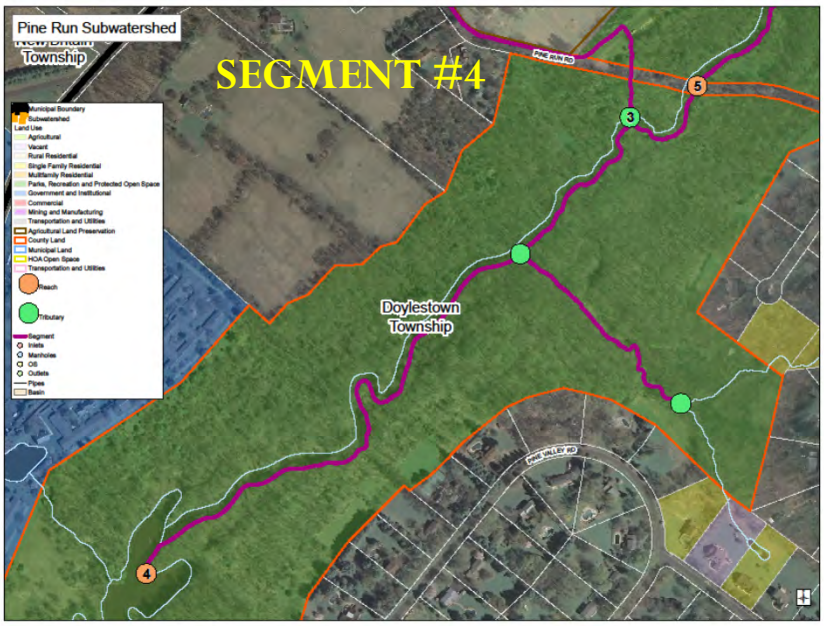
Segment #3 Dam Spillway and Forebay Area

Segment #3 Dam Spillway and Forebay Area

- **Potential Solutions:**
  - Conservation Pool
    - Fred Lubnow, PhD and Clay Emerson, PhD, PE from Princeton Hydro will touch upon potential solutions

Segment #4 Pine Run Forebay to Pine Run Road

- **Pine Run Forebay to Pine Run Road:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Slow-deep and slow-shallow velocity/depth variability
  - Silty, red, highly erodible soil on banks
  - Numerous log jams, channelization, erosion and scouring of left and right banks



Segment #4 Pine Run Forebay to Pine Run Road Dam

Segment #4 Pine Run Forebay to Pine Run Road Log Jams / Channelization / Braided Channel

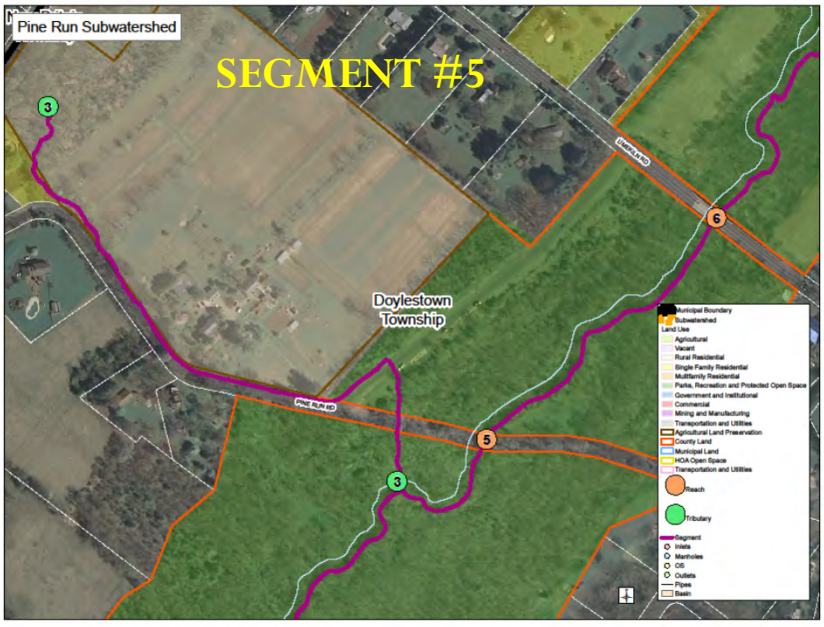
Segment #4 Pine Run Forebay to Pine Run Road
Bank Erosion/Under Cutting of Banks

Segment #4 Pine Run Forebay to Pine Run Road

- **Potential Solutions:**
  - Explore opportunity for bank stabilization
  - Consider removing fallen trees and logs blocking water flow
  - Consider potential for dam removal

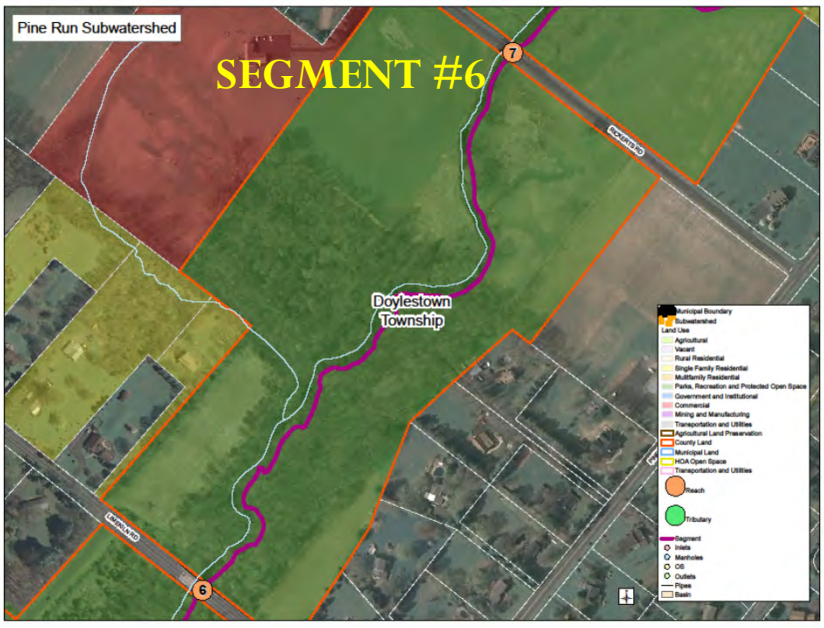
Segment #5 Pine Run Road to Limekiln Road

- **Pine Run Road to Limekiln Road:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Extreme bank erosion and fallen trees
  - Numerous log jams
  - Many erosion channels to Pine Run
- **Potential Solutions:**
  - Explore opportunity for bank stabilization
  - Removal of fallen trees and logs blocking water flow



Segment #6 Limekiln Road to Rickerts Road

- **Limekiln Road to Rickerts Road:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Greenish water along entire segment
  - Stream is slow moving and shallow
  - Silt is present along entire creek bottom
  - Clay-like soil ledge that crumbles/erodes
  - Dumping of yard waste and miscellaneous trash in open space area



Segment #6 Limekiln Road to Rickerts Road Erosion

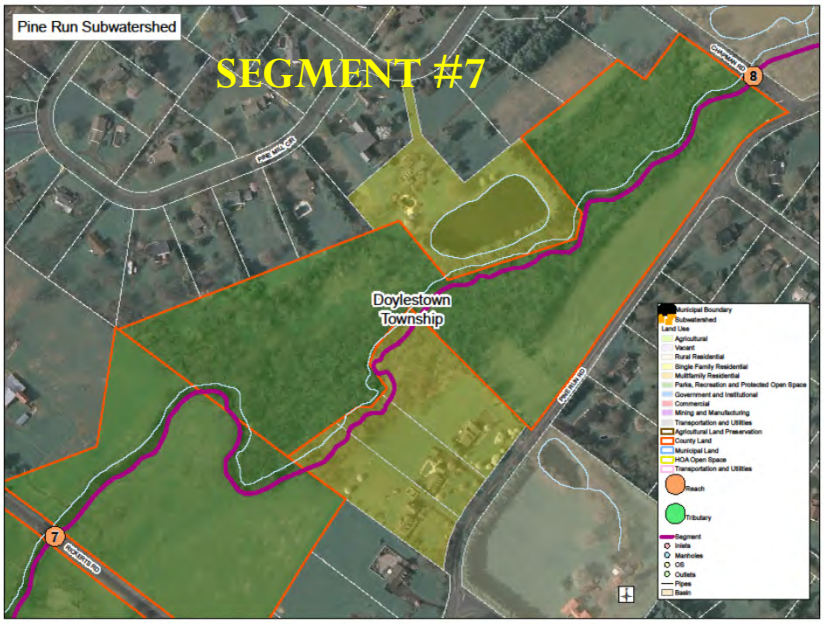
Segment #6 Limekiln Road to Rickerts Road Erosion/ Log Jam

Segment #6 Limekiln Road to Rickerts Road

- **Potential Solutions:**
  - Potential opportunity for bank stabilization
  - Removal of fallen trees and logs blocking water flow
  - Homeowner education/ monitoring open space areas

Segment #7 Rickerts Road to Chapman Road

- **Rickerts Road to Chapman Road:**
  - Municipal location: Doylestown Township
  - Land Use: Parks, Recreation and Protected Open Space
- **Primary Problems Identified:**
  - Banks are unstable, inside and outside bends are eroding and some slope failures (especially near agricultural areas where riparian buffers are lacking)
  - Pea green /brown water along entire segment
  - Silty/sedimentation throughout stream
  - Stream is primarily shallow and fast moving with some deep pools
  - Some gravel bars
  - Turtles, cray fish and mayfly present, which would suggest the water quality of the stream is healthy



Segment #7 Rickerts Road to Chapman Road Lacking Riparian Buffer

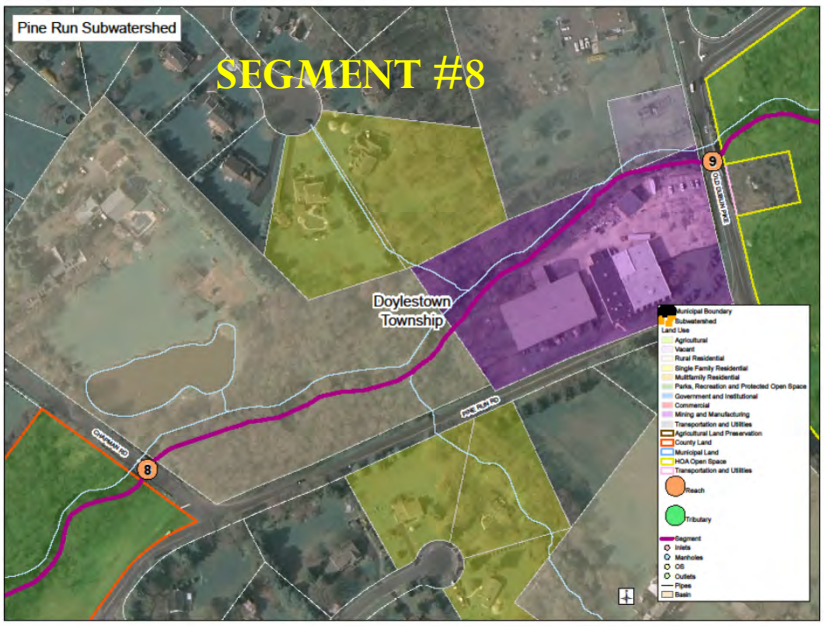
Segment #7 Rickerts Road to Chapman Road
Eroded Banks / Soil Type Classification

Segment #7 Rickerts Road to Chapman Road

- **Problem Statements:**
  - Perhaps Limited options for riparian buffer plantings in some areas due to present land use practices
  - Appears that soil type classification may present challenges (i.e., continued erosion)

Segment #8 Chapman Road to Old Dublin Pike

- **Chapman Road to Old Dublin Pike:**
  - Municipal location: Doylestown Township
  - Land Use: Rural Residential and Manufacturing
- **Primary Problems Identified:**
  - Stream bank behind building was almost vertical and very eroded
  - Numerous pipes and a concrete outflow draining stormwater runoff from parking lot into creek
  - Downed trees and huge log jams. Debris lodged up high on top of stream banks in floodplain
  - Lots of erosion and scouring of the left bank



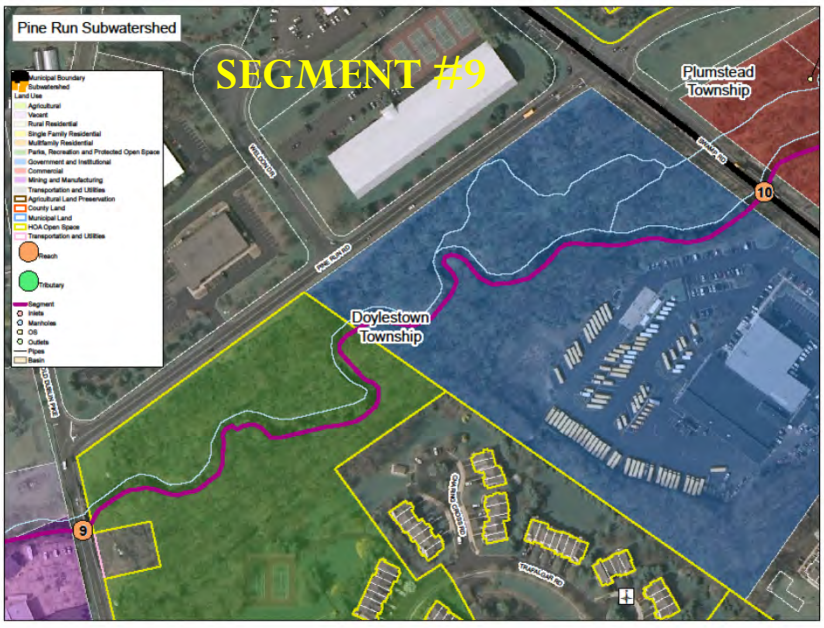
Segment #8 Chapman Road to Old Dublin Pike
Culvert from parking lot

Segment #8 Chapman Road to Old Dublin Pike

- **Potential Solutions:**
  - Control Runoff from parking lot with new stormwater management facilities (e.g., change pitch of driveway and explore opportunities for infiltration)
    - Since this presentation, numerous BMPs have been proposed for this sight (e.g., removal of some impervious coverage, riparian corridor restoration and an infiltration basin)

Segment #9 Old Dublin Pike to Swamp Road

- **Old Dublin Pike to Swamp Road:**
  - Municipal location: Doylestown Township and Border of Plumstead Township
  - Land Use: Homeowner Open Space and Government /Institutional
- **Primary Problems Identified:**
  - Extreme erosion and fallen trees. Numerous log jams.
  - This Segment had a foul odor. Only a few fish and birds viewed
  - Sewer manholes present along stream reach

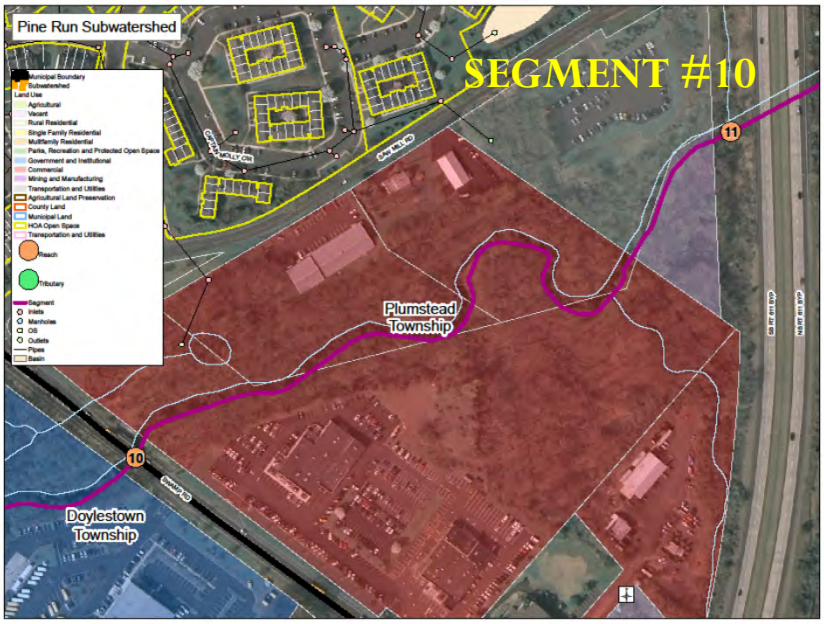


Segment #9 Old Dublin Pike to Swamp Road

- **Potential Solutions:**
  - Remove log jams blocking water flow
  - Water quality sampling

Segment #10 Swamp Road to Easton Road

- **Swamp Road to Easton Road:**
  - Municipal location: Plumstead Township
  - Land Use: Commercial/ Transportation/Utility/Government and Institutional
- **Primary Problems Identified**:
  - Extreme erosion, fallen trees and log jams



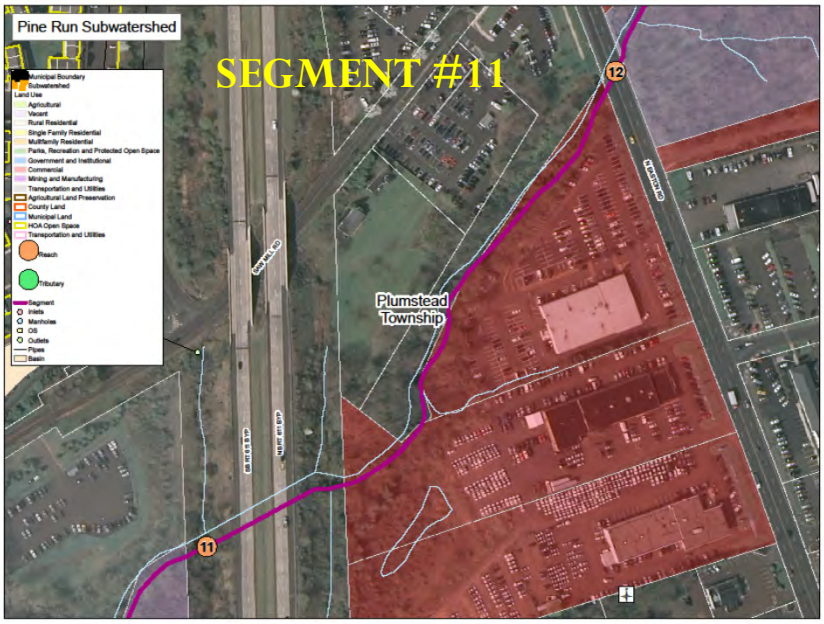
Segment #10 Swamp Road to Easton Road Bends Actively Eroding

Segment #10 Swamp Road to Easton Road

- **Potential Solutions:**
  - Remove log jams blocking water flow
  - Perhaps opportunities for bank stabilization

Segment #11 Easton Road to North Easton

- **Easton Road to North Easton Road:**
  - Municipal location: Plumstead Township
  - Land Use: Commercial/Single Family Residential/ Rural Residential/Vacant
- **Primary Problems Identified:**
  - Extreme erosion / fallen trees/ log jams
  - Scouring of stream banks
  - Trash present
  - Significant sediment buildup under bridge



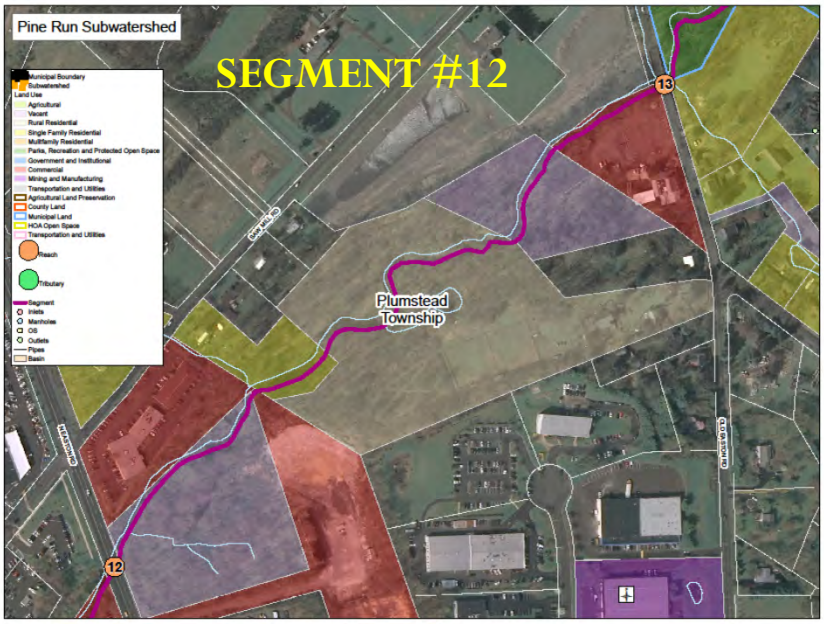
Segment #11 Easton Road to North Easton Road

Segment #11 Easton Road to North Easton Road

- **Potential Solutions:**
  - Remove log jams blocking water flow
  - Opportunities for bank stabilization
  - Remove trash
  - Remove sediment under bridge

Segment #12 North Easton Road to Old Easton Road

- **North Easton Road to Old Easton Road**
  - Municipal Location: Plumstead Township
  - Land Use: Rural Residential /Agricultural / Commercial / Vacant
- **Primary Problems Identified:**
  - Commercial use property: Large fill area used for dumping of cement and stone mix. Leaking into what appears to be wetland area adjacent to, and possibly into Pine Run (* added information since May 30 presentation)



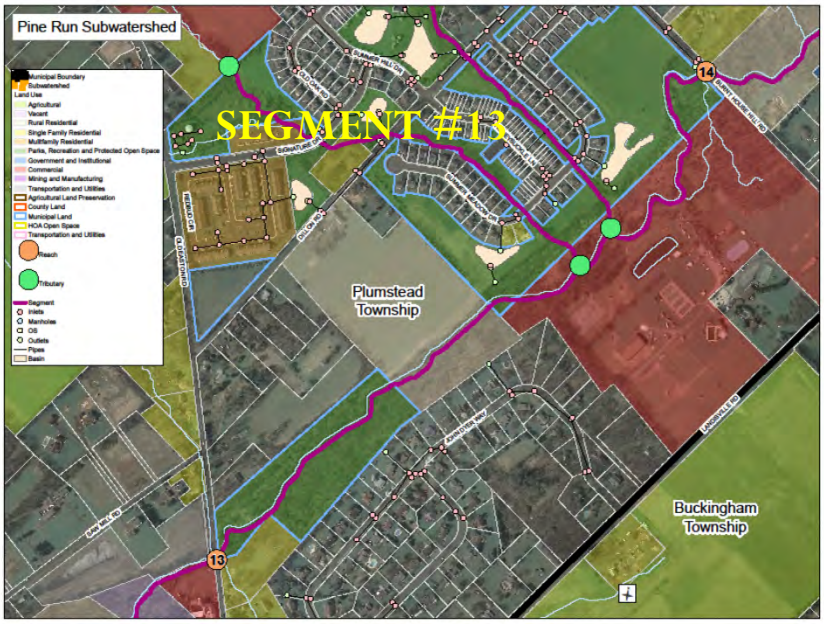
Segment #12 North Easton Road to Old Easton Road

Segment #12 North Easton Road to Old Easton Road

- **Potential Solutions:**
  - Remove log jams blocking water flow
  - Potential opportunities for bank stabilization
  - Research land use practices on commercial property (*added information since May 30 presentation)

Segment #13 Old Easton Road to Burnt House Hill Road

- **North Easton Road to Old Easton/Old Easton Road to Burnt House Hill Road:**
  - Municipal location: Plumstead Township
  - Land Use: Commercial/Single Family Residential/ Rural Residential/Vacant
- **Primary Problems Identified:**
  - Erosion / fallen trees/ log jams/ scouring of stream banks /braided channels /erosion channels due in part to runoff from subdivisions
  - Turbidity throughout
  - 3 dams/abutments
    - > 1 foot drop 1st dam (fish barrier)
    - > 3 ft drop 2nd manmade dam (fish barrier)
  - Sewer line for new development along right bank and 3 yards from creek. Manhole shows signs of what appears to be past overflows



Segment #13 Old Easton Road to Burnt House Hill Road: Dam 1

Segment #13 Old Easton Road to Burnt House Hill Road: Dam 2

Segment #13 Old Easton Road to Burnt House Hill Road: Abutments

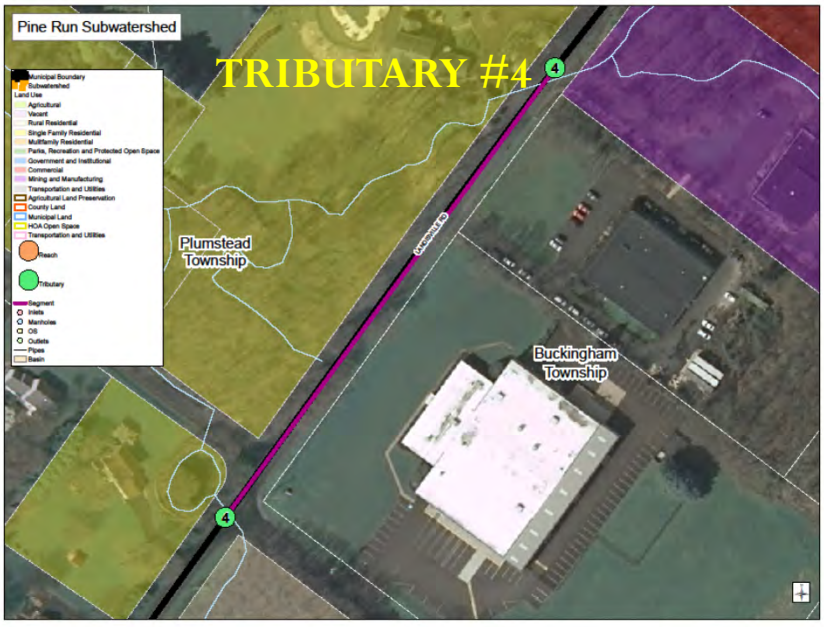
Segment #13 Old Easton Road to Burnt House Hill Road
Possible opportunity for stormwater infiltration or Manufactured Treatment Device

Segment #13 Old Easton Road to Burnt House Hill Road

- **Potential Solutions:**
  - Consider removal of dams
  - Consider infiltration/stormwater detention basin along Burnt House Hill Road at bridge
    - At present runoff flows directly into the stream
    - Boulders are in place to slow velocity
  - Inspect sewer manholes for overflows

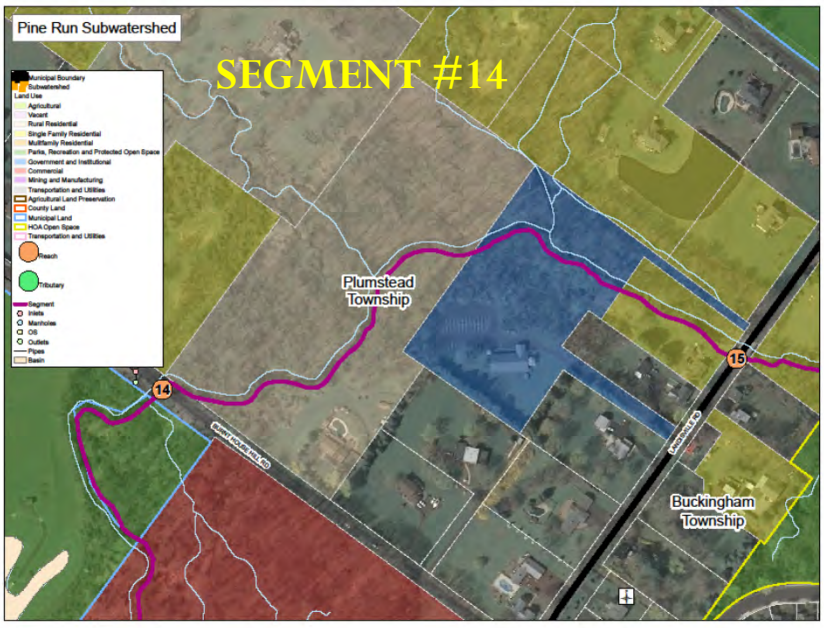
Tributary #4 Old Easton Road to Landisville Road

- **Old Easton Road to Landisville Road:**
  - Municipal location: Plumstead Township
  - Land Use: Single Family Residential
  - Visual assessment from the road conducted
    - The tributary is in good condition. Diversity of plant species in buffer area. Lawns are not mowed up to banks of tributary.



Segment #14 Burnt House Hill Road to Landisville Road

- **Burnt House Hill Road to Landisville Road:**
  - Municipal location: Plumstead Township
  - Land Use: Single Family Residential / Rural Residential/ Agricultural /Government and Institutional
- **Primary Problems Identified:**
  - Many invasive plant species and thickets. Difficult to navigate
  - Erosion channels

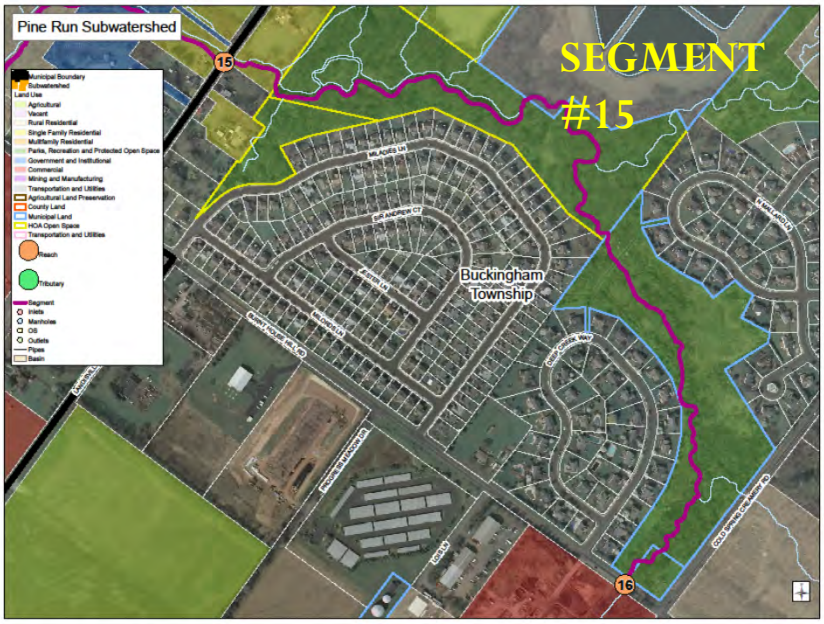


Segment #14 Burnt House Hill Road to Landisville Road

- **Potential Solutions:**
  - Invasive plant removal (large scale)
  - End of Impaired Segments

Segment #15 Landisville to Burnt House Hill Road

- **Landisville to Burnt House Hill Road (road loops around):**
  - Municipal location: Plumstead and Buckingham Townships
  - Land Use: Park, Recreation and Protected Open Space/Some Agricultural and Single Family Residential
- **Primary Problems Identified:**
  - Residential dumping of yard waste, etc. along stream
  - Debris gets caught under bridge. Evidence of significant velocity of runoff through containment area before the bridge
  - Braided Channels



Segment #15 Landisville to Burnt House Hill Road
Yard Waste and Wall Along Private Properties

Segment #15 Landisville to Burnt House Hill Road Access Bridge with Extensive Riprap

Segment #15 Landisville to Burnt House Hill Road Access Bridge is Low /Debris Gets Trapped

Segment #15 Landisville to Burnt House Hill Road
Braided Channel/Island

Segment #15 Landisville to Burnt House Hill Road
Yard Waste and Wall Along Private Properties

- **Potential Solutions:**
  - Public Outreach and Education
  - Remove log jams blocking water flow

Stormwater Infrastructure Assessment

- **Stormwater Infrastructure Assessment Field Sheet**
  - Precipitation
  - Time/Quantity of last rain
  - Site Description
  - Dominant Watershed Land Uses
  - Structure submerged in water?
  - Sediment present?
  - Trash/Litter present?
  - Yard Waste present?
  - Pet/other animal feces?
  - Odor?
  - Green or rusty slime?
  - Structure Type and Condition
  - Underground Manufactured Treatment Device (MTD) or other infrastructure present?
  - General visual observation of site
  - Recommendations:

Stormwater Infrastructure Assessments Conducted in the West Branch Sub-Watershed

- Primary focus in the West Branch to date has been based on municipal feedback regarding potential problem areas, or areas contributing to sediment loads.
- **Hilltown Township:**
  - **Hilltown Pike and Key Drive (subdivision):**
    - Outfall structure from stormwater detention basin piped under the road and into a tributary of the West Branch #4.
    - Recent work involved digging up of ground around a culvert. Extensive crumbling and erosion of the soil bank which fell into the tributary leading to the West Branch.
    - Approximately 1' drop inside of the culvert which can be a barrier to fish.

Hilltown Pike and Key Drive (subdivision)

Recommendation: Use soil packs to hold banks in place

Stormwater Infrastructure Assessment Conducted in the West Branch Sub-Watershed

- **Hilltown Township:**
- **Township Line Road and Keystone Drive (subdivision):**
  - Basin: Sparrow Way Road
    - This basin was not designed as a wet pond but rather the drain at the bottom has not been maintained and is clogged.
- **Potential Solutions:**
  - Do not mow the banks
  - Address erosion area
  - Maintain stormwater facility

Sparrow Way Road Basin

Stormwater Infrastructure Assessment Conducted in the West Branch Sub-Watershed

- **Hilltown Township:**
- **Berry Brow Drive:**
  - Storm drains have fabric inside in order to catch debris and prevent it from entering storm system
  - Several drains were clogged and need to be removed and maintained
- **Potential Solutions:**
  - Regular maintenance of drains

Berry Brow Road: Storm Drains are Clogged

Stormwater Infrastructure /Stream Assessment Conducted in the West Branch Sub-Watershed

- **Hatfield Borough:**
  - Assessed a series of potential "problem areas"
  - A dam is located between areas #3-5
- **Potential Solutions:**
  - Dam removal would be good for aquatic life, etc. Removal would release rocks and sediment but the sediment would settle out

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

QUESTIONS?

Rea Monaghan, Environmental Planner
remonaghan@co.bucks.pa.us

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

Workshop #2

Draft Plan Review

November 21, 2013

Rea Monaghan, Environmental Planner
Bucks County Planning Commission
remonaghan@co.bucks.pa.us

Meeting Goals

- **Part One:**
  - Coastal Zone Management Program
  - National Pollutant Discharge Elimination System (NPDES) General Permit (PAG 13) Municipal Separate Storm Sewer System (MS4)
  - Stream Assessments / Inventory of Stormwater Facilities
  - Project Timeline / Municipal Participation /Plan Review / Municipal BOS and Council Support of Plan
- **Part Two:**
  - Review field /desktop findings
  - Review plan preparation
  - Potential restoration actions

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION **Coastal Resources MANAGEMENT PROGRAM**

- PA's DEP's Water Planning Office coordinates and implements the Coastal Resources Management (CRM) Program to execute sound coastal management policies in Pennsylvania's two coastal areas (Lake Erie and Delaware Estuary).

- Receives funding from the National Oceanic and Atmospheric Administration (NOAA) to administer the CRM program and provide grants to local governments, state agencies, and nonprofit organizations to undertake projects in the coastal zones.

A map of the boundaries can be found on DEP's website http://www.dep.state.pa.us/river/about/about.htm.

CZM Program Grants

Eligible organizations include municipalities, townships, boroughs, cities, counties and non-profit organizations with projects located in one of Pennsylvania's coastal zones.

FY 2012-PD.05
Neshaminy Creek Watershed Sediment Reduction Plan for Municipal Implementation

Lead agency: Bucks County Planning Commission

Neshaminy Watershed Municipalities (41)

Project Partners:

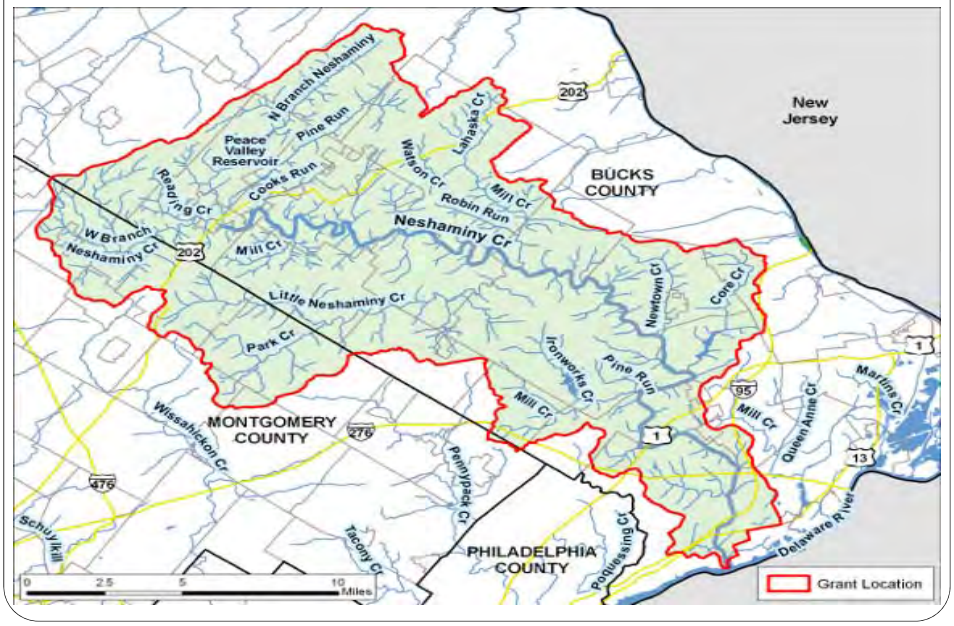
pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUCKS COUNTY CONSERVATION DISTRICT

MCPC

MONTGOMERY COUNTY CONSERVATION DISTRICT

FY 2012-PD.05
Neshaminy Creek Watershed Sediment Reduction Plan for Municipal Implementation



Pennsylvania's Stormwater Management Act (Act 167)

- PADEP requires municipalities classified as urban areas by the U.S. Census to implement a ***stormwater management program*** as part of the National Pollutant Discharge Elimination System (NPDES).
- NPDES permit requirements:
  - Referred to as "General Permit PAG-13 or the Municipal Separate Storm Sewer System (MS4) permit.
  - Every municipality within the Neshaminy Creek watershed in Bucks and Montgomery counties are "MS4 Municipalities" and must comply with the PAG-13 permit and implement a stormwater management program.
- The goal of ***each program*** should be to reduce the discharge of pollutants to the "maximum extent practicable," to protect water quality and satisfy the requirements of the Clean Water Act.

NPDES -- PAG 13 (MS4)

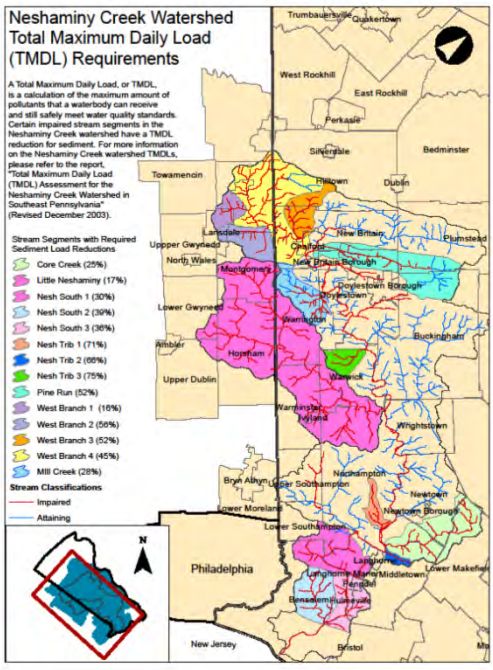
- **The second generation NPDES (PAG-13) requirements:**
  - Scheduled to be effective March 16, 2013
  - Will require any regulated MS4 municipality which discharges to an impaired waterway with a TMDL, to develop, implement, and enforce a MS4/TMDL plan that will achieve the pollutant reductions consistent with DEP's TMDL report.
- **Implications:**
  - New stormwater BMPs imposed as the result of a local ordinance will now need to reduce sediment pollutant loadings to the MS4 permit requirements.
  - These actions alone are not expected to be enough to reduce the sediment loads in the Neshaminy Creek as required by the TMDL.

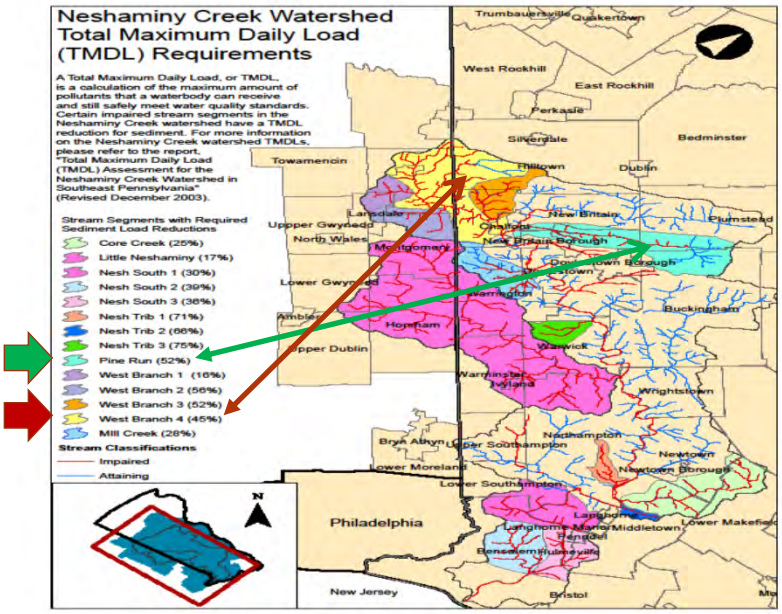
Total Maximum Daily Load (TMDL)

- Federal regulations require that any PADEP-designated impaired waterway must have a Total Maximum Daily Load (TMDL) developed.
  - The TMDL must be implemented until the waterway is no longer impaired.
  - Several stream segments within the Neshaminy Creek watershed are impaired from excess sediment contributions.
- PADEP finalized the sediment TMDL in December 2003 in a report titled *Total Maximum Daily Load (TMDL) Assessment for the Neshaminy Creek Watershed in Southeast Pennsylvania*.

Neshaminy Creek Watershed TMDL Report

- 14 sub-watersheds with assigned sediment reduction loads. Impairments caused by runoff.
- Sediment reduction requirements range from 16% to 75%.
- The sub-watersheds cross through 31 different municipalities.





Categorization Scheme of Sub-watersheds

- Planning Goal of the *Neshaminy Creek Sediment Reduction Plan for Municipal Implementation* is:
  - To determine what additional efforts will be needed by each municipality to fulfill their TMDL sediment reduction baselines.
  - West Branch sub-watershed #4, Neshaminy Creek and Pine Run sub-watersheds account for slightly more than half (52.5%) of the total amount of sediments, measured as total suspended solids (TSS), targeted for reduction.
  - These two sub-watersheds were categorized as "high" in terms of need.
  - Also considered sub-watersheds having a mix of land uses and potential for future development.

Stream Assessments and Inventory of Stormwater Facilities

- Stream assessments and an inventory of stormwater facilities were conducted of the Pine Run sub-watershed.
  - Consistent problems were found to exist throughout the Pine Run sub-watershed (stream reaches and stormwater facilities).
- Some stream assessments (Hatfield Borough) and the inventory of stormwater facilities (Hilltown Township, New Britain Township) were conducted in the West Branch 4 subwatershed.

Plan Development

- Existing watershed, rivers conservation and stormwater management Act 167 plans were reviewed in order to develop a list of problem areas and issues within the Neshaminy Creek watershed.
- According to 2003 report, some municipalities within the Neshaminy Creek watershed do not have waste load allocations assigned.
- Solicited municipalities for a list of problem areas and associated maps.
  - 11 municipalities provided specific information regarding hot spot areas that could be contributing to sediment loads.
  - Additional municipal responses:
    - No stormwater outfalls identified in their MS4
    - Only small land coverage within either sub-watershed
    - No known areas contributing to sediment loads

Stream Segment Assessments

- **Stream Assessments and Stormwater Facilities Inventories:**
  - Conducted May – July 2013
- **Primary focus:**
  - Public open space land /county or municipal-owned land / Homeowner open space
- **Assessments conducted :**
    - Stormwater facilities and areas assessed were those suggested by municipalities as having the potential to contribute to sediment loads or that experience significant flooding.
    - Aerial inventories (GIS/Google Earth) and field assessments of additional stormwater facilities were conducted.
    - Stream assessment areas were broken down by stream segment and road crossings for ease of identification.
  - Utilized a modified version of Princeton Hydro's stream assessment and stormwater infrastructure field sheet to document conditions.
  - Mapped, via GIS, segments and sub-watershed location.
  - Indentified longitude and latitude for beginning and ending points.
  - Created pdfs of each mapped segment.

Pine Run Stream Segments/Tributaries Assessed

- Segment #1: (1 to 2) Bridgeview Park to Old Iron Hill Road
- Tributary #1 Old Iron Hill Road to Tributary Below Pine Run Reservoir
- Segment #2: (2 to 3) Old Iron Hill Road to end of Pine Run Reservoir
- Tributary #2 Ferry Road to Hagan Court to Dam Spillway
- Tributary #3: Ditch/Gulch on Pine Run Road to Pine Run
- Segment #3: (3 to 4) Dam Spillway and Forebay Area
- Segment #4: (4 to 5) Pine Run Forebay to Pine Run Road
- Segment #5: (5 to 6) Pine Run Road to Limekiln Road
- Segment #6: (6 to 7) Limekiln Road to Rickerts Road
- Segment #7: (7 to 8) Rickerts Road to Chapman Road

Pine Run Stream Segments/Tributaries Assessed

- Segment #8: (8 to 9) Chapman Road to Old Dublin Pike
- Segment #9: (9 to 10) Old Dublin Pike to Swamp Road
- Segment #10: (10 to 11) Swamp Road to Easton Road
- Segment #11: (11 to 12) Easton Road to North Easton
- Segment #12: (12 to 13) North Easton Road to Old Easton
- Segment #13: (13 to 14) Old Easton Road to Burnt House Hill Road
- Tributary #4 (below Segment #13) Old Easton Road to Landisville (conducted visual assessment of tributary from the road)
- Segment #14: (14 to 15) Burnt House Hill Road to Landisville Road (End of Impaired Stream Segments)
- Segment #15: (15 to 16): Landisville to Burnt House Hill Road (looped around)

Stream Visual Assessment

- **Stream Visual Assessment Scoring Sheet**
  - Vegetated Buffer Width
  - Vegetated Buffer Condition
  - Canopy Cover
  - Bank stability
  - Channel Condition
  - Hydrologic Alterations
  - Floodplain Encroachment
  - Aquatic Plant Community
  - Invertebrate Habitat
  - Instream Fish Cover
  - Barriers to Fish Movement
  - Velocity / Depth Variability
  - Manure Sources

Stream Assessment Consistencies Throughout Pine Run Sub-watershed

- **Vegetated Buffer Width:** Many segments range from 25-50 feet or > 50 feet (optimal).
- **Vegetated Buffer Condition:** Many segments have one habitat layer missing with scattered invasive species.
- **Canopy Cover:** Many segments have > 50% of the stream as shaded, or upstream poorly shaded; some have canopy cover of 20-50%.
- **Bank Stability:** Vast majority of segments have unstable banks; some moderately unstable.

Stream Assessment Consistencies Throughout Pine Run

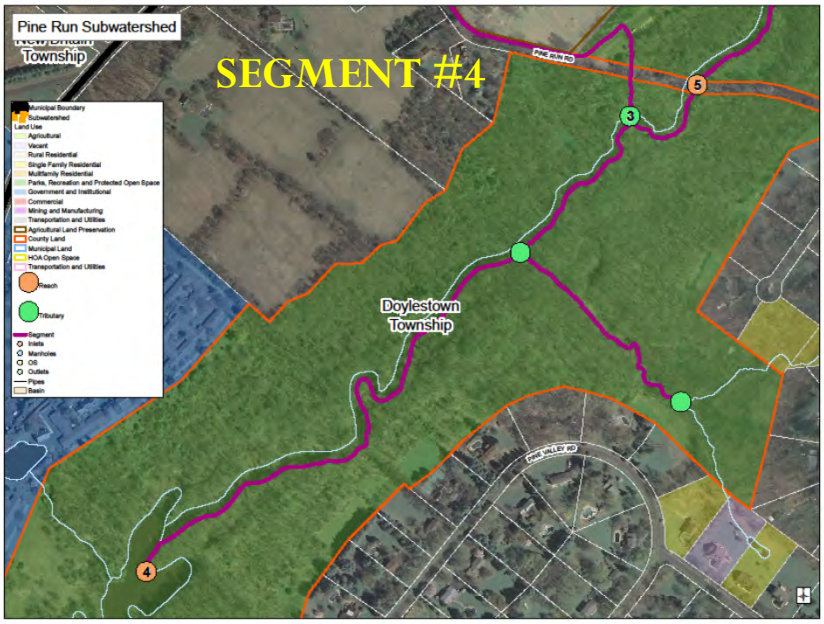
- **Floodplain Encroachment:** Many stream segments have no evidence of floodplain encroachment or manmade structures.
  - Some have minor floodplain encroachment: fill materials, development, or manmade structures that may affect floodplain function.
- **Aquatic Plant Community:** The majority of stream segments have green or brown water throughout due to sediment/turbidity. Many segments have heavy siltation on stream bed and slow moving water.
- **Channel Condition:** The majority of segments consist of natural channels. Some have mid-channel gravel bars and braided channels.
- **Hydrologic Alterations:** Several have evidence of hydrologic alterations (dams, channels or ditches).

Stream Assessment Consistencies Throughout Pine Run

- **Invertebrate Habitat and Instream Fish Cover:** Some stream segments have a habitat and fish cover present but very few fish, invertebrates, turtles, frogs, were present. In those segments lacking fish, the bottom of the stream segments were laden with silt, had few rocks or gravel and only a few riffles.
- **Velocity / Depth Variability:** Stream segments have, on average, 2-4 velocity/depth regimes present (4 being the most beneficial).
- There are some examples of segments having some features that help maintain water quality and stabilize banks (e.g., wide vegetated buffer or wetland areas).

Examples of Stream Segments Assessed

- **Segment #4 Pine Run Forebay to Pine Run Road**
  - **Pine Run Forebay to Pine Run Road:**
    - Municipal location: Doylestown Township
    - Land Use: Parks, Recreation and Protected Open Space
  - **Primary Problems Identified:**
    - Slow-deep and slow-shallow velocity/depth variability
    - Silty, red, highly erodible soil on banks
    - Numerous log jams, channelization, erosion and scouring of left and right banks



Segment #4 Pine Run Forebay to Pine Run Road Dam

Segment #4 Pine Run Forebay to Pine Run Road
Log Jams / Braided Channel

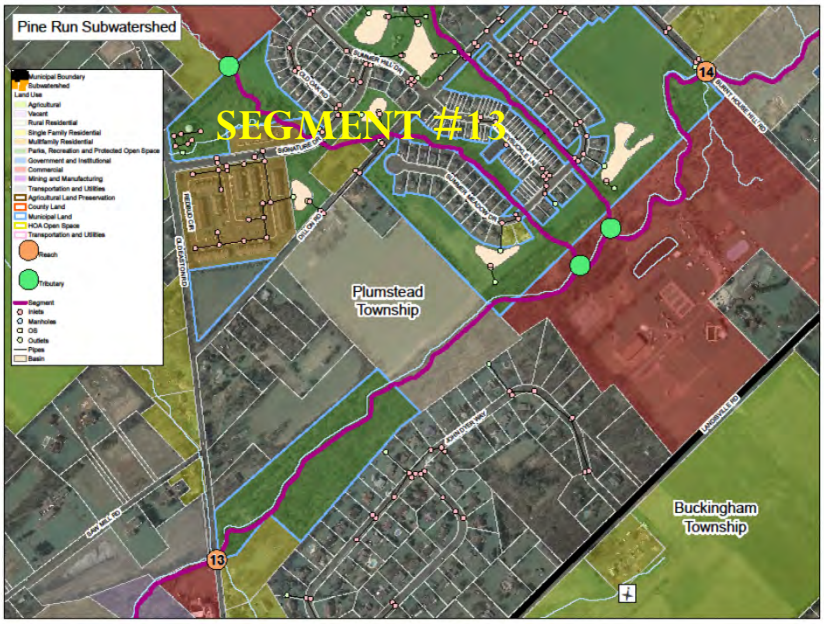
Segment #4 Pine Run Forebay to Pine Run Road
Bank Erosion/Under Cutting of Banks

Segment #4 Pine Run Forebay to Pine Run Road

- **Potential Solutions:**
  - Explore opportunity for bank stabilization
  - Removal of fallen trees and logs blocking water flow
  - Consider potential for dam removal

Segment #13 Old Easton Road to Burnt House Hill Road

- **North Easton Road to Old Easton/Old Easton Road to Burnt House Hill Road:**
  - Municipal location: Plumstead Township
  - Land Use: Commercial/Single Family Residential/ Rural Residential/Vacant
- **Primary Problems Identified:**
  - Erosion / fallen trees/ log jams/ scouring of stream banks/braided channels / erosion channels due in part to runoff from developments adjacent to stream
  - Turbidity throughout
  - 3 dams/abutments
    - > 1 foot drop 1st dam (fish barrier)
    - > 3 ft drop 2nd manmade dam (fish barrier)
  - Sewer line for new development along right bank and 3 yards from creek. Manhole shows signs of what appears to be past overflows



Segment #13 Old Easton Road to Burnt House Hill Road: Dam 1

Segment #13 Old Easton Road to Burnt House Hill Road: Dam 2

Segment #13 Old Easton Road to Burnt House Hill Road: Abutments

Segment #13 Old Easton Road to Burnt House Hill Road
Possible opportunity for stormwater infiltration

Segment #13 Old Easton Road to Burnt House Hill Road

- **Potential Solutions:**
  - Consider removal of dams
  - Potential to construct infiltration/naturalized stormwater detention basin along Burnt House Hill Road at bridge
  - Consider the use of Manufactured Treatment Devices
    - At present runoff flows directly into the stream
    - Boulders are in place to slow velocity
  - Inspect sewer manholes for overflows

Stormwater Infrastructure Assessment

- **Stormwater Infrastructure Assessment Field Sheet**
  - Precipitation
  - Time/Quantity of last rain
  - Site Description
  - Dominant Watershed Land Uses
  - Structure submerged in water?
  - Sediment present?
  - Trash/Litter present?
  - Yard Waste present?
  - Pet/other animal feces?
  - Odor?
  - Green or rusty slime?
  - Structure Type and Condition
  - Underground Manufactured Treatment Device (MTD) or other infrastructure present?
  - General visual observation of site
  - Recommendations

Consistencies Throughout Pine Run and West Branch Sub-watersheds

- Undersized culverts and bridges
- Sediment and debris backed up under bridges
- Traditional stormwater detention basins (low flow channels)
  - Mowed turf / very few naturalized basins
  - Trash racks clogged with debris
  - Trash and debris located in low flow channel/ outfall areas

Stormwater Infrastructure Design / Maintenance issues

Failed outfall control structure / clogged trash rack

Traditional Stormwater Detention Basin Design

Benefits

1. Protects the public from floodwaters
2. Controls the rate of runoff
3. Allows for some pollutant settling during large storm events

Challenges:

1. Concrete channels provide no opportunity for sediment to settle during small storm events
2. Mowed grass provides little to no infiltration

Plan Review and Meeting Timeline

- **November 14**: draft plan URL posted to the BCPC web site
- **November 14**: emails/letters sent to managers, engineers, WPAC members, and project partners. Comments to be submitted prior to the November 21 meeting or no later than Friday, December 6, 2013
- **December 6, 2013**: draft Plan comments due
- **December 6, 2013**: provide answers to questions contained in BCPC letter dated November 14
- **December 19, 2013:** all comments have been incorporated by PH/BCPC
- **December 20, 2013**: revised plan re-posted to BCPC website and URL notification sent via email and letter
- **December 20, 2013 – January 31, 2014**: Review plan, submit comments and place on January BOS /Council agenda for review / support of plan
- **February 11, 2014**: cut-off date for final review and comments stemming from BOS review
- **February 14, 2014**: final plan re-posted to BCPC website and email/letter notifications sent
- **February 27, 2014**: third and final meeting. Comments can be submitted prior to February 27 meeting for discussion, or no later than March 7
- **Friday, March 10, 2014:** final plan review and comment period completed
- **March 10 - March 31:** submit final plan and reporting documents to DEP
- **March 31, 2014:** grant concludes

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

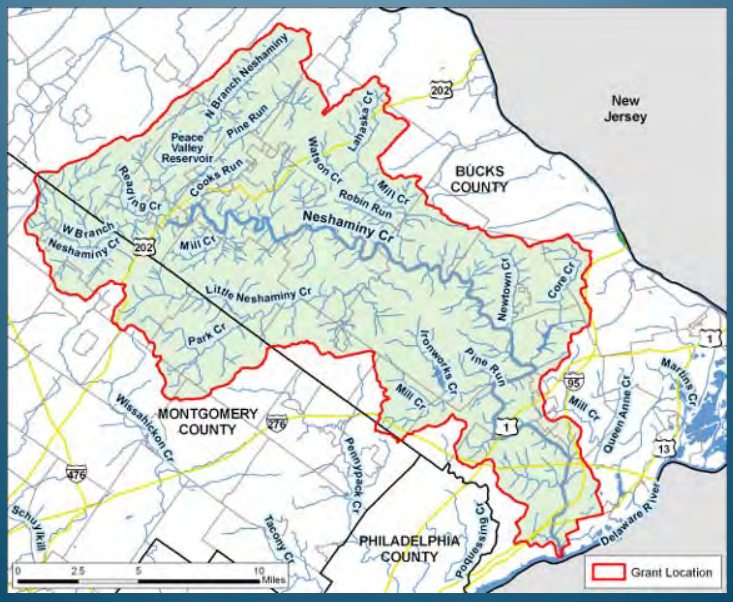
QUESTIONS?

Rea Monaghan, Environmental Planner
remonaghan@co.bucks.pa.us

Assisting the Bucks County Planning Commission in the Development of the Neshaminy Creek Sediment Reduction Plan
Draft Plan

Fred S. Lubnow, Ph.D.
Princeton Hydro, LLC

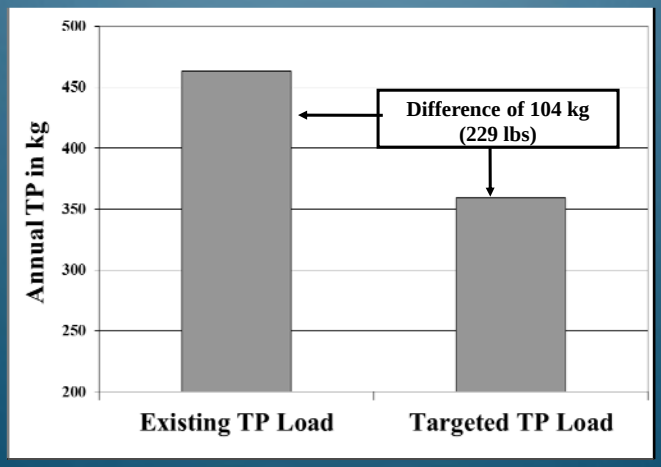
21st November 2013



Total Maximum Daily Load for Neshaminy Creek Watershed

- Total maximum daily load (TMDL) is a calculation of the maximum amount of pollutants that a waterbody can receive and still attain State water quality standards.
- The primary pollutant of concern for this study of the Neshaminy Creek watershed is sediments (or total suspended solids – TSS) and will be reported as lbs per year.
- DEP revised the TMDL in December 2003.

Harveys Lake, Luzerne County, PA TMDL for Total Phosphorus



Neshaminy Creek Watershed TMDL

- TMDL's primary pollutant of concern is sediments or TSS.
- A series of 14 impaired sub-watersheds were identified that are required for sediment load reductions in order for the watershed to comply with its TMDL.
- Existing TSS load for the 14 sub-watersheds is approximately 36 million lbs/yr, while the targeted TSS load is approximately 25 million lbs/yr.
- Thus, a required reduction of approximately **14 million lbs/yr** has been identified under the TMDL (includes a margin of safety).

Harveys Lake, Luzerne County, PA

Implemented Stormwater or In-Lake Project	Total Phosphorus Removed in kgs (lbs)
Two streambank / shoreline stabilization projects	10.0 (22)
Hemlock Garden Nutrient Separating Baffle Box	13.6 (30)
Series of small, catch basin retrofits	6.1 (13.4)
Wood Street Nutrient Separating Baffle Box	3.0 (6.6)
Old Lake Road Nutrient Separating Baffle Box	3.0 (6.6)
Floating Wetland Islands (Five); 2014	22.7 (50)
Two more Nutrient Separating Baffle Boxes; 2014	6.0 (13.2)
TOTAL	**64.4 (141.7)**

By the end of 2014, the TMDL should be approximately 62% in compliance for total phosphorus; compliance tentatively scheduled for 2019

Lake Hopatcong, Morris / Sussex Counties, New Jersey

Implemented Stormwater or In-Lake Projects at Lake Hopatcong Morris / Sussex Counties, NJ	Total Phosphorus Removed (kgs)
Mechanical weed harvesting program (mean 2002-2012)	162.4
Partial sewering of B. of Hopatcong (40% within SZI)*	615.2
Two Aqua-Swirl / Aqua-Filter MTDs in B. of Hopatcong and One Aqua-Filter MTD in T. of Jefferson (SFY 2005 319-grant) + One Filterra at T. of Jefferson	7.3
Three Nutrient Separating Baffle Boxes (two in Jefferson; one in Mt. Arlington; US EPA TWG)	29.6
One Nutrient Separating Baffle Box + Wetland Stormwater Basin (Roxbury; US EPA TWG)	14.8
Peat Biofilter retrofit to an existing community septic system (Jefferson; US EPA TWG)	4.6
Sub-TOTAL	**833.9**

Lake Hopatcong

Implemented Stormwater or In-Lake Projects at Lake Hopatcong Morris / Sussex Counties, NJ	Total Phosphorus Removed (kgs)
Sub-TOTAL	**833.9**
Watershed-wide use of non-P fertilizers (US EPA TWG; based on 2008-09 study; only for residential lawns)	199.0
Mandatory pump-outs of existing septic systems (Jefferson; Water Quality 604(b)-grant)*	52.0
One Nutrient Separating Baffle Box in Roxbury and One Bioretention System at Lake Hopatcong State Park (SFY2010 319-grant)	1.0
Installation of two Floating Wetland Islands; scheduled for installation in 2014 (SFY2010 319-grant)	9.1
GRAND TOTAL	**1,095.0 (2,409 lbs)**

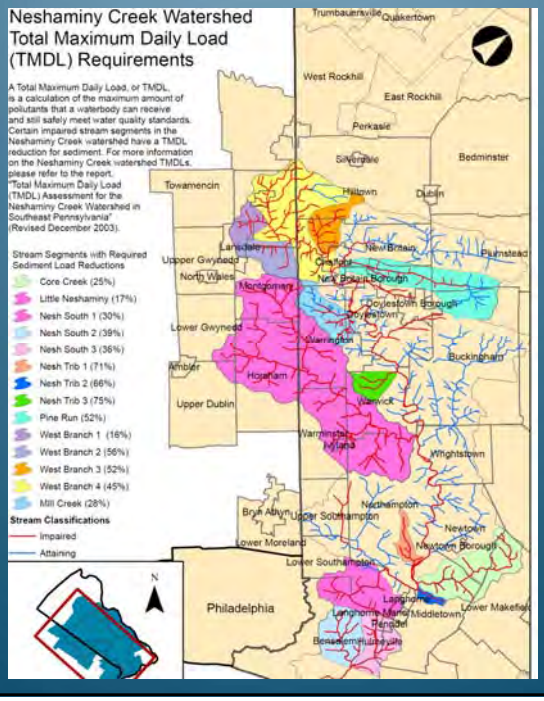
By the end of 2014, the TMDL should be approximately 33% in compliance for total phosphorus.

What the Plan Does Not Do

- The Plan does not review existing ordinances or develop ordinances
- With the exception of Pine Run and Core Creek, the Plan does not provide a list of detailed projects for implementation
- The Plan does not account for future TSS loads as a result of development and other land use activities (TMDL accounts for "sins of the past")
- The Plan does not address flooding, the removal of dams, creating habitat or managing invasive species

What the Plan Will Do

- Develop a flexible, objective and practical strategy in addressing existing elevated TSS loads
- Serve as a long-term "blue-print" for the implementation phase
- Contribute toward getting the Neshaminy Creek waterways to meet water quality standards (move from impaired to attained)
- Satisfy US EPA and PA DEP's Nine (9) Elements of a Watershed Implementation Plan, making it eligible for State and Federal funds



Neshaminy Creek Watershed TMDL

- The required reductions for each impaired sub-watershed were calculated and used to conduct a classification analysis, ranking the reductions from highest to lowest.
- The West Branch (#4) and Pine Run sub-watersheds had the highest and second highest required reductions, respectively
- Combined, these two sub-watersheds account for 52.5% of the required reductions in TSS.

Neshaminy Creek Watershed TMDL

- In May 2013 a number of the municipalities provided ideas / suggestions on potential sites for restoration
- In May – July 2013 a series of site visits were conducted by BCPC and PH
- The BCPC continued to conduct detailed site assessments to provide information for the Plan through spring and summer

Neshaminy Creek Watershed TMDL

- PH reviewed the existing TMDL document
- Each sub-watershed as existing and established (or targeted) TMDL load for TSS
- These loads, with a 10% margin of safety, were used to identify the targeted reduction each sub-watershed needs to reach to comply with the TMDL
- Keep in mind that based on the TMDL 75.5% of the sediment originates from streambank erosion while the remaining 24.5% originates from surface runoff

Neshaminy Creek Watershed TMDL

Summary of Neshaminy Creek TMDL for TSS (all values in lbs per year)			
Sub-Watershed	**Existing TSS Load**	**Established TMDL**	**Targeted Reduction**
Subbasin #4 W Br.	9,859,400	4,828,640	5,030,760
Pine Run	4,089,625	1,944,239	2,145,386
Little Neshaminy Creek	8,369,480	6,937,351	1,432,129
Nesh Creek S #1	3,073,400	2,155,010	918,390
Nesh Creek Trib #3	1,054,746	263,400	791,346
Nesh Creek S #2	1,780,400	1,058,322	722,078
Mill Creek	2,181,460	1,562,114	619,346
Nesh Creek S #3	1,414,300	899,783	514,517
Nesh Creek Trib #1	721,215	209,543	511,672
Subbasin #3 W Br.	930,419	446,989	483,430
Core Creek	1,775,981	1,327,251	448,730
Subbasin #2 W Br.	682,119	295,629	386,490
Nesh Creek Trib #2	165,561	56,144	109,417
Subbasin #1 W Br.	154,296	128,940	25,356
Totals	**36,252,402**	**22,113,355**	**14,139,047**

Streambank Erosion

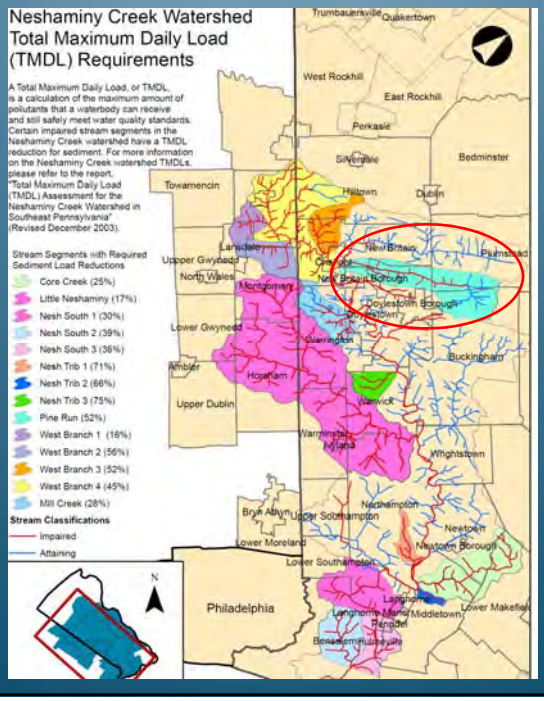
- Based on the TMDL sub-watershed plans estimate the amount of sediment erosion (varied between 2 and 62 lbs / ft / yr; mean of 18.9 and a median of 9.5) – *may use the mean or median to account for site-specific variability*
- Based on land use acres estimated amount of impaired waterways in each land type
- Restoration buffer was the BMP of choice for the streambank projects (PA DEP stormwater manual)

Streambank Erosion

- For forested lands used 65% removal rates for TSS (riparian buffer restoration)
- For developed / agricultural lands used a slightly reduced rate of 55% for TSS
- Ascribed a % of the impaired waterway for each land use to be restored
- The percent of impaired waterway to be addressed through restoration varies between 25% and 100%.

Streambank Erosion – Pine Run

- For the Pine Run sub-watershed the TMDL applies to 8.4 miles of waterway.
- For the plan, 1.7 miles of stream through agricultural lands is recommended for stabilization / restoration (55% of waterways targeted)
- 0.6 miles of stream through residential lands is recommended for stabilization / restoration (55% waterways targeted)
- 0.8 miles of stream through forested lands is recommendations for stabilization / preservation (25% waterways targeted)



Surface Runoff (stormwater)

- Focused on BMPs that are reasonably priced, “relatively easy to implement”, remove a “decent” amount of TSS on an individual basis, with a relatively low amount of maintenance / upkeep
- However, other BMPs are strongly encouraged

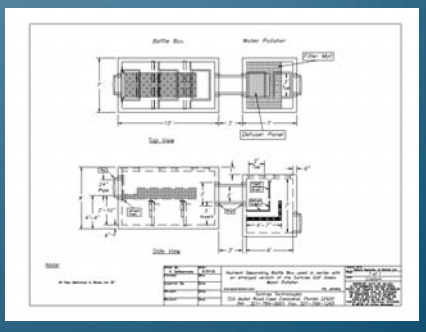
Surface Runoff (stormwater)

- **Basin retrofits** – converting existing dry basins into extended basins (60% removal rate)
- **Retrofitting roadside / other swales** to enhance settling of TSS (50% removal rate)
- **Installation of Manufactured Treatment Devices** (MTDs) to remove TSS and leaf litter (used a conservative removal rate of about 40%; *however will probably increase this to 70%*)
- **Rain Gardens / Bioretention Systems** (85% removal rates)
- **Large, regional settling basins** (50% removal rate)
- **Others – stormwater wetlands** (85% removal rates)

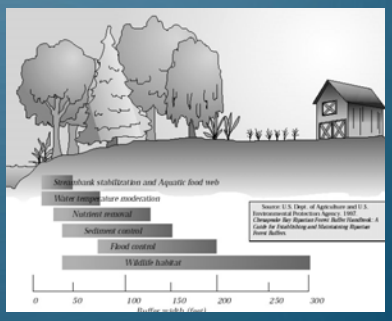
Table 3	
Projects Proposed for TSS Reduction in the Pine Run Sub-watershed which is part of the Neshaminy Creek Watershed, Bucks County, PA	
Maintenance dredging of Pine Run Reservoir	
(conservatively ascribed TSS removal rate of 55%;	1,970,381
15% lower than PA BMP Manual)	
Streambank restoration - Agricultural Lands	
(focuses on 1.7 miles of the 8.4 miles of waterways	91,769
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Streambank restoration - Developed Lands	
(focuses on 0.6 miles of the 8.4 miles of waterways	30,590
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Riparian Buffers	
(focuses on 0.8 miles of the 8.4 miles of waterways	52,166
excluding agr. and developed streambank restoration projects	
TSS removal rate of 65% as per PA BMP Manual)	
Create riparian zone immediately below Pine Run Reservoir	
(TSS removal rate of 65% as per PA BMP Manual)	12,350
Basin Retrofits (20 unidentified basins)	
(TSS removal rate of 60% as per PA BMP Manual)	7,500
Pine Run Swale	
(TSS removal rate of 50% as per PA BMP Manual)	3,047
Nottingham Way (7 basins targeted for retrofitting	
(TSS removal rate of 60% as per PA BMP Manual)	2,625

Roadside Swale, Pine Run Road	
(TSS removal rate of 50% as per PA BMP Manual)	1,878
Roadside Swale, Ferry Road	
(TSS removal rate of 50% as per PA BMP Manual)	1,479
Shrine of Czestochowa	
(includes basin retrofits, swale upgrade, two MTDs and a rain garden	1,140
TSS removal rate is an accumulative estimated total)	
Confluence at North Branch and Pine Run streambank stabilization	
(TSS removal rate of 30% as per PA BMP Manual)	1,140
Dillon Road Apt. Complex (3 basins targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	1,125
Large Meadow / Wet Pond project, Grandview Lane	
(this project was completed as part of a 319-grant	**910**
TSS removal rate of 70%, for wet pond, as per PA BMP Manual)	
Old Easton Road to Signature Drive (2 basins targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	750
Redfield Basin (1 basin targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	546
Summer Hill Road, near Deep Glen Way (1 basin targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	375
Old Oak Road and Dillon Road (1 basin targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	375
Grundy Basin (1 basin targeted for retrofitting)	
(TSS removal rate of 60% as per PA BMP Manual)	375
Total Amount of TSS Removed	**2,180,521**

Retrofit and installation of a Manufactured Treatment Device in existing stormwater infrastructure

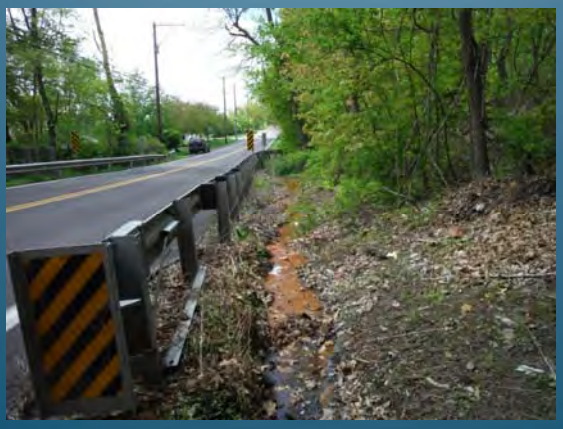


Streambank Stabilization / Riparian Buffer Restoration



Roadside Swales

(Below Pine Run Reservoir)



Retrofitting existing Dry Basins

(Summer Hill / Summer Meadows, Condominiums)

Large, Conservation Pools

(Core Creek / Lake Luxembourg's Conservation Pool)

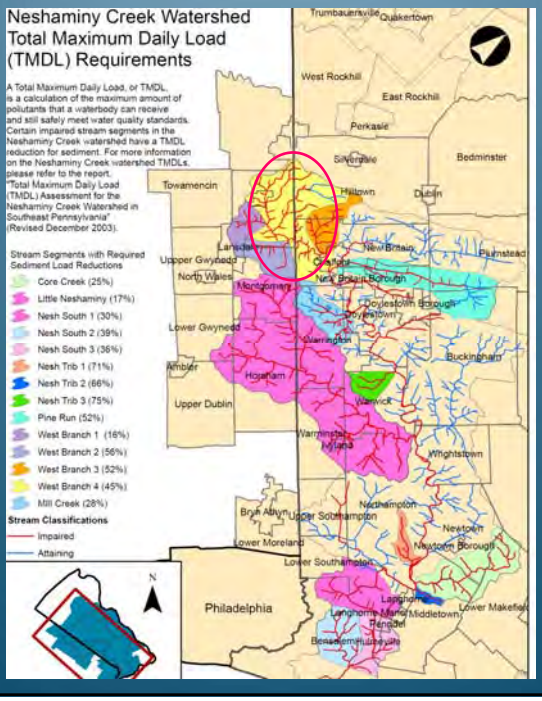


Table 2 Projects Proposed for TSS Reduction in the West Branch #4 Sub-watershed which is part of the Neshaminy Creek Watershed, Bucks County, PA	
Streambank restoration - Agricultural Lands	
(focuses on 6.8 miles of the 22.8 miles of waterways	873,988
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Streambank restoration - Developed Lands	
(focuses on 6.2 miles of the 22.8 miles of waterways	786,589
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Riparian Buffers	
(focuses on 4.4 miles of the 22.8 miles of waterways	664,435
excluding agr. And developed streambank restoration projects	
TSS removal rate of 65% as per PA BMP Manual)	
Retrofit Basins - Residential Development	
Approximately 99 basins in low intensity development and	40,079
35 basins in high intensity development	10,055
(TSS removal rate of 60% as per PA BMP Manual)	
Retrofit Basins - Agricultural Lands	
Approximately 34 basins in hay / pasture and	27,720
119 basins in croplands	2,362,536
(TSS removal rate of 60% as per PA BMP Manual)	
Retrofit Basins - Transitional Lands	
Approximately 18 regional basins to address transitional lands	282,974
(TSS removal rate of 60% as per PA BMP Manual)	
Manufactured Treatment Devices	
Approximately 98 MTDs in low intensity development and	10,420
35 MTDs in high intensity development	2,614
(TSS removal rate of 39% as per US EPA)	
Total Amount of TSS Removed	**5,061,410**

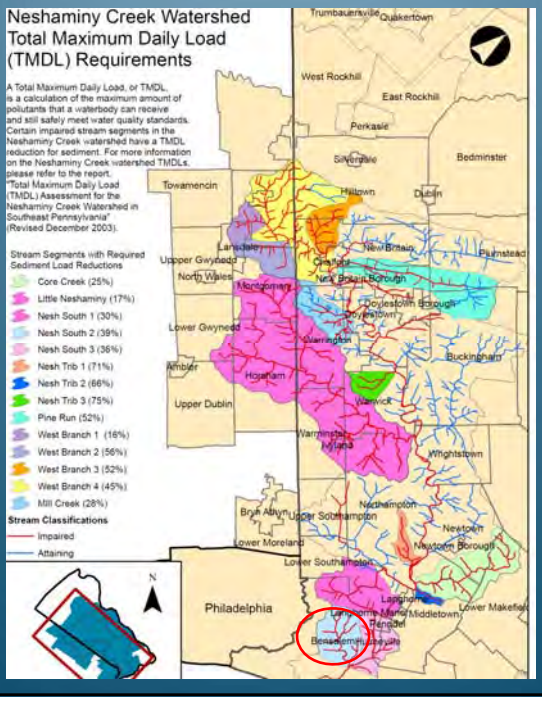
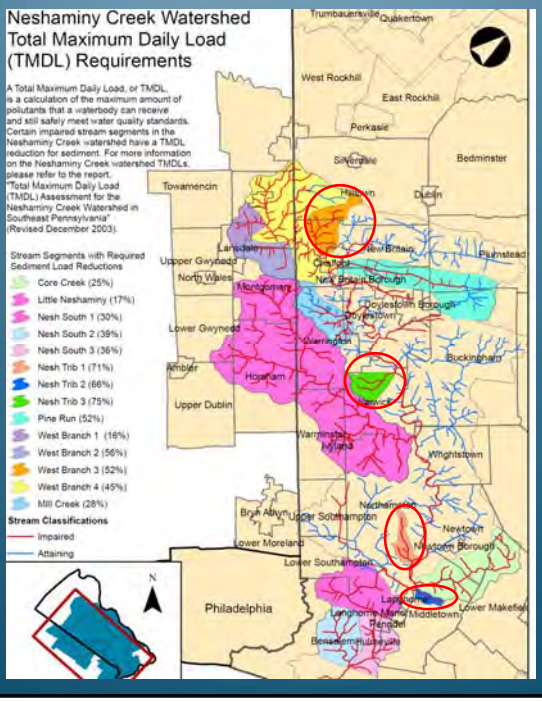


Table 7	
Projects Proposed for TSS Reduction in the Neshaminy Creek South #2 Sub-watershed	
which is part of the Neshaminy Creek Watershed, Bucks County, PA	
Streambank restoration - Agricultural Lands	
(focuses on 1.6 miles of the 9.9 miles of waterways	122,258
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Streambank restoration - Developed Lands	
(focuses on 4.4 miles of the 9.9 miles of waterways	343,486
identified as impaired	
TSS removal rate of 55%; modified from the PA BMP Manual)	
Riparian Buffers	
(focuses on 1.5 miles of the 9.9 miles of waterways	137,606
excluding agr. and developed streambank restoration projects	
TSS removal rate of 65% as per PA BMP Manual)	
Retrofit Basins - Residential Development	
Approximately 47 basins in low intensity development and	11,571
15 basins in high intensity development	5,229
(TSS removal rate of 60% as per PA BMP Manual)	
Retrofit Basins - Agricultural Lands	
Approximately 2 basins in hay / pasture and	2,930
9 basins in croplands	170,035
(TSS removal rate of 60% as per PA BMP Manual)	
Retrofit Basins - Transitional Lands	
Approximately 3 regional basins to address transitional lands	16,965
(TSS removal rate of 60% as per PA BMP Manual)	
Manufactured Treatment Devices	
Approximately 47 MTDs in low intensity development and	4,212
15 MTDs in high intensity development	1,903
(TSS removal rate of 39% as per US EPA)	
Total Amount of TSS Removed	**816,195**

Neshaminy Creek Watershed TMDL

Summary of Neshaminy Creek TMDL for TSS (all values in lbs per year)			
Sub-Watershed	**Targeted Reduction**	**Predicted Reduction**	**Net Difference between Targeted and Predicted**
Subbasin #4 W Br.	5,030,760	5,061,410	30,650
Pine Run	2,145,386	2,180,521	35,135
Little Neshaminy Creek	1,432,129	1,804,907	372,778
Nesh Creek S #1	918,390	1,000,120	81,730
Nesh Creek Trib #3	791,346	622,355	-168,991
Nesh Creek S #2	722,078	816,195	94,117
Mill Creek	619,346	661,807	42,461
Nesh Creek S #3	514,517	522,304	7,787
Nesh Creek Trib #1	511,672	430,837	-80,835
Subbasin #3 W Br.	483,430	267,332	-216,098
Core Creek	448,730	787,894	339,164
Subbasin #2 W Br.	386,490	403,184	16,694
Nesh Creek Trib #2	109,417	29,096	-80,321
Subbasin #1 W Br.	25,356	44,182	18,826
Totals	**14,139,047**	**14,632,144**	**493,097**



Neshaminy Creek Watershed, Bucks / Montgomery Counties, PA Cost Estimates for Project Implementation		
Sub-Watershed	**Low Estimate**	**High Estimate**
Subbasin #4 W Br.	$5,455,700.00	$20,461,280.00
Pine Run	$944,420.00	$3,882,840.00
Little Neshaminy Creek	$4,021,460.00	$14,070,880.00
Nesh Creek S #1	$2,355,700.00	$7,229,760.00
Nesh Creek Trib #3	$682,300.00	$3,257,320.00
Nesh Creek S #2	$2,442,400.00	$7,687,400.00
Mill Creek	$651,900.00	$3,213,800.00
Nesh Creek S #3	$1,523,380.00	$5,187,720.00
Nesh Creek Trib #1	$581,420.00	$2,404,480.00
Subbasin #3 W Br.	$471,820.00	$2,694,240.00
Core Creek	$1,285,040.00	$4,956,080.00
Subbasin #2 W Br.	$2,128,720.00	$6,800,840.00
Nesh Creek Trib #2	$728,260.00	$4,444,640.00
Subbasin #1 W Br.	$502,740.00	$2,136,880.00
Total Costs	**$23,775,260.00**	**$88,428,160.00**

What Needs to be Done

- Re-calculate the MTD removal rates with 70%
- Consider using mean / median soil loss rates
- Complete review of existing documents and include, where available, potential projects
- Integrate municipal / County comments into Plan
- Provide cost estimates for long-term maintenance
- Finalize the Nine Elements for the approval of the document by DEP and EPA
- Include completed Core Creek projects
- Grammar / formatting of document

Other BMPs / Activities

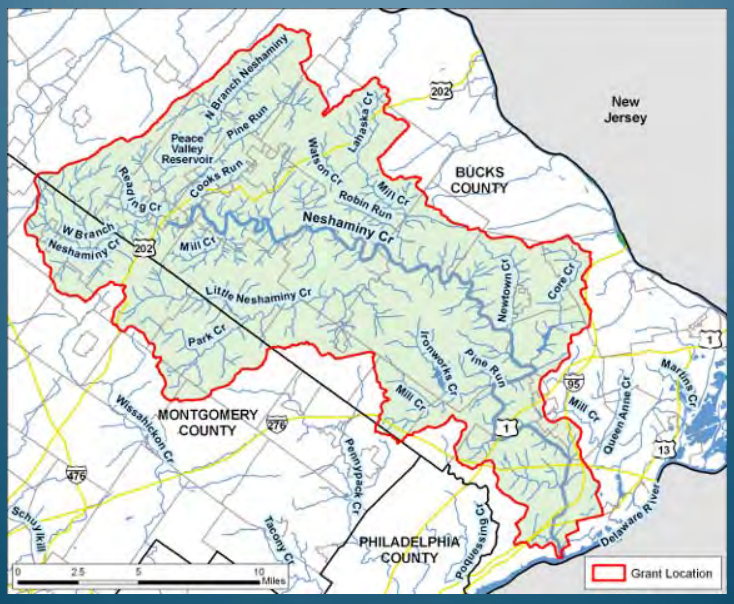
- Other BMPs should still be considered on a site specific basis. For example neighborhoods / communities interested in implementing a series of rain gardens would be effective
- Implementing bioretention structures for existing parking lots
- Other BMP listed in the PA DEP Stormwater Manual
- Activities such as street sweeping contribute toward reductions in TSS
- Example: Borough of New Britain; street sweeps about 6 miles of road a year. This activity is estimated to remove about 92 lbs of TSS per year (assuming mechanical and not regenerative / vacuum street sweeper)

Princeton Hydro pH

Assisting the Bucks County Planning Commission in the Development of the Neshaminy Creek Sediment Reduction Plan *Final Plan*

Fred S. Lubnow, Ph.D.
Princeton Hydro, LLC

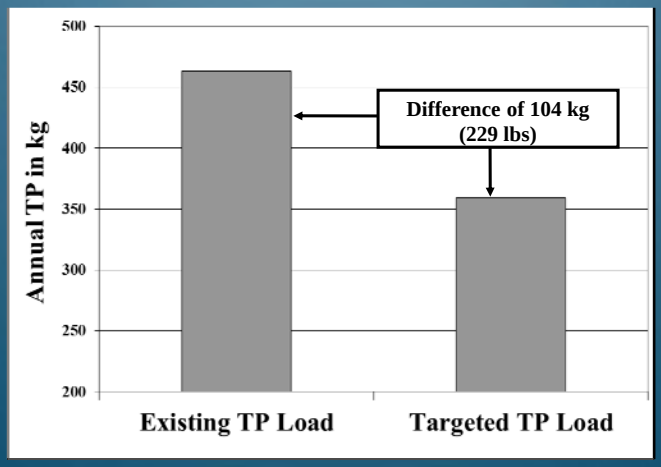
27th February 2014



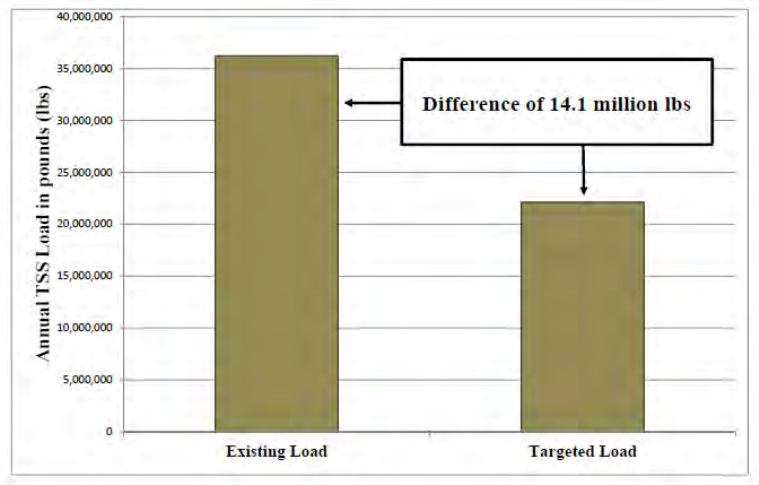
Total Maximum Daily Load for Neshaminy Creek Watershed

- Total maximum daily load (TMDL) is a calculation of the maximum amount of pollutants that a waterbody can receive and still attain State water quality standards.
- The primary pollutant of concern for this study of the Neshaminy Creek watershed is sediments (or total suspended solids – TSS) and will be reported as lbs per year.
- DEP revised the TMDL in December 2003.

Harveys Lake, Luzerne County, PA TMDL for Total Phosphorus

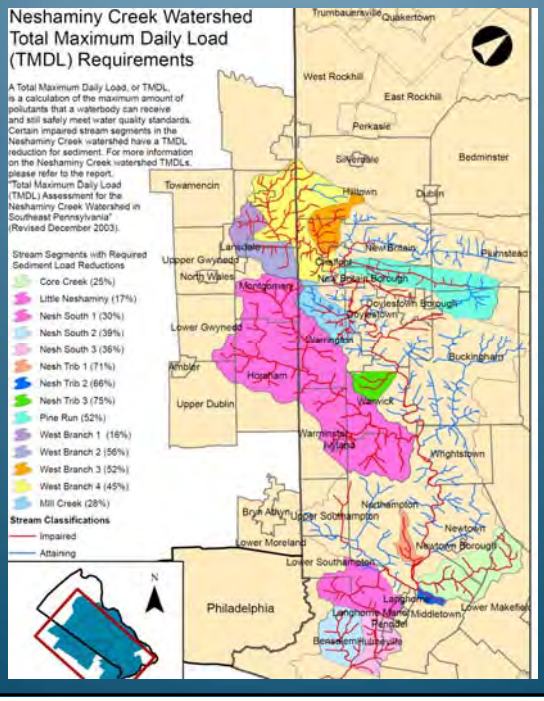


Neshaminy Creek Watershed, PA TMDL for Total Suspended Solids



Neshaminy Creek Watershed TMDL

- TMDL's primary pollutant of concern is sediments or TSS.
- A series of 14 impaired sub-watersheds were identified that are required for sediment load reductions in order for the watershed to comply with its TMDL.
- Existing TSS load for the 14 sub-watersheds is approximately 36 million lbs/yr, while the targeted TSS load is approximately 22 million lbs/yr.
- Thus, a required reduction of approximately **14 million lbs/yr** has been identified under the TMDL (includes a margin of safety).



Neshaminy Creek Watershed Plan

- Develop a TMDL-based Sediment Reduction Implementation Plan (flexible, adaptive blueprint for reducing the sediment load)
- Efforts can contribute toward a municipality's MS4 permit (existing and future impacts)
- Participating in a TMDL-based Plan substantially increases your chances of receiving funding
- TMDL focuses on existing impacts

Issues of Clarification

- Why should a municipality sign onto this TMDL-based Plan?
- Can projects that are completed under a MS4 permit or Act 167 Plan be counted as credit toward a TMDL?
- Can past watershed / stormwater projects be credited toward a TMDL?
- Can street sweeping be credited toward TMDL?

Issues of Clarification

- Can the establishment of riparian buffers through the development of ordinances be credited toward the TMDL?
- Why is such a Sediment Plan needed?

Additions to the Plan

- Lake Galena Sub-Watershed Plan was included in the Plan to address its TSS load
- In addition to providing a range of cost estimates for implementation, a range of annual maintenance costs were provided for each sub-watershed
- Identified additional projects or activities that could be implemented (street sweeping, rain barrels, rain gardens, newer technologies)
- List of potential project sites from some past reports / plans
- Nine elements of a Watershed Implementation Plan

Potential Upcoming Sources of Funding

- **Growing Greener grant program** – can be used for a variety of watershed / stormwater / riparian projects. Better suited for municipal projects; can receive credit toward a MS4 permit and a TMDL with a GG-funded project
- **Non-Point Source (319) grant program** – better suited for larger, more regional projects (e.g. conservation pools, inter-municipal / inter-County projects); can only received credit toward a TMDL and not a MS4 permit

Questions?

Fred Lubnow, Ph.D.; Princeton Hydro, LLC
flubnow@princetonhydro.com

Photo from Trout Unlimited (tu468.org)

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

Workshop #3

Final Plan Review

February 27, 2014

Rea Monaghan, Environmental Planner
Bucks County Planning Commission
remonaghan@co.bucks.pa.us

Meeting Goals

- **Part One:**
  - Questions & Answers regarding Plan components
  - Review of new sections added to Plan
- **Part Two:**
  - Review Funding Opportunities
  - Timeline
  - DEP approval of Plan

2013 Growing Greener Watershed Protection, 319, Surface Mining Conservation and Reclamation Act

- The RFP for the 2014 grant has not yet been released.
  - Anticipate 2014 grant cycle to be announced soon.
- **Type/Agency:** State / PA Department of Environmental Protection
- **Match Required:** Yes. Cash/In-kind. At least 15 percent of the award amount requested via cash or in-kind contributions. Matching contributions must be listed in the application.
- **Last Application Due Date:** August 16, 2013.
- **Program is comprised of** (Part A): Growing Greener and (Part B): Section 319 Nonpoint Source.
- **Section 319 Nonpoint Source** grant funds are provided to DEP each year from the EPA and authorized through Section 319(h) of the federal Water Pollution Control Act.

2013 Growing Greener Watershed Protection, 319, Surface Mining Conservation and Reclamation Act (Continued)

- **Program Overview:**
  - Pennsylvania's Nonpoint Source Management Program establishes the strategy the state uses to implement watershed restoration and protection activities.
  - Supports the implementation of watershed restoration and protection activities targeting impaired watersheds.
  - Accomplished through local, watershed-based planning, restoration and protection efforts.

Watershed Protection Grants (Part A): Growing Greener

- **Growing Greener** supports improving water quality in impaired watersheds and protecting water quality in non-impaired watersheds.
- **Watershed priorities include:**
  - Implementation of restoration activities that result in load reductions of pollutants;
  - Restoration and maintenance of restored streams, and/or protection activities that are recommended in watershed based plans;
  - Projects that support the establishment and/or sustainability of riparian forested buffers;
  - Projects that support implementation of agricultural best management practices (BMPs);
  - Projects that support MS4 communities implementing BMPs consistent with Act 167, TMDL, or Chesapeake Bay Pollution Reduction Implementation Plans; and
  - Projects that provide for the repair and perpetual maintenance of implemented BMPs.

Watershed Protection Grants (Part A): Growing Greener (Continued)

- **Growing Greener**: Eligible applicants must meet one of the following criteria or obtain a sponsor that meets one of the criteria:
  - Incorporated watershed organizations
  - Counties and municipalities
  - County conservation districts
  - Councils of governments
  - Other authorized organizations:
    - 501(c)(3) nonprofit organizations
    - Educational institutions
    - Municipal authorities
  - More information is available online: http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958

Watershed Protection Grants (Part B): Section 319 Nonpoint Source

- **Section 319 Nonpoint Source:** supports implementation of projects identified in an EPA-accepted 319 Priority Watershed Implementation Plan (WIP) that will improve water quality or contribute to the achievement of load reduction goals from an approved TMDL.
- Support may also be provided for projects outside the listed 319 priority watershed, or that protect water quality where threatened by nonpoint sources.
- The Department receives grant funds from the EPA each year to implement Pennsylvania's approved Nonpoint Source Management Program 2008 update.

- More information is available online:

  http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958

Watershed Protection Grants (Part B): Section 319 Nonpoint Source (Continued)

- Eligible **Section 319 Nonpoint Source** applicants must meet one of the following criteria or obtain a sponsor that meets one of the criteria:
  - Incorporated watershed organizations
  - Counties and municipalities
  - County conservation districts
  - Councils of governments
  - Other authorized organizations:
    - 501(c)(3) nonprofit organizations
    - Educational institutions
    - Municipal authorities

Watershed Protection Grants (Part B): Section 319 Nonpoint Source (Continued)

- **Eligible Projects:**
  - Applications that implement project sites including mining projects identified in a 319 Priority Watershed Implementation Plan (WIP)
  - Copies of the WIPs can be viewed at:

    http://www.portal.state.pa.us/portal/server.pt?open=514&objID=554271&mode=2

  - If funds remain after funding projects within 319 WIP watersheds, applications that implement projects that address nonpoint sources of pollution to restore or improve water quality of impaired water bodies (Integrated List) or protect water quality where threatened by impairment from nonpoint sources outside 319 priority watersheds may be considered.

  - More Information is available online:
    http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958

Delaware Valley Regional Planning Commission (DVRPC): Transportation Alternatives Program (TAP)

- **Type / Agency:** State / PA Department of Transportation
- **Office:** Delaware Valley Regional Planning Commission (DVRPC)
- **Multipart Grant: No**
- **Application Due Date**: Friday, April 4, 2014
- **Match Required:** Yes. Applicants must provide a 20 percent match.
- Applicants are responsible for all pre-construction or pre-acquisition activities.
- **Actual Funds:** $7,500,000 (Confirmed for all categories) to support awards during fiscal years 2015 and 2016.

Delaware Valley Regional Planning Commission (DVRPC): Transportation Alternatives Program (TAP) (Continued)

- Awards may be combined with other funding, including state grants and private contributions.
- Approximately $3.74 million is available for each fiscal year. Funding is provided on a reimbursement basis.
- The minimum amount for construction awards is $250,000, and the maximum soft cap is $1 million.
- Projects with a construction value over $1 million must be of "exceptional value" and justified.
- Award selections will be completed by September 30, 2014.
- Projects must be ready for construction by September 30, 2016.

Delaware Valley Regional Planning Commission (DVRPC): Transportation Alternatives Program (TAP) (Continued)

- **Program Overview:**
  - Supported by a suballocation to the DVPRC from the state Transportation Alternative Program (TAP), and funds the following types of activities:

- **Eligible Projects**
  - **Vegetation Management** - Communities improve roadway safety, prevent against invasive species, and provide erosion control along transportation corridors.
    - Clearing of low-hanging branches or other vegetation encroaching on a travel corridor
    - Landscaping to improve sightlines or other safety considerations
    - Removal of invasive species
    - Planting grasses or wildflowers to manage erosion along transportation corridors

Delaware Valley Regional Planning Commission (DVRPC): Transportation Alternatives Program (TAP) (Continued)

- **Eligible Projects Continued:**
  - **Stormwater Management** - projects allow communities to decrease the negative impact of roads on the natural environment.
  - Projects funded in this category seek to reduce these environmental impacts.
    - Detention and sediment basins
    - Stream channel stabilization
    - Storm drain stenciling and river clean-ups
    - Water pollution studies

Delaware Valley Regional Planning Commission (DVRPC): Transportation Alternatives Program (TAP) (Continued)

- **Eligible applicants include:**
  - Local governments
  - Regional transportation authorities
  - Transit agencies
  - Natural resource or public land agencies, including federal agencies
  - School districts, local education agencies, or schools
  - Tribal governments
  - Other local or regional governmental entities with responsibility for oversight of transportation or recreational trails
- More information is available online:

  http://www.dvrpc.org/TAP/

National Center for Sustainable Water Infrastructure Modeling Research

- **Type / Agency:** Federal / U.S. Environmental Protection Agency
- **Office:** National Center for Environmental Research (NCER)
- **Multipart Grant:** No
- **Application Due Date:** Monday, March 10, 2014 (Pre-application).
  - April 30- successful applicants invited to submit a full application.
  - Full applications must be received by June 9, 2014.
- **Match Required:** No
- **Actual Funds:** $4,000,000 (Estimated)
- **Funding Notes:**
  - An estimated $4 million is available through this program to support approximately one cooperative agreement of up to ≈ $4 million.
  - The project period may last up to five years.
  - Funding may not be used to pay salaries for permanent employees of federally funded research and development centers.

National Center for Sustainable Water Infrastructure Modeling Research (Continued)

- **Program Overview:**
  - Support the creation of a National Center for Sustainable Water Modeling Research to facilitate exchange of open source water infrastructure modeling, share green infrastructure tools, and research advancements with local communities/stakeholders.
  - Advance the goal of protecting and restoring watersheds and aquatic ecosystems, as provided in EPA's Strategic Plan.
    http://www2.epa.gov/planandbudget/strategicplan
- **Project Components:**
  - Community and outreach that fosters and trains a growing global community of sustainable water infrastructure modelers, model users, and stakeholders.
  - Model and code development that maintains, supports, and helps develop freely available software models of sustainable stormwater, wastewater, and water supply systems.

National Center for Sustainable Water Infrastructure Modeling Research (Continued)

- **Eligible Applicants:**
  - Local Government
  - Academic Institutions
  - Consortia
  - Native American Tribes
  - 501(c)(3) nonprofit organizations
  - State Government

  - More information is available online: http://www.epa.gov/ncer/rfa/2014/2014_star_sustainable-water.html

Department of Conservation and Natural Resources (DCNR) Community Conservation Partnerships Program (C2P2)

- **Type / Agency:** State / Pennsylvania Department of Conservation and Natural Resources
- **Office:** Bureau of Recreation and Conservation (BRC)
- **Multipart Grant:** Yes
- **Application Due Date:** Wednesday April 16, 2014 (electronically)
- **Match Required:** Yes. These grants require a minimum of a 50% match, which can consist of cash and/or non-cash values.
- **Actual Funds:** Unspecified
- **Optional Workshops are available**
- River Conservation Projects are applicable for recommendations contained in TMDL

Department of Conservation and Natural Resources (DCNR) Community Conservation Partnerships Program (C2P2) (Continued)

- **C2P2 Program Overview:**
  - Encourages planning, design and development of sustainable projects.
  - Help communities develop practical projects that conserve resources, generate economic and environmental benefits, and become sustainable places to live.
    - **Rivers Conservation Program:** This program addresses DCNR's responsibility to serve as an advocate for Pennsylvania's River Resources.
    - **Rivers Related Projects:** Implement river conservation plan recommendations, enhance water trails, and expand public river access to aquatic resources, or increase awareness of Pennsylvania's river systems.

Department of Conservation and Natural Resources (DCNR) Community Conservation Partnerships Program (C2P2) (Continued)

- **Land Conservation Projects:**
  - Emphasis on the protection of high value conservation and recreation lands including the protection of critical habitat and biologically important areas, forested watersheds, wetlands, and riparian corridors.
  - Land conservation that creates critical connections with other public lands, open space and outdoor recreation and education opportunities is a priority.

Department of Conservation and Natural Resources (DCNR) Community Conservation Partnerships Program (C2P2) (Continued)

- **Eligible projects include those that:**
  - Implement river conservation plan recommendations
  - Expand public access to aquatic resources
  - Increase awareness of Pennsylvania's river system
  - Priority is given to projects that implement plan recommendations in watersheds that are recorded on the Pennsylvania Rivers Registry.
- **Eligible entities include:**
  - 501(c)3) nonprofit organizations
  - Municipalities
    - Nonprofit organizations are encouraged to partner with a municipal entity to develop and execute this type of project.
  - Consortia
  - More information is available online: http://www.dcnr.state.pa.us/cs/groups/public/documents/document/D_001230.pdf

US Five Star and Urban Waters Restoration Program – FY 2014

- **Funding Type / Agency:** Federal / U.S. National Fish and Wildlife Foundation
- **Office:** National Association of Counties Wildlife Habitat Council (WHC)
- **Multipart Grant:** Yes
- **Last Application Due Date: March 5, 2014**
- **Amount of Funding Per Project:**
  - Smaller-scale projects will receive awards for a project period of up to one year.
  - Larger-scale urban projects will receive awards for a project period of up to two years.
  - Awards are expected to average between $25,000 and $35,000.
- **Match:** Yes. Cash/In-Kind
  - At least a one-to-one match using cash or in-kind contributions obtained from nonfederal sources.
  - Applicants requesting awards that exceed $30,000 are expected to provide greater matching contributions.
- **Actual Funds:** 180,000,000 (estimated for four projects/geographic areas)

US Five Star and Urban Waters Restoration Program (Continued)

- **Program Overview and Purpose:**
  - To increase community capacity to sustain local natural resources for future generations.
  - To support diverse local partnerships for wetland, forest, riparian, and coastal habitat restoration; stormwater management; outreach; and stewardship.
  - To fund efforts that focus on water quality, watersheds, and the habitats supported by participating partners.

US Five Star and Urban Waters Restoration Program (Continued)

- **Eligible applicants are:**
  - Partnerships that include at least five public or private entities:
    - Local governments and agencies
    - Youth groups
    - Colleges and universities
    - Resource conservation and development councils
    - Soil and water conservation districts
    - Conservation organizations
    - Watershed organizations
    - Businesses or corporations
    - Community groups

US Five Star and Urban Waters Restoration Program (Continued)

- **Priority:**
  - Given to projects that take place on, or directly benefit public lands.
- Award notification for applications submitted in March is anticipated for July 2014.
- Indirect costs may not exceed 15 percent of the requested award amount.
- Projects with a budget primarily consisting of indirect costs and salaries will be less competitive.

- More information is available online:
  http://www.nfwf.org/fivestar/Pages/home.aspx

American Water: Environmental Grant Program (Select Areas) – FY 2014

- **Type:/ Agency:** Federal / Foundation
- **Office:** American Water
- **Multipart Grant:** No
- **Application Due Date:** Monday, March 31, 2014
- **Match Required:** No
- **Funding:** $10,000 (maximum per project)

American Water: Environmental Grant Program (Continued)

- **Program Overview:**
  - Protect water resources by supporting innovative, community-based environmental projects that improve, restore, and/or protect watersheds and community water supplies.
  - Support new or innovative projects, or expansions to existing source water or watershed protection projects, which may include the following eligible activities:
    - Watershed cleanup
    - Reforestation
    - Biodiversity projects, such as habitat restoration or wildlife protection
    - Streamside buffer restoration
    - Wellhead protection initiatives
    - Hazardous waste collection
    - Surface or groundwater protection education, including the design and provision of workshops for citizens and local officials

American Water: Environmental Grant Program (Continued)

- **Eligible Applicants:**
  - Municipalities
  - 501(c)(3) nonprofit organizations
  - Schools
  - Projects must be carried out by a partnership between two or more organizations in an American Water service area in Pennsylvania.
    - American Water serves the Borough of Yardley and portions of Lower Makefield and Falls Townships. A portion of the Core Creek sub-watershed study area is located within Lower Makefield Township.
- **Program Requirements:**
  - Partnerships that demonstrate evidence of sustainability.
  - Projects must be located within American Water service areas in Pennsylvania.
  - More information is available online:

http://amwater.com/corporate-responsibility/Environmental-Sustainability/environmental-stewardship-and-innovation/environmental-grant-program.html

Coastal Zone Management

- **Type / Agency:** Federal / Coastal Zone Management (CZM) Program of the National Oceanic and Atmospheric Administration (NOAA)
- **Office:** Delaware Valley Regional Planning Commission and Pennsylvania Department of Environmental Protection
- **Multipart Grant:** Yes. CZM and Coastal Nonpoint Pollution Program (CNPP)
- **Application Due Date:** October each year
- **Match Required:** Yes. 50% cash or in-kind
- **Funding: Varies** (2012: $40,000-$50,000 maximum per project)

Coastal Zone Management (Continued)

- **Program Overview:**
  - Construction / acquisition projects to be submitted by a government entity and located in zone 306A.
- **Eligible Projects and Primary Focus Area:**
  - Coastal hazard areas
  - Wetlands
  - Public access for recreation
  - Intergovernmental coordination
  - Ocean Resources/Biodiversity
  - Coastal Non-Point Source Pollution Program
  - Public involvement
- CZM grants fund green infrastructure solutions
- More information online: http://www.dep.state.pa.us/river/grants/crmgrants/crmgrants.htm

Water Resources Education Network (WREN)

- **Type / Agency:** Foundation / League of Women Voters of Pennsylvania Citizen Education Fund
- **Multipart Grant:** No
- **Application Due Date:** Friday, March 21, 2014
- **Match Required:** Yes. Applicants must provide at least 15 percent of the requested award amount using cash or in-kind contributions.
- **Funding:** $5,000 (maximum per project)

Water Resources Education Network (WREN) (Continued)

- **Program Overview and Purpose**:
- To raise public awareness, encourage behavior change, and improve public policies that will protect water resources.
- Partnerships must educate citizens and local officials regarding the role of individuals in environmental stewardship, and the impacts of polluted runoff/non-point source pollution (NPS).
- Projects must accomplish one or more of the following objectives:
  - Form a new partnership or strengthen an existing partnership committed to addressing NPS problems.
  - Promote awareness among local officials and residents about local water resources, community-based watershed stewardship practices and solutions that will prevent NPS.
  - Educate and demonstrate innovative solutions to NPS that can replicated.
  - Promote water-sustaining public/municipal policies and practices that will minimize NPS.
  - Encourage and provide education on water-sustaining behavior change using social marketing concepts.

Water Resources Education Network (WREN) (Continued)

- **Eligible activities include:**
  - Demonstrate NPS best management practices on municipal property or publicly accessible open space.
  - Conduct educational tours for municipal officials and community leaders that address NPS issues.
  - Workshops, forums, and informational presentations for citizens and local officials about NPS sources in the watershed.
  - Share scientific information about existing local water quality impairments in the watershed.
  - Conduct educational forums about green infrastructure techniques.
  - Conduct review of existing local codes, regulations, and ordinances to determine barriers and ensure policies work compatibly to protect water quality.

Water Resources Education Network (WREN) (Continued)

- **Eligible applicants are partnerships of two or more of the following entities:**
  - Municipalities, municipal authorities and environmental advisory councils
  - Planning commissions
  - Watershed associations
  - Civic groups
  - Conservation organizations that promote local watershed efforts
  - Community water systems
  - Non Profits 501(c)3
  - Schools/School Districts
  - Partnerships must include at least one municipality.
  - Partnerships must designate a 501(c)(3) nonprofit organization, government entity, or a conservation district to manage project funds.
  - Priority will be given to partnerships that include a community water system, if one exists in the project area.
    - More information is available online: http://wren.palwv.org/grants/grants_wren.html

TMDL Grant Committee

- **Formation of a volunteer committee:**
  - BCPC and perhaps one representative from each municipality to look for and review various grants, prioritize and establish an application schedule.
  - Each municipality makes a commitment to implement Plan recommendations.

Timeline

- **February 24, 2014**: Final Draft Plan available for download
- **March 3, 2014:** Cut-off date for final review
- **March 10, 2014:** Final plan review and comment period completed
- **March 10 - March 31:** add GIS maps to final Plan and submit final plan and reporting documents to DEP
- **March 31, 2014:** grant cycle closes
- DEP Plan review and approval (date to be determined)
- Review of Plan by municipal Board of Supervisors or Borough Council

Neshaminy Creek Sediment Reduction Plan for Municipal Implementation

QUESTIONS?

Rea Monaghan, Environmental Planner
remonaghan@co.bucks.pa.us

APPENDIX 6: NESHAMINY CREEK MUNICIPAL AND COUNTY REPRESENTATIVES AND PROJECT SUPPORT

We would also like to thank the following individuals, municipalities and engineers and engineering firms for their interest in preserving the Neshaminy Creek watershed. We are grateful that they expressed their commitment by providing the time and expertise required to complete this plan.

NESHAMINY CREEK MUNICIPAL REPRESENTATIVES

BUCKS COUNTY MUNICIPAL MANAGERS AND MUNICIPAL PERSONNEL

William Cmorey, Manager, Bensalem Township
Matthew K. Takita, Director of Building and Planning, Bensalem Township
James Dillon, Manager, Bristol Borough
William J. McCauley III, Manager, Bristol Township
Dana S. Cozza, Manager, Buckingham Township
Richard Myers, Watershed Specialist, Buckingham Township
Melissa A. Shafer, Manager, Chalfont Borough
John H. Davis, Manager, Doylestown Borough
Phil Ehlinger, Deputy Borough Manager, Doylestown Borough
Stephanie J. Mason, Manager, Doylestown Township
Richard E. John, Municipal Authority Executive Director, Doylestown Township
Sandra Zadell, Assistant Township Manager, Doylestown Township
Richard C. Schnaedter, Manager, Hilltown Township
Thomas E. Wheeler, President of Council, Hulmeville Borough
Robert Severn, President of Council, Ivyland Borough
Rosemarie Curran, Manager/Zoning Officer, Langhorne Borough
Loretta M. Luff, Manager, Langhorne Manor Borough
Terry S. Fedorchak, Manager, Lower Makefield Township
John McMenamin, Manager, Lower Southampton Township
Stephanie Teoli, Manager, Middletown Township
Robin Trymbiski, Manager, New Britain Borough
Eileen Bradley, Manager, New Britain Township
Robert Walker, Jr., President of Council, Newtown Borough
Kurt M. Ferguson, Manager, Newtown Township
Robert M. Pellegrino, Manager, Northampton Township
Sean Weckerly, President of Council, Penndel Borough
Carolyn McCreary, Manager, Plumstead Township

BUCKS COUNTY MUNICIPAL MANAGERS AND MUNICIPAL PERSONNEL *(continued)*

Dennis H. Carney, Manager, Solebury Township
Sally Slook, Manager, Upper Makefield Township
David Nyman, Acting Manager, Upper Makefield Township
Joseph W. Golden, Manager/Zoning Officer, Upper Southampton Township
Richard J. Manfredi, Manager, Warminster Township
Gregory J. Hucklebridge, P.E., Director of Engineering and Operations, Warminster Township
Timothy J. Tieperman, Manager, Warrington Township
Roy Rieder, Director of Planning, Warrington Township
Fred Gaines, Chairman, Planning Commission, Warrington Township
Gail V. Weniger, Manager, Warwick Township
Joseph F. Pantano, Manager, Wrightstown Township

BUCKS COUNTY ENGINEERS

Ron Gans, P.E., O'Donnell & Naccarato, Bensalem Township
Kurt M. Schroder, P.E., Gilmore & Associates, Bristol Borough
Larry Young, P.E., Gilmore & Associates, Bristol Township, Upper Makefield Township
Dan Gray, P.E., Knight Engineering, Inc., Buckingham Township
Patrick DiGangi, P.E., CKS Engineers, Inc., Chalfont Borough
Michele Fountain, P.E., CKS Engineers, Inc., Chalfont Borough, Warwick Township
Karyn Hyland, P.E., Gilmore & Associates, Doylestown Borough
Mario Canales, P.E., Pickering, Corts & Summerson, Doylestown Township, Hulmeville Borough, Langhorne Manor Borough, Newtown Borough, Wrightstown Township
C. Robert Wynn, P.E., C. Robert Wynn Associates, Inc., Hilltown Township, Plumstead Township, Solebury Township
Mark Eisold, P.E., Boucher & James, Inc., Ivyland Borough, Lower Makefield Township
John Genovesi, P.E., TriState Engineers, Langhorne Borough, Lower Southampton Township
Wayne Kiefer, P.E., TriState Engineers, Middletown Township, Upper Southampton Township
Mark Hintenlang, P.E., New Britain Borough
Jim Dougherty, P.E., Gilmore & Associates, New Britain Township
Craig D. Kennard, P.E., Gilmore & Associates, New Britain Township, Warminster Township
James Majewski, P.E., Remington, Vernick & Beach Engineers, Northampton Township
Carol Schuehler, P.E., Urwiler & Walter, Penndel Borough
Richard Wieland, P.E. Carroll Engineering Corporation, Warrington Township
Tom Gockowski, P.E., Carroll Engineering Corporation, Warrington Township
Mary Stover, P.E., Carroll Engineering, Warrington Township
Brian McAdam, P.E., CKS Engineers, Inc., Warwick Township, Chalfont Borough

MONTGOMERY COUNTY MUNICIPAL MANAGERS AND MUNICIPAL PERSONNEL

Kevin D. Baver, Manager, Franconia Township
Michael J. DeFinis, Manager, Hatfield Borough
Devan Stewart, Assistant Manager, Hatfield Township
William T. Walker, Manager, Horsham Township
Timothea M. Kirchner, Manager, Lansdale Borough
Daniel Shinski, Superintendent, Wastewater Treatment Plant, Lansdale Borough
Jeff Morgan, P.E., SC Engineers, Lansdale Borough
Larry M. Comunale, Manager, Lower Gwynedd Township
Christopher R. Hoffman, Manager, Lower Moreland Township
Lawrence J. Gregan, Manager, Montgomery Township
P. Michael Coll, Manager, Souderton Borough
Robert A. Ford, Manager, Towamencin Township
Paul Leonard, Manager, Upper Dublin Township
Leonard T. Perrone, Manager, Upper Gwynedd Township

MONTGOMERY COUNTY ENGINEERS

Barry Wert, P.E., Metz Engineers, Franconia Township
William K. Dingham, P.E., Bursich Engineers, Hatfield Borough
Richard Coleman, P.E., Bursich Engineers, Hatfield Borough
Joe Nolan, P.E., CKS Engineers, Hatfield Township
Michele Fountain, P.E., CKS Engineers, Inc., Hatfield Township
Erik Garton, P.E., Gilmore & Associates, Horsham Township
Jim Dougherty, P.E., Gilmore & Associates, Horsham Township, Montgomery Township
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Edward Pluciennik, P.E., Pennoni Associates, Lower Moreland Township
Karyn Hyland, P.E., Gilmore & Associates, Montgomery Township
Robert Bricker, P.E., Boucher & James, Souderton Borough
Thomas Zarko, P.E., CKS Engineers, Inc., Towamencin Township
Jeff Wert, P.E., Metz Engineers, Upper Dublin Township
Gregory Duncan, P.E., T&M Associates, Upper Gwynedd Township
Russell Benner, P.E., T&M Associates, Upper Gwynedd Township

ADDITIONAL PROJECT SUPPORT

BUCKS COUNTY POLICE DEPARTMENTS

Steve. P. Daniels, Chief, Buckingham Township Police Department
Frank Campbell, Chief, Chalfont Borough Police Department
James Donnelly, Chief, Doylestown Borough Police Department
Dean Logan, Chief, Doylestown Township Police Department
Chris Engelhart, Chief, Hilltown Township Police Department
James Donnelly, Chief, New Britain Borough Police Department
Robert Scafidi, Chief, New Britain Township Police Department
Duane Hasenauer, Chief, Plumstead Township Police Department

MONTGOMERY COUNTY POLICE DEPARTMENTS

Joseph Kozeniewski, Chief, Franconia Township Police Department
Mark A. Toomey, Chief, Hatfield Borough Police Department
Mark A. Toomey, Chief, Hatfield Township Police Department
Robert McDyre, Chief, Lansdale Borough Police Department
Scott Bendig, Chief, Montgomery Township Police Department

PROJECT PARTNERS

Gretchen Schatschneider, District Manager, Bucks County Conservation District
Meghan Rogalus, Watershed Specialist, Bucks County Conservation District
Drew Shaw, Senior Chief - Environmental Unit, Montgomery County Planning Commission
Susan Harris, Watershed Specialist, Montgomery County Conservation District
Gus Meyer, District Manager / Agricultural Conservation Programs, Montgomery County Conservation District

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Stacey Box, Water Program Specialist
Rich Breitenstein, Environmental Compliance Specialist
William Brown, Division of Water Quality Standards, TMDL Development, Chief
Jenifer Fields, Environmental Programs Manager, Regional Clean Water Manager
Doug Goodlander, Division of Conservation, Nonpoint Source Management, Chief

BUCKS COUNTY PLANNING COMMISSION STAFF

Lynn Bush, Executive Director
Tim Koehler, Director of Planning Services
Dennis Livrone, Senior Planner
Rea Monaghan, Environmental Planner, Project Manager
Kelly Jerrom, GIS Technician
Donna Byers, Office Supervisor
Patricia Stockett, Administrative Assistant
Kevin Sager, Administrative Aide

TECHNICAL/ENGINEERING CONSULTANT

Fred S. Lubnow, PhD, Director of Aquatic Programs, Princeton Hydro

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