The Mispillion and Cedar Creek River Watershed Pollution Control Strategy

A Watershed-Based Strategy to Implement Total Maximum Daily Loads in Delaware

December 2012

Prepared for the Mispillion and Cedar Creek River Tributary Action Team
By the Watershed Assessment and Management Section
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MISPILLION AND CEDAR CREEK WATERSHEDS POLLUTION CONTROL STATEGY

Section 303(d) of the Clean Water Act (CWA) and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are violating water quality standards. TMDLs represent the total pollutant loading that a waterbody can receive without violating water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and nonpoint sources to restore and maintain the quality of their water resources (USEPA 1991).

Due to their high nutrient concentrations, low dissolved oxygen levels, and high bacteria levels the Delaware Department of Natural Resources and Environmental Control (DNREC) identified and included in the state's 1996, 1998, 2002, 2004, and Draft 2006 Section 303(d) lists of impaired waters several waterbodies in the Mispillion River and Cedar Creek Watersheds. The nine listings in the Mispillion River Watershed and three listings in the Cedar Creek Watershed include tidal and non-tidal rivers and streams as well as several ponds and lakes. As such, Delaware is required to develop TMDLs for applicable water quality parameters. The first steps in the TMDL development process have already been conducted and included compilation of available data; evaluation of monitoring data to identify the extent, location, and timing of water quality impairments; development of a technical approach to analyze the relationship between source pollutant loading contributions and in-stream response; model configuration; model testing (calibration and corroboration); and scenario analysis. These steps were detailed in "Data Review and Modeling Approach – Mispillion River and Cedar Creek TMDL Development," dated March 31, 2005 and "Model Configuration and Calibration Results – Mispillion River and Cedar Creek Models for TMDL Development," dated November 1, 2005. This document presents the results of the modeling studies and provides the technical basis for the calculation of the TMDLs.

Table 1 – TMDL Reductions Required from 2001-2003 Baseline Period for Mispillion River and Cedar Creek Watershed

	Nitrogen	**Phosphorous**	**Bacteria**
Mispillion River	57%	57%	87%
King's Causeway Branch[1]	88%	88%	87%
Cedar Creek	45%	45%	96%

The location of the Mispillion River, Cedar Creek, and King's Causeway Branch are shown in Figures 1 and 2 below.

[1] King's Causeway Branch is within the Mispillion River Watershed.

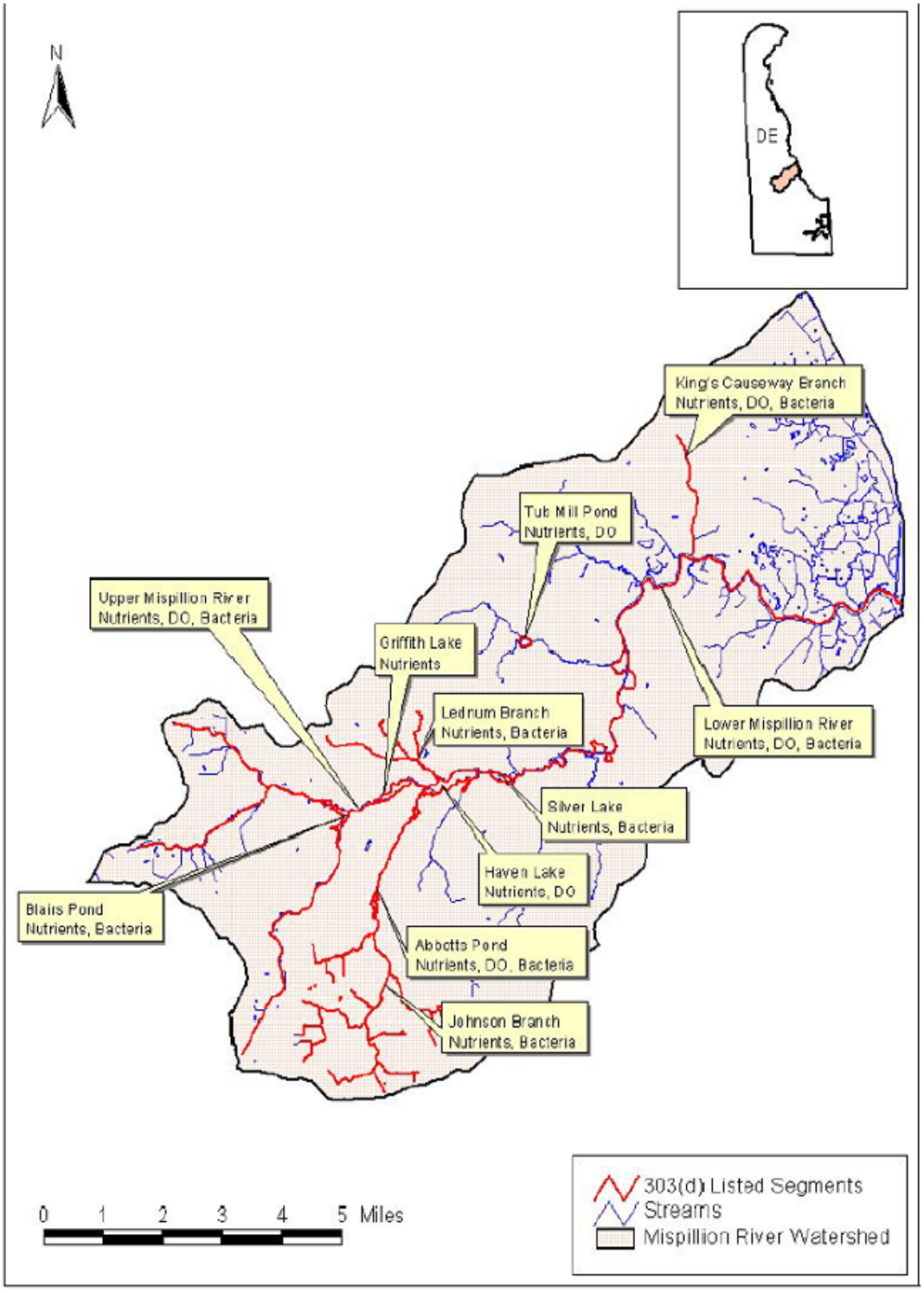


Figure 1 – Location of impaired segments in the Mispillion Watershed

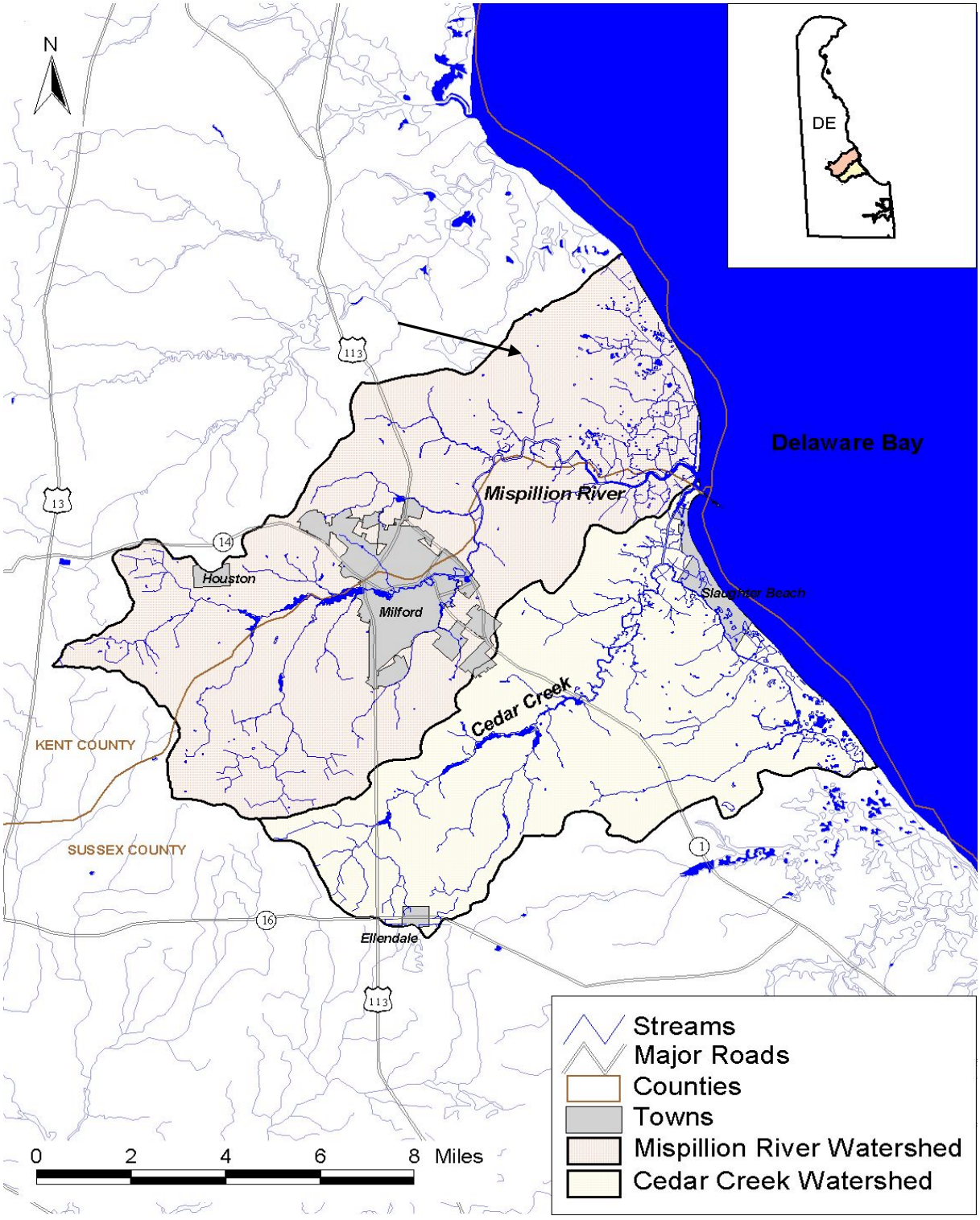


Figure 2 – Map of the Mispillion and Cedar Creek Watersheds with arrow pointing to Kings Causeway Branch

Overview of the Watershed

The Mispillion River and Cedar Creek discharge into the Delaware Bay in close proximity (Figure 2). The Watershed straddles Kent and Sussex Counties and includes the City of Milford, encompassing an area of 128 square miles. The Mispillion River is approximately 20 miles long and is fed by nearly 70 miles of tributary streams within an area of approximately 76 square miles. Cedar Creek is a smaller stream that is approximately 15 miles long with a watershed area of approximately 52 square miles. The River and Creek both flow eastward and drain into the Delaware Bay, joining just before they enter the Bay.

There are a number of large ponds within the Greater Mispillion River Watershed: Abbotts Mill Pond, Blairs Pond, Griffith Lake, Haven Lake, Silver Lake, Tub Mill Pond, and Marshall Millpond in the Mispillion subwatershed and Clendaniel Pond, Cubbage Pond, Hudson Mill Pond and Cedar Creek Pond in the Cedar Creek subwatershed. Most of the ponds show evidence of nutrient over-enrichment, with algal blooms and blue-green algae.

Within the Mispillion River and Cedar Creek Watershed, the land is flat to gently sloping, which is typical of the coastal plain. Tidal influences affect the lower Mispillion up to the eastern edge of the City of Milford. The lower portion of the watershed primarily consists of wetlands. This portion of the watershed is where freshwater and saltwater mix and is considered an estuary.

The watershed contains a number of recreational and public-use facilities. Several of the ponds have public fishing areas. Abbotts Mill Nature Center manages the Milford Millponds Nature Preserve. Several conservation organizations own land making up the Milford Neck Wildlife Area. A portion of the Cedar Creek watershed lies within the Prime Hook National Wildlife Refuge. The DuPont Nature Center, which overlooks the Mispillion River Inlet, is a hotspot for observing migrating shore birds. The Milford Riverwalk borders the Mispillion in the heart of Milford. Cultural, commercial, and historical activities are found along the Riverwalk. Public swimming areas were once provided at Marshall Millpond and Haven Lake, but currently there are no public areas for swimming.

The relative amount of land in each land use category is shown in Figure 3. Agricultural land is the largest portion of land cover, followed by wetlands, urban land, and forests.

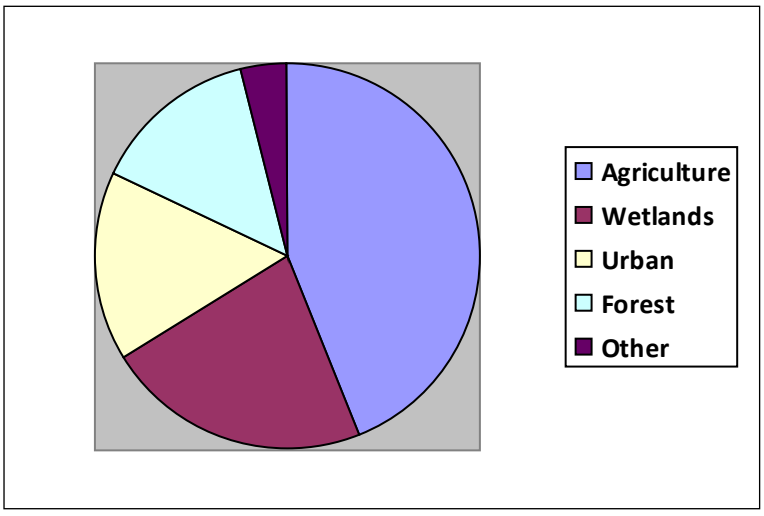


Figure 3 – Land use in the Mispillion and Cedar Creek Watersheds

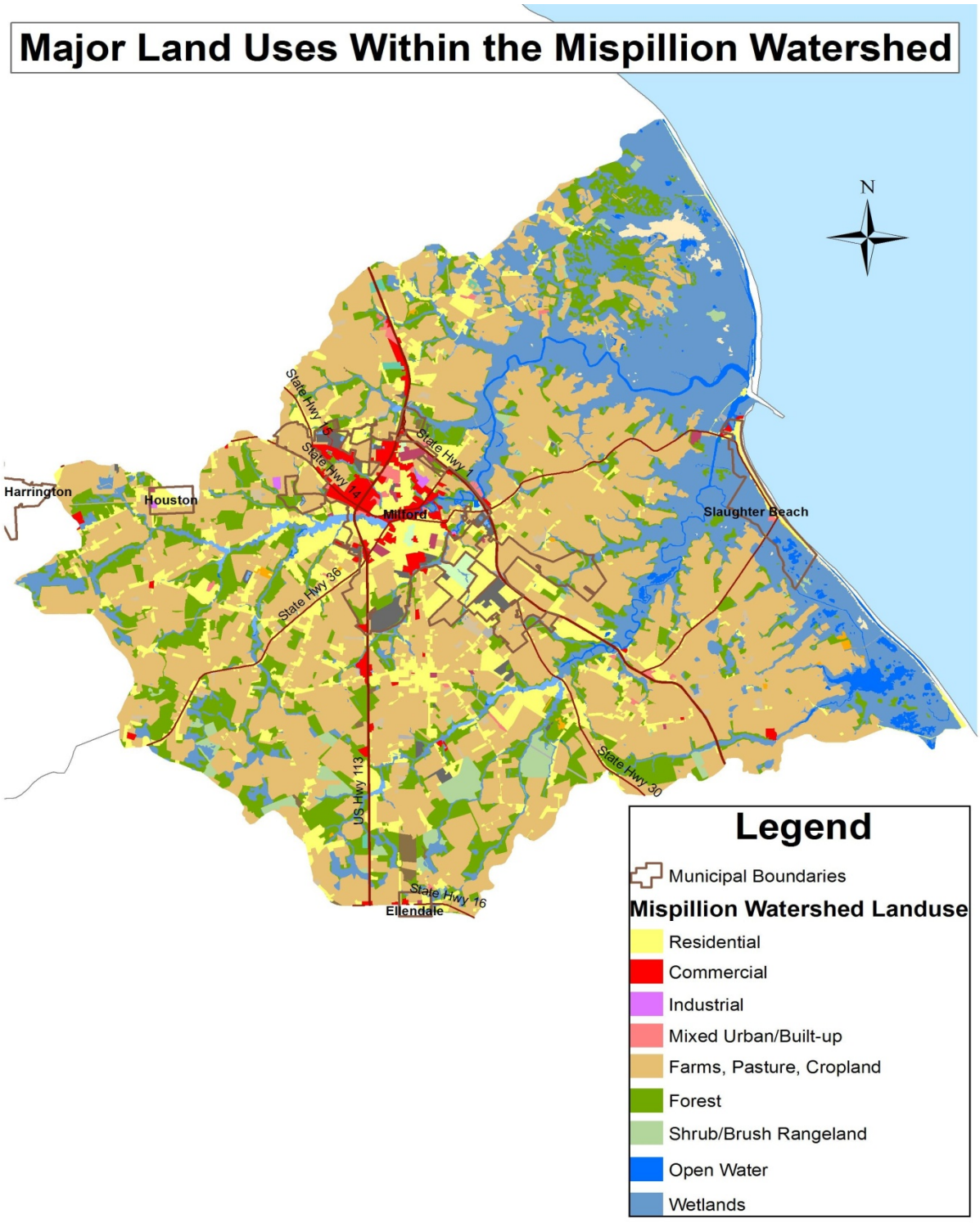


Figure 4 – The Mispillion and Cedar Creek Watersheds 2007 land use

Table 2 – Land use change from 1997 to 2007 within the Mispillion and Cedar Creek Watersheds			
Land Use	1997 % Total Area	2007 % Total Area	Change
Cedar Creek Watershed			
Agriculture	52.5	52.0	-0.5%
Barren/Open	0.96	3.0	2%
Urban	7.3	8.2	0.9%
Forest Land	14.9	12.4	-2.5%
Wetlands/Water	24.4	24.26	-0.14%
Mispillion River Watershed			
Agriculture	46.6	43.8	-2.8%
Barren/Open	0.98	2.8	1.8%
Urban	13.3	15.8	2.5%
Forest Land	15.0	13.9	-1.1%
Wetlands/Water	24.1	23.7	-0.4%

The Cedar Creek Watershed had very little land use changes from 1997 to 2007 (Figure 4 and Table 2). Urban land use increased by 1% whereas forest land lost about 2.5% of its 1997 acreage. Agricultural lands only lost about 0.5% of its 1997 acreage. In contrast to the Cedar Creek Watershed, the Mispillion Watershed lost acreage in the agriculture, forest land and wetlands/water land use and the urban and barren/open land use gained acreage from 1997 to 2007. Agricultural acreage loss was approximately at the same rate as urban lands gain in acreage over the time period.

The total population of the Watershed is 21,598, with 16,177 in the Mispillion River Watershed and 5,421 in the Cedar Creek Watershed. The distribution of the population is shown below in Figure 5.

Wastewater is handled through a mix of sewered areas (served by the Kent County Wastewater Treatment Plant in the Murderkill Watershed) and on-site wastewater treatment. There are 6,407 septic systems in the watersheds. As of June 2011 there are 14 holding tanks and 3 large-sized community wastewater systems in the Mispillion Watershed (serving 2 campgrounds and 1 golf course). Currently, there is one permitted wastewater treatment facility (Baltimore Aircoil Milford Plant) located in the watershed.

Pollution Control Strategy for the Mispillion and Cedar Creek Watersheds

The purpose of the Mispillion and Cedar Creek Watersheds Pollution Control Strategy recommendations is to achieve the reductions in nutrient and bacteria levels required in the Total Maximum Daily Loads (TMDLs) for the watershed in order to reduce the pollutants reaching the Mispillion River and Cedar Creek. The contents of the Mispillion River and Cedar Creek Pollution Control Strategy are intended to fulfill the elements of a Watershed Plan in compliance with the a) through i) criteria as established by EPA. The Mispillion River and Cedar Creek Pollution Control Strategy will specify actions to implement both the Mispillion River and Cedar Creek Pollution Control Strategy and EPA Watershed Plan.

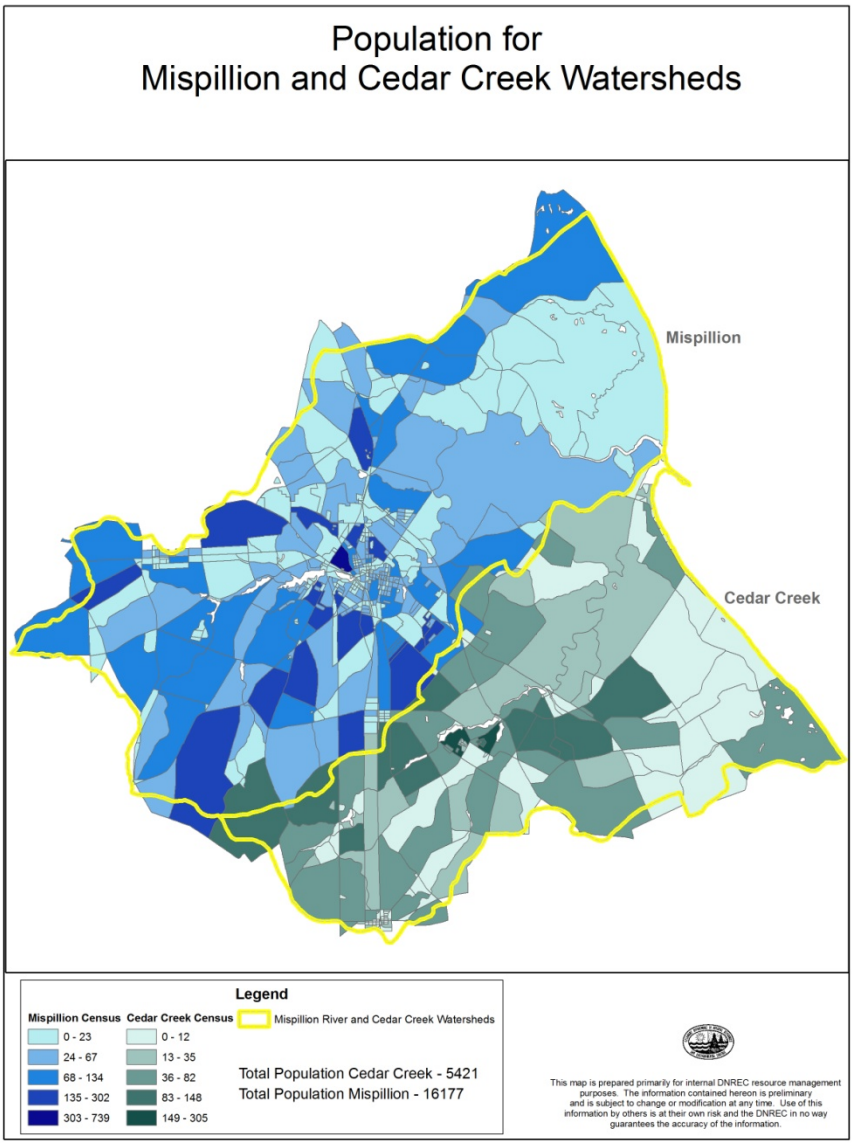


Figure 5 – Population Distribution in Mispillion and Cedar Creek Watersheds

The Pollution Control Strategy was developed utilizing information found with the following documents:

- Mispillion and Cedar Creek Watersheds Pollution Control Strategy – by the Department of Natural Resources and Environmental Control.
- State of Delaware – 2010 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs.
- Bacteria, Nutrient and Dissolved Oxygen TMDL Development for the Mispillion River and Cedar Creek, Delaware. August 2006.
- Surface Water Quality Monitoring Plan, 2007.

The specific goal of the Strategy is to reduce the pollutants to levels at or below the TMDL values specified in the regulation establishing the TMDLs for the Mispillion River and Cedar Creek Watersheds[2], as shown in Table 3.

Table 3 – TMDLs for Mispillion River and Cedar Creek Watersheds			
	Nitrogen (Pounds/day)	Phosphorous (Pounds/day)	Bacteria (Colony forming units/day)
Mispillion River	1115.45	19.36	2.92E+10
Cedar Creek	593.84	9.38	7.15E+10

Meeting the TMDLs will require significant reductions in pollutant loadings, as shown in Table 3. The reductions are calculated utilizing a standard baseline of the years 2001-2003.

Development Process for the Pollution Control Strategy Recommendations

Mispillion River and Cedar Creek Watersheds Tributary Action Team

These recommendations were developed through the work of the Mispillion River and Cedar Creek Watershed Tributary Action Team (TAT). The TAT formed in June 2009 following three education sessions that were advertised and open to anyone interested in attending. The education sessions presented information on TMDLs, land use, groundwater, uses of the river, stormwater management, and other topics pertinent to water quality. Members of the TAT self-selected themselves based on interest in improving the watershed and a willingness to commit to monthly meetings for a year. The team of 34 people included representation from the private sector, agriculture, environmental organizations, the City of Milford, and the residential community.

Team members developed an issue book (Appendix E) laying out the need to reduce pollutant loadings in the watershed and a variety of approaches to achieving the reductions: prevent pollution from entering the waterways; plan for and implement river-friendly growth and development; and encourage and support beneficial uses of the river. The issue book was made available to the public at numerous locations throughout the watershed, including libraries, sporting stores, and other locations where people would be likely to pick up and read information on the river.

The issue book and approach options were presented at a public forum on November 4, 2009 at the Carlisle Fire Hall to solicit opinions on how to improve water quality in the watershed. Thirty two residents of the watershed attended the forum. Following an introduction to how the forum will be conducted, attendees introduced themselves and shared their reasons for attending the forum. The audience varied with residents who have lived in the watershed 3 years to families that have been here over 100 years. The general sense was that the Mispillion is central to the identity of the City of Milford and the area, and that all the approaches had merit but the

[2] Secretary's Order No. 2006-W-0051 Re: Approving Final Regulations for Total Maximum Daily Loads for the Broadkill River, Cedar Creek, and Mispillion River Watersheds, Date of Issuance: November 14, 2006, Effective Date: December 11, 2006

approach – plan for and implement river-friendly growth and development - was the best approach to take to improve water quality.

Based on the comments and discussion at the public forum, the TAT identified the following principles to guide them in developing the Pollution Control Strategy recommendations:

- The River is part of the identity of the local community.
- There are lots of regulations already – those need to be enforced.
- Ensure that we have the science for new regulations and be prepared to enforce them.
- Need education so people understand why they should or should not do something.
- Regulation must be fair and reasonable and rules must apply to everyone equally.
- Leave people with a celebration of the River.

Following the forum, the team identified some additional education they wanted and then spent approximately six months developing and refining the recommendations contained in this strategy. Recommendations which received an average priority ranking of 4 or greater on a scale of 1 to 5 are identified as High Priority recommendations.

Table 4 – Land use loading rates for the Mispillion and Cedar Creek Watersheds based upon TMDL data

	TN (lbs/acre/yr)	**TP (lbs/acre/yr)**
Urban (high density)	19.35	0.53
Agriculture	24.79	0.3
Grassland	5.0	0.3
Forests	1.71	0.1
Wetlands	1.47	0.08

Using the land use loading rates listed in the above Table 4, the nutrient loads coming from nonpoint sources during the baseline period could be determined using the equation below.

Load for land-use type by reduction area (lbs/day)	=	Acreage of specific land-use	X	Loading rate for that land-use type (lbs/acre/yr) divided by 365 days

The daily nutrient load reductions needed from nonpoint sources in order to achieve the reductions outlined in the Mispillion Watersheds TMDL are calculated using the following equation.

Required TMDL Reduction (lbs/day)	=	Total baseline period load for area (lbs/day)	X	Percent reduction as required in TMDL

Table 5 – Mispillion and Cedar Creek Watersheds Nutrient Loads based upon land use and land use load rates (See appendix D)					
Nutrients	Urban	Agricultural	Forest	Wetland	Other
TN (lbs/day)	116.9	2598.2	51.4	70.7	31.0
TP (lbs/day)	14.8	58.2	2.85	4.1	1.8

Current Best Management Practices in the Watersheds

The Mispillion and Cedar Creek Watersheds has a considerable number of BMPs in place. This section details the BMPs in practice and their associated nutrient reductions. The following Table 6 summarizes the reductions from the BMPs and where that places the watersheds with regard to compliance with the TMDLs.

Table 6 – Nutrient Reduction achieved by existing Best Management Practices				
	Nitrogen Load Reduction (lbs/day)	**Percent of Required Reduction Achieved**	**Phosphorus Load Reduction (lbs/day)**	**Percent of Required Reduction Achieved**
Total for Existing BMPs for Mispillion River and Cedar Creek Watersheds	804.96	47	22.14	78
Reduction Needed for TMDL	1709.29		28.74	

Bacteria Reductions

Specific information regarding bacteria is not included in the chart below, or in most of the recommendations, since the analysis of source tracking data is not yet available. However, bacteria survival is dependent on soil moisture, temperature, pH, availability of nutrients and antagonistic organisms. Under ideal conditions the bacteria is retained near the soil surface long enough for infiltration into unsaturated soil to occur resulting in bacteria die off within the first two feet. Under less than ideal conditions, best management practices (BMPs) are the most effective and practical means of preventing or reducing bacteria from entering surface waters.

BMPs reduce bacteria levels in many different ways. Non-structural BMPs are practices that mainly control bacteria at the source. These practices include routine septic inspections and pump-outs. Septic tanks should be inspected every three years and pumped as needed, usually every three years or when the tank is about 1/3 filled. By maintaining your septic system regularly, it is less likely to fail and contaminate surface or ground water. It also extends the longevity of your septic system, saving money for costly repairs or replacements. Another very inexpensive non-structural BMP is simply being a good neighbor and managing pet waste properly. Another example is managing livestock manure. Structural BMPs usually involve building a structure and may have a higher cost associated with it. Examples include buffers, constructed wetlands, sand filters, infiltration trenches, low impact development, and stream fencing. Dense vegetative buffers facilitate conventional bacteria removal through detention, filtration by vegetation, and infiltration into soil.

Other methods include the use of chemicals such as chlorine or even using ultraviolet lights. These methods can be costly and require considerable oversight. Table 7 illustrates typical bacterial reductions

Table 7 – Typical bacteria, suspended solids, and nutrient from commonly used BMPs

BMP	Land Area Needed	Cost	Total Nitrogen % Reduction	Total Phosphorus % Reduction	Suspended Solids % Reduction	Bacteria Reduction %
Buffer Strips	Low	Medium	20 – 60	20 – 60	20 – 80	43 – 57
Constructed Wetlands	N/A	N/A	20	45	65	78 – 90
Sand Filters	N/A	N/A	47	41	57	36 – 83
Dry Detention Pond	High	High	15	25	70	
Infiltration Trenches	Low	Medium	45 – 70	50 – 75	75 – 99	
Wet Ponds*	Medium	High	20	45	55 – 94	44 – 99
Biofiltration	N/A	N/A	25	34		>99
Bioswales	Low	Medium	25	34	70	
Storm water wetlands	N/A	N/A	30	49	N/A	N/A

*if properly managed

The Mispillion and Cedar Creek Watersheds bacteria TMDL requires over 89% reduction in bacteria numbers. The State of Delaware Surface Water Quality Standards, as amended July 11, 2004, provides specific numeric criteria for bacteria for the waters of the Christina Basin. The water quality standard for enterococcus bacteria in the Christina Basin is as follows for primary contact recreation for fresh waters:

- Single-sample value is 185 enterococcus colonies per 100 ml.
- The geometric mean of representative samples should not exceed 100 colonies per 100 ml.

The geometric mean enterococcus bacteria levels in the Mispillion River are discussed in more detail below.

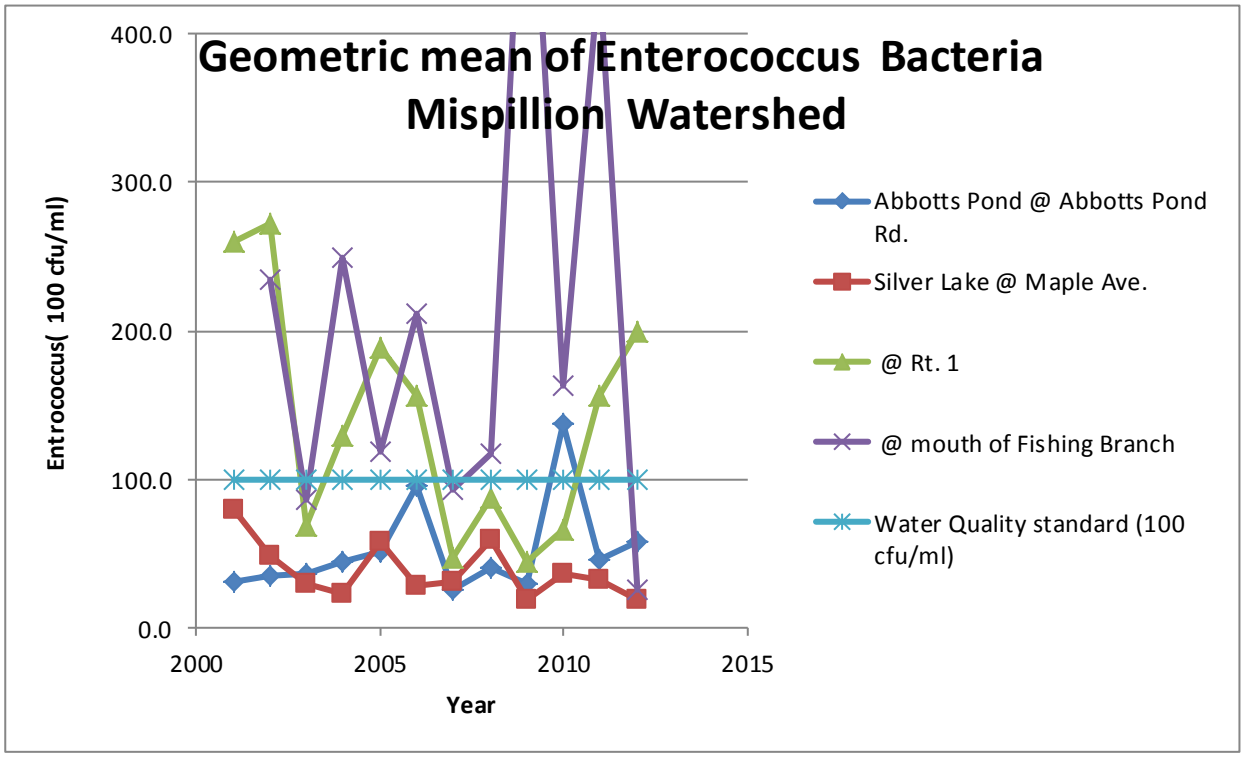


Figure 6 – The yearly geometric mean of Entrococcus Bacteria in the Mispillion River

The levels of enterococcus bacteria in Mispillion River show no apparent trend as was observed in Cedar Creek. The levels continue to fluctuate in the Mispillion River as well as, Cedar Creek. Figure 6 shows the geometric mean enterococcus bacteria levels in the Mispillion River from 2001 to 2012.

Implementing these Pollution Control Strategies will result in continued reduction in bacteria numbers. Only monitoring of the surface-water will clearly demonstrate the effectiveness of the installed BMPS in reducing bacteria numbers.

Stormwater Best Management Practices

Stormwater BMPs in use in the Mispillion and Cedar Creek Watersheds are biofiltration/bio-swales, dry ponds, urban infiltration practices, wet ponds, and infiltration practices. The acreage treated by each best management practices is shown below. The reduction in lbs/day for these stormwater BMPs is 6.38 for TN and 0.038 TP.

Table 8 – Acreage of various Stormwater Best Management practices utilized in the Mispillion and Cedar Creek Watersheds

Best Management Practice	Acreage of Practices
Biofiltration/bioswales	72.1
Dry Ponds	514.3
Urban Infiltration practices	97.7
Infiltration systems	24.2
Wet Ponds	748.1
TOTAL	**1483.4**

Agricultural Best Management Practices

Agricultural BMPs are a significant source of current nutrient reductions in the watershed. The following table summarizes the number of acres utilizing each BMP and the load reductions for that BMP[3]. Data is only available for the land under cost share programs, more land may be implementing BMPs, however data is not available. The reduction in lbs/day for these agricultural BMPs is 804.96 for TN and 22.140 TP.

Table 9 – Agricultural Best Management Practices implemented in the Mispillion and Cedar Creek Watersheds as of July 2012			
Mispillion River Watershed			
	Acres	***Nitrogen Load Reduction (lbs/day)***	***Phosphorus Load Reduction (lbs/day)***
Cover Crops	3432.4	152.81	0.28
CRP Practices			
Wildlife Food Plots	6.1	0.25	0.00
Wildlife Habitat	115.2	4.73	0.06
CREP Practices			
Grassed Filer Strips	22.9	2.38	0.06
Shallow Water Areas for Wildlife	3.9	0.27	0.01
Riparian Buffers	19.9	2.78	0.06
Wetland Restoration	175	24.45	0.52
Wildlife Plantings	100.3	10.44	0.23
Hardwood Plantings	427.6	59.75	1.28
Critical Area Planting	14.3		0.0002
Conservation Tillage	1,964		0.0037
Manure Relocation/Alt. Use	1,110	20.28	1.28
Nutrient Management Plans	21,423.36	196.63	9.47
TOTAL		**474.78**	**13.26**
Cedar Creek Watershed			
	Acres	***Nitrogen Load Reduction (lbs/day)***	***Phosphorus Load Reduction (lbs/day)***
Cover Crops	3383.8	150.65	0.27
CRP Practices			
Wildlife Habitat	37	1.52	0.02
CREP Practices			
Grassed Filer Strips	8	0.83	0.02
Shallow Water Areas for Wildlife	10.8	0.38	0.00
Riparian Buffers			
Wetland Restoration			
Wildlife Plantings	5	0.52	0.01
Hardwood Plantings	43.8	6.12	0.13
Critical Area Planting			
Conservation Tillage			
Manure Relocation/Alt. Use	69	1.26	0.08
Phytase[4]	N/A		N/A
Nutrient Management Plans	16836.2	154.5	7.4
TOTAL		**322.67**	**8.33**

[3] Data from Natural Resource Conservation Service, 2006

Wastewater Best Management Practices

The reduction obtained by pumping out 15 holding tanks in the Mispillion and Cedar Creek Watersheds in accordance to their permit is 1.13 lbs/day of TN and 0.38 lbs/day of TP.

Pollution Control Strategy Recommendations

The recommendations to reduce nutrients flowing into the Mispillion and Cedar Creek Watersheds can be grouped into three main categories:

- Recommendations reducing nutrients from a developed land (existing and future).
- Recommendations to provide incentives for additional nutrient reductions from agriculture.
- Education-based recommendation.

In addition to the recommendations listed below, the Tributary Action Team recommends creation of a watershed association to maintain and increase public involvement in improving the quality of the watershed. A watershed association is a non-profit organization engaged in activities to preserve, protect and enhance rivers and related natural resources. The Team believes that with the strong identification of the community with the river, that there would be a significant interest in participation in a watershed association. An ongoing association would be beneficial in publicizing and conducting educational programs.

Authority

The authority to create a Strategy comes from the Delaware Code, Title VII, Chapter 60. The General Assembly found multiple reasons why regulation of natural resources was needed, including recognizing that "the regulation of the development and utilization of the land, water, underwater and air resources of the State is essential to protect beneficial uses and to assure adequate resources for the future" (7 Del. Code §6001 (a)).

The related policies and purposes are also broad in their coverage (§6001 (b, c)). Section 6010 (a) states that the "Secretary may adopt, amend, modify or repeal rules or regulations, or plans, after public hearing, to effectuate the policy and purposes of this chapter." Thus, control of pollution and protection of resources are legitimate regulatory goals.

The TMDL for the Mispillion and Cedar Creek requires the development and execution of an implementation plan. Additionally, the State Water Quality Standards state that all "human induced nonpoint sources, subject to control through the use of best management practices or otherwise, shall be required to remove nutrients to the extent necessary to prevent excessive growth of photosynthetic organisms." The TMDL has determined that level, and this Strategy outlines the actions for achieving that level of water quality.

Recommendations Relating to Existing and Future Developed Land

1. **A statewide ban phosphorous in residential automatic dishwasher detergents should be enacted by the General Assembly**. (High Priority)

   Implementation goal: Have legislation in place to ban phosphorous in residential automatic dishwasher detergents.

   Basis for recommendation: During the 1970s, the U.S. government recognized that laundry and dishwashing detergents were contributing to phosphorus pollution, which can cause massive algal blooms in waterways and destroy ecosystems by robbing the water and aquatic life of oxygen. Companies started to create alternative laundry detergents that did not contain phosphorus. By the 1990s, enough states had limited or restricted laundry detergent phosphates that detergent companies finally realized that, in order to appeal to their consumers; they would have to develop a phosphate-free detergent. Companies decided to voluntarily phase out all domestic formulations of detergents with phosphorus by the mid-1990s.

   Dishwasher detergents on the other hand still contain harmful phosphates. The Kent County Dept. of Public Works determined that at least 20% of the phosphorous entering the county's wastewater treatment plant comes from residential automatic dishwater detergents. Elimination of phosphorous in these detergents (at the source of the pollution, aka pollution prevention) can result in a considerable reduction in cost associated with removing phosphorous from the wastewater. By July 1, 2010, 15 states, including Virginia, Maryland and Pennsylvania, have implemented laws banning phosphorous in household dishwasher detergent (a limit of no more that 0.5% phosphorous by weight).

   Expected Reduction: 99.5% reduction in phosphorous from residential automatic dishwashers.

   Nutrient Reducing Recommendations Effectiveness Criteria: Only phosphorous-free residential automatic dishwashers detergent sold in Delaware.

   Cost: Alternative, phosphorous free, dishwashing detergents are currently available locally at competitive costs.

   Action Needed: Initiate a process to develop legislation to ban phosphorus in household from residential dishwater detergents.

2. **Prioritize areas where failing individual, large, and community wastewater treatment and disposal systems can be eliminated by either connecting to a Waste Water Treatment Plant or retrofitted to meet current septic system performance standards. (High Priority)**

   Implementation Goal 2: Eliminate failing septic systems located within Kent County portion of the Mispillion Watershed by connecting them to Kent County Waste Water Treatment Plant. The failing septic systems within the Cedar Creek Watershed and the ones within the Mispillion watershed located in Sussex County should be fixed by installing replacement systems in compliance with current septic regulations.

Basis for Recommendation: In Delaware, since surface and groundwater are directly connected; impacts on groundwater will impact the quality of the surface water. In the summer months, surface water flow is primarily groundwater seepage into the stream. Thus, nutrients from ill functioning onsite wastewater treatment and disposal systems reach the surface water through groundwater contamination. An individual onsite wastewater treatment and disposal system may contribute 10.6 pounds per year of nitrogen and 0.1 lbs per year of phosphorus to the groundwater. As July of 2012, approximately 8,441 septic tanks were identified in the Mispillion and Cedar Creek Watersheds and of those septic systems two systems treat over 2500 gal per day. In 1997, which is the baseline year for the TMDL, there were 5,238 individual septic tanks in the watershed. Based upon the septic permitting records from 1989 to July 2012, there were 465 septic system replaced in the Mispillion and Cedar Creek Watersheds or 22 septic systems were replaced per year in the watershed. Over the above time, only six septic systems per year were replaced in the Cedar Creek Watershed. The potential contribution of phosphorus from septic systems could reach up to 15.2 lbs per day, while 21.9 lbs per day of nitrogen will enter groundwater and ultimately end up in the surface water.

In addition, current regulations require that units must connect to a sewer line if it is there, but no timeframe for that connection is specified. A time limit should be established in the regulation. In Sussex County, if the area is sewered, the owners in the sewered area have one year to connect to the wastewater facility. Kent County is not as aggressive in requiring systems to be connected to its Kent County Treatment Facility.

Expected Reduction: Replacing 22 failing systems could reduce 0.74 lbs/day of TP and 0.32 lbs/day of TN by implementing this recommendation. Requiring the two large systems to reduce their nutrient load when their current permit expires would reduce nitrogen by 1.63 lbs per day of TN and TP 0.25 lbs per day. 100% nutrient reduction, if connected to a waste water treatment plant due to the plant discharging into a different watershed. Significant reductions could also be achieved through retrofits, although less than total elimination if the system discharges into the Mispillion and Cedar Creek Watersheds.

Implementation Schedule: Replacing failing septic systems is an ongoing process.

Nutrient Reducing Recommendation Effectiveness Criteria 2: Effectiveness will be measured by the number of systems installed with nutrient reducing technologies installed within the watershed.

Cost: Approximately $860/EDU/yr, which corresponds to $81.13/lbs of Nitrogen reduced and $8600/lbs of Phosphorous reduced. The septic system owner will pay the cost of these systems. Cost-share funds may be found to assist those of middle-income and below. At present, State Revolving Fund (SRF) money and Septic Rehabilitation Loan Program funds may be used to provide low interest loans to property owners that need to replace a failing system.

Action Needed: With the existing septic system permitting database, most all the records are geo referenced, a GIS analysis can be conducted on the data in order to identify areas within the greater Mispillion that have a large number of failing wastewater treatment and disposal systems due to systems age and undersized disposal areas. Once these areas are determined,

staff can check for addition failing systems, and once found the process to replace or eliminate them can begin.

3. Require Nutrient Management Plans for open space greater than 10 total acres within a development. (High Priority)

Implementation Goal 3: Encourage the planting of open space in native vegetation and require compliance of Nutrient Management Act for parcels greater than 10 acres.

Basis for Recommendation: Open space within developments is often simply mowed and fertilized fields. Open space can have many valuable functions and should include natural areas. Natural areas should be maintained with appropriate native vegetation and protected through easements. Nutrient management plans have been successful in improving the efficiency and effectiveness of nutrient applications for farm operations. Nutrient management plans should have similar impacts on the effectiveness of fertilizer use on open space within developments

In the past ten years, land changes have taken place in the Mispillion and Cedar Creek Watersheds. Urban and residential land uses have increased by 6.4% in the watershed and agricultural and forested land uses have decreased by 6.4% and 1.40%, respectively. Along with these changes, the amount of impervious surface in the watershed grew as more rural land was converted to urban uses.

Open space can have many valuable functions and should include natural areas such as wetland restoration areas and buffers. Open space should be planted with appropriate native vegetation and protected though easements. In impaired watersheds, water quality protection must be a priority when developers design open space; more emphasis placed on water quality leads to lower nutrient loads. Keeping some of the developing area as open space also helps to reduce nutrient loads. Kent County subdivision ordinances have established protection and planting standards for woodlands, and have restricted subdivision and/or clearing under the jurisdiction of United Sates Army Corps of Engineers. In addition, Kent County considers lakes, ponds, and streams as permanent open space.

In Sussex County ordinance §99.51 (Public Site and Open space) serves as a guide for determining the minimum percentage of the total site which shall be set aside for park and open space in residential subdivision and other residential land development. It was modified in December 2008 by Ordinance number 2022 and that amendment defines minimum percent of open space required based dwellings units per acre Table 10.

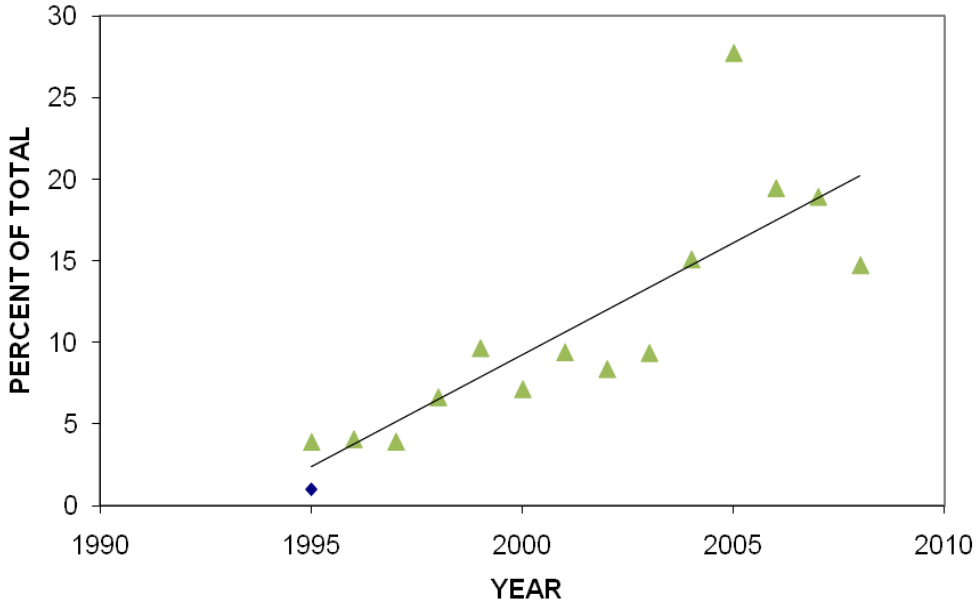
Table 10 – Minimum open space required per dwellings in Sussex County

Gross Density (dwelling units per acre)	Minimum Percentage of Open Space
2 to 5	10
6 to 10	15
Over 10	25 or more

With these county ordinances, open space will only continue to increase as more land is developed. Delaware Nutrient Management Commission (DNMC) is the controlling

authority for fertilizer application on parcels of land greater or equal to 10 acres within the State based upon the Nutrient Management Act promulgated in 2000. The Nutrient Management Act requires nutrient applicators to be certified. Requiring applicators to log the amount of nutrients they are applying will help to track the amount of nutrients being applied to individual non-agricultural properties. The DMNC has also recognized that significant contributions of nitrogen and phosphorous come from land parcels less than 10 acres in size. In response to this knowledge, the DNMC has produced brochures on proper lawn maintenance. These brochures have been placed in most retail outlets that sell fertilizer in the watershed. In addition, a public service advertisement was broadcast on WBOC television station reminding people about proper lawn nutrient application and urging people to get a soil test done prior to applying fertilizer. Lawn care companies must be in compliance with the Nutrient Management Act requirement for turf management.

It is apparent from the data set below that the non-farm fertilizer tonnage has grown significantly since 1995 to 2008. Correspondingly, there has been an eight percent increase in urban acreage over this time period suggesting that fertilizer applications to other land uses, such as residential lawns, is increasing. Sims et al. [4] (2007) reported that from 2000 to 2006, 50%, 30%, and 20% of the non-farm N fertilizer and 44%, 32%, and 24% of the non-farm P fertilizer was used in New Castle, Kent, and Sussex County, respectively.



(Source: Jones, Lyle and Volk Jennifer. 2008. *Effect of Delaware's Nutrient Management Law On Nutrients Sold in Delaware and Its Apparent Impact on Nitrogen and Phosphorus Total Maximum Daily Loads ---- Another Perspective*.)

Figure 5 – Percentage of Non-Farm Fertilizer Sold in Delaware by Year

Preventing over fertilization on any lawn will reduce nutrient runoff into the watershed's surface waters. The Delaware Livable Lawns Program certifies lawn care companies that follow environmentally-friendly practices in fertilizer application while educating

[4] Sims, J.T., J. McGrath, and A.L. Shober. 2007. *Nutrient Mass Balances for the State of Delaware: Final Project Report, Submitted to the Delaware Nutrient Management Commission*. University of Delaware, Newark, DE.

homeowners. While many homeowners may be unaware of where, when, and how much fertilizer to apply, professional lawn care staff have the expertise to fertilize lawns correctly. Certified Delaware Livable Lawns companies go a step beyond the current regulations that govern fertilizer use by following environmentally-friendly practices resulting in healthy lawns and healthy water. In addition, the Delaware Livable Lawns program has a residential education portion to educate homeowners as to their responsibility when it comes to fertilizer application and how what they do on their lawns can affect us all.

The Delaware Nursery & Landscape Association (DNLA) administers the Delaware Livable Lawns Program. The DNLA is a non-profit trade organization serving Delaware's horticultural related businesses and the companies that supply them. The DNLA's mission is to advance the common interests of its members and to promote the use, and enhance the quality, of the products and skills of the green industry. The DNLA also works in cooperation with the Delaware Department of Agriculture and Delaware Cooperative Extension to shape legislative and administrative policies and procedures on matters that are of interest to Delaware's Green Industry.

The Delaware Livable Lawns Program Advisory Group was developed through a cooperative effort of:

- Delaware Department of Transportation
- Delaware Department of Natural Resources & Environmental Control
- Appoquinimink River Association
- Delaware Department of Agriculture Nutrient Management Commission
- New Castle Conservation District
- US Department of Agriculture Natural Resources Conservation Service
- University of Delaware Institute for Public Administration Water Resources Agency
- University of Delaware Cooperative Extension
- Delaware Grounds Management Association
- Delaware Nursery & Landscape Association

Expected Reduction: Is being accessed through Delaware Liveable Lawns program and initial estimate should be available after the first year of reporting (Dec. 2012).

Nutrient Reducing Recommendation Effectiveness Criteria 3: The number of developments within the Mispillion and Cedar Creek Watersheds with nutrient management plans for their open space. Delaware Liveable Lawns would be a vehicle to measure this criterion.

Cost: Cost of the Delaware Liveable Lawns program was $40,000 for the first year and will be $25,000 each year thereafter.

Implementation Schedule: Delaware Liveable Lawns program started in January 2011.

Potential Funding Source: Delaware Liveable Lawns Program was funded initially through DelDOT. The Department will work with partners including the County and local governments to apply for grants for this work.

Action Needed: DNREC will work with the Department of Agriculture about promulgating regulations prohibiting the application of nutrients to open space unless prescribed by a nutrient management plan and will work with the County and municipalities to implement. The Department also requests communities to follow the Helping the Environment Starts in Your Back Yard which was developed by the Department's Coastal Program to restore, manage and maintain open space.

4. DNREC should conduct a proactive search for and systematically eliminate cesspool and seepage pits. (High Priority)

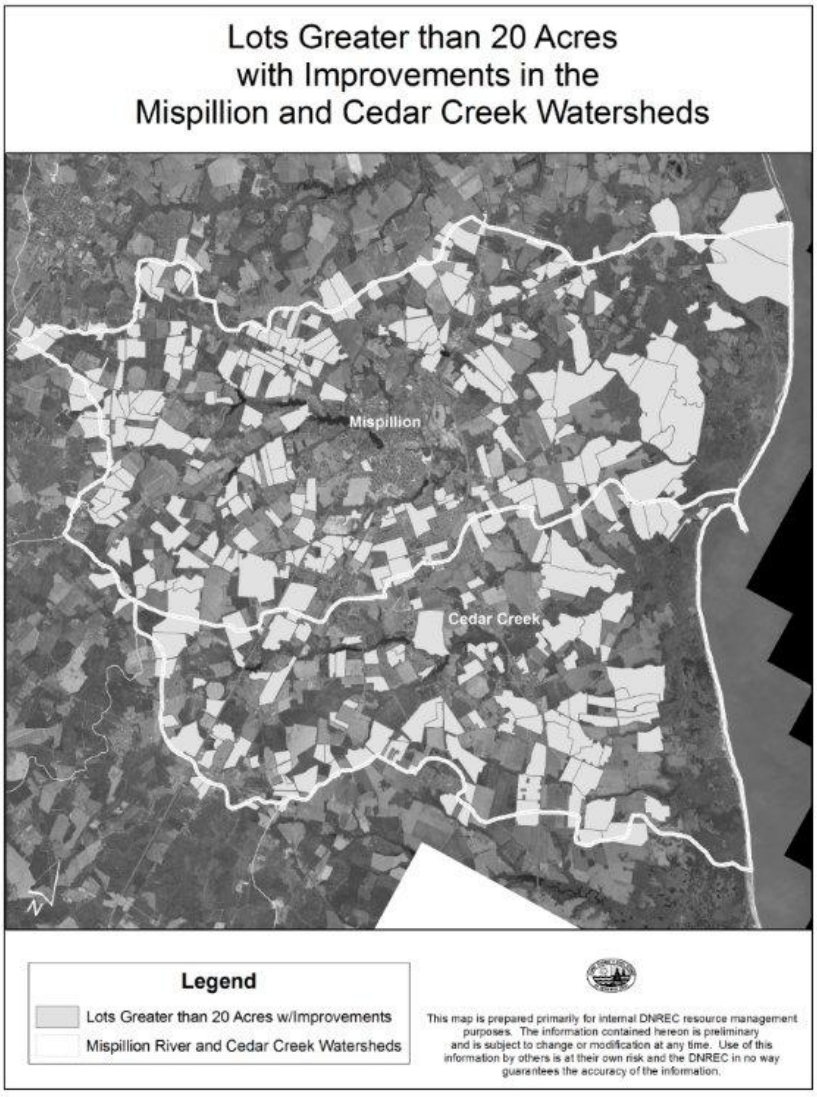


Figure 6 – Larger parcel that may have cesspool on the Mispillion and Cedar Creek Watersheds

Implementation Goal 4: Eliminate all cesspools in Watershed.

Basis for Recommendation: Significant sources of nitrogen, phosphorous, and bacteria can be reduced by eliminating cesspool and seepage pits since they discharge nutrients and

bacteria directly into groundwater. In the watershed there are 340 parcels that are 20 acres or greater and have buildings on them that could have cesspools or seepage pits (see Figure 6).

Any existing cesspools in the Mispillion River and Cedar Creek Watersheds would likely be with old farmsteads and very old mobile home parks and based upon the GIS analysis by DNREC's Watershed Assessment Section there could be numerous cesspools in the Mispillion and Cedar Creek Watersheds.

Due to the cost of these systems, the Financial Assistance Branch which administers the Septic Rehabilitation Loan Program provides a source of low interest financing for repairing or replacing failing septic systems or cesspools with systems that will function in an environmentally sound and cost effective manner. Eligibility is open to property owners with on-site wastewater disposal systems that need rehabilitation in order to meet regulatory requirements. In addition, the property owners must meet program income guidelines and must demonstrate the ability to repay the loan. Financing is available at an interest rate of 3 or 6 percent depending on income and can be repaid over 20 years with no prepayment penalty. Loans range from $1,000 to $25,000 for individual systems with maximum loans of $250,000 for community or mobile home park systems. Eligible costs include:

- Site evaluation fees
- Septic system design fees
- Permit fees
- Construction costs

A new Septic Extended Funding Option (SEFO) has been established for homeowners who do not qualify for the Septic Rehabilitation Loan Program. SEFO can be used when the current program cannot provide all the funds necessary to assist an applicant. All SEFO loans are interest-free and secured by a due-on-transfer mortgage lien that stipulates full loan repayment when the property is sold or transferred. To receive funding, loan recipients must sign a mortgage lien and loan note. No monthly payments are required and SEFO loans will be forgiven after 20 years, the useful life of the septic system.

Implementation Schedule: To be completed by July 2015.

Expected Reduction: 0.6 lbs/day of total nitrogen and 0.16 lbs/day of total phosphorus can be reduced if 30 cesspools are removed and 100% if connected to a wastewater treatment plant (WWTP) that discharges outside the watershed; 90% if connected to WWTP that utilizes spray irrigation within the watershed.

Nutrient Reducing Recommendation Effectiveness Criteria 4: Effectiveness will be measured by the number of cesspools and seepage pits eliminated within the watershed.

Cost: The cost depends on the number of systems that need replacement and the types of systems that would be permitted in their place.

Potential Funding Sources: The cost of these systems will be paid by the land owner. Cost-share funds may be found to assist those of middle-income and below. At present, State

Revolving Fund (SRF) money and Septic Rehabilitation Loan Program funds may be used to provide low interest loans to property owners that need to replace a failing system.

Action Needed: With the promulgation of the new proposed regulations governing the design, installation, and operation of on-site wastewater treatment and disposal systems regulations in 2013, the Department believes that this recommendation will be met. If the new on-site wastewater treatment and disposal system regulations are not promulgated as anticipated, the Department will try promulgating the necessary regulations for this recommendation.

5. Identify areas where stormwater retrofits would effectively reduce sediment and nutrients. (High Priority)

Implementation Goal 5: Use the existing stormwater BMP database to identify retrofit areas.

Basis for Recommendation: Land developed prior to 1990 did not have any stormwater requirements. Kent Conservation District has delegated authority from DNREC to run the stormwater program in Kent County and is in the process of identifying priority areas for stormwater retrofits. In Sussex County the Sussex Conservation District is the delegated authority to run the stormwater program.

DNREC believes that the development of a Watershed Implementation Plan like was done in the Appoquinimink, Broadkill, and St. Jones watersheds would achieve the retrofit recommendation listed above. The Plan would produce a stormwater retrofit list that would prioritize where stormwater management practices should be installed to improve water quality in the Mispillion and Cedar Creek Watersheds. Previous plans have resulted in the installation of best management practices that have improved water quality in these watersheds.

Implementation Schedule: On going

Expected Reduction: Nutrient reductions will depend on the specific systems selected for upgrade and the acreages involved. Table 11 shows the pollutant removal efficiencies of some of the most common stormwater BMPs

Table 11 – Qualitative Pollutant Removal Efficiencies

Relative Pollutant Removal Capabilities for Storm Water Treatment Practices						
	TSS	*TP*	*TN*	*Metals*	*Bacteria*	*Oil & Grease*
Dry Detention Ponds	○	○	○	○	○	○
Wet Ponds	●	●	◉	●	●	●
Stormwater Wetlands	●	●	◉	◉	●	●
Filtering Practices	●	●	●	●	○	●
Infiltration Practices	●	●	●	●	●	Don't Use
Water Quality Swales	●	◉	●	●	○	◉
● High Removal ◉ Medium Removal ○ Low Removal						

Source: CWP, 2005

Based upon work done in other Delaware watersheds, there is an anticipated reduction of 0.28 lbs/yr of Phosphorus, 1.7 lbs/yr of Nitrogen and 83 lbs/yr of sediment for every acre retrofitted with storm water best management practices. This translates to up to 70% in Nitrogen, 65% in Phosphorous and 36-99% in bacteria depending upon the specific BMP utilized.

Nutrient Reducing Recommendation Effectiveness Criteria 5: Effectiveness will be measured by the number of systems installed that are compliant with new stormwater regulations within the watershed.

Cost: The Watershed implementation plans generated for the St Jones and Broadkill watersheds cost $175,000 for each watershed. Actual retrofits costs can be high, particularly in older developments.

Potential Funding Source: State and federal grants.

Action Needed: The Department will work with the two Conservation Districts to identify areas that are suitable for stormwater retrofits by producing a watershed implementation plan.

6. Require Low Impact Development (LID) in new construction and development, including requiring any new development to achieve a stormwater flow and nutrient loading equal to or less than pre-development conditions. (High Priority)

Implementation Goal 6: Develop sediment and stormwater regulations that require nutrient reducing stormwater management practices**.**

Basis of Recommendation: LID is the integration of site ecological and environmental goals and requirements into all phases of urban planning and design, from the individual residential lot level to the entire watershed. LID varies from traditional stormwater practices; it reduces runoff volumes by attempting to maintain pre-development hydrologic conditions. LID practices include, but are not limited to green roofs, pervious pavers, bioretention areas, grass swales, rain gardens and minimizing impervious area. These practices increase runoff infiltration, storage, filtering, evaporation and detention onsite.

Since 1991, stormwater runoff from new development is regulated under the Delaware Sediment & Stormwater Regulations, administered by the Division of Watershed Stewardship. As stormwater moves over land, it picks up natural and human-made pollutants from lawns, streets, parking lots, and industrial and commercial facilities, eventually depositing them into the waters of the Greater Mispillion. Stormwater management is the primary way to control nonpoint source pollution from developed areas. A variety of methods can be used to control and treat runoff from lawns, homes, parking lots, roads, and commercial and industrial facilities. Some of these methods reduce nutrient loading from stormwater more than others. When possible, these methods should be preferred. However, there may be instances where the pollutant of most concern on the site would not be reduced sufficiently by the most effective nutrient removal technique. In these cases, the method used should be the best at treating the removal of the pollutant of most concern. Reducing stormwater impacts within the Mispillion and Cedar Creek Watersheds will require all stakeholders to implement innovative management techniques.

Additionally, the report "Governor Minner's Task Force on Surface Water Management" recommends including nutrient reduction as an aspect of sediment and stormwater law. As part of recommendations 10 A and B, it is suggested that State Sediment and Stormwater Regulations and plans be updated to include requirements for stormwater recharge, runoff volumes, land use cover conditions, turbidity limits, adequate conveyance, and pollutant loads. The Sediment and Stormwater Regulations are currently under revision and will be modified to better address volume management by increasing emphasis on recharge and infiltration of stormwater, where it is technically and environmentally feasible. In addition, regulations should include design criteria to reduce nutrient contributions through practices such as comparing post development conditions with and without stormwater quality controls, using treatment trains of stormwater controls, and/or reducing impervious cover.

Implementation Schedule: Regulations to be promulgated by December 2013.

Expected Reduction: This action will only impact new construction. DNREC is currently conducting an assessment to determine what nutrient reductions have been achieved in other jurisdictions from LID approaches.

Nutrient Reducing Recommendation Effectiveness Criteria 6: Effectiveness will be measured by the number of new developments installed that are compliant with new stormwater regulations within the watershed.

Cost: Approximately $200,000 for consulting services for regulation development.

Potential Funding Sources: The development community and ultimately buyers of lots in new housing developments.

Action Needed: Promulgate the new Sediment and Stormwater regulations.

7. Implement a Stormwater Utility

Implementation Goal 7: Institute a stormwater utility within the Mispillion River and Cedar Creek Watersheds.

Basis of Recommendation: A stormwater utility is a special assessment district set up to generate a stable source of funding for stormwater management within a region, usually through user fees. A stormwater utility should be considered to manage stormwater runoff from residential and commercial parcels. One or more stormwater utilities should be established, perhaps one for each watershed – Mispillion and Cedar Creek. A consideration for implementation of this recommendation is that some residents may object to paying fees to cover stormwater runoff issues that they do not feel they are creating.

Former Governor Minner's Task Force on Surface Water Management quantified the statewide financial need for stormwater management. "The Finance Subcommittee identified stormwater capital requirements of $207.3 million over the next five years and projected annual maintenance requirements of $13.73 million" (DNREC, 2005). The Task Force further recommended that a stormwater utility operating at the county or local level should be formed as a funding vehicle for the purpose of providing a simplified and comprehensive

approach to drainage and flooding problems. A stormwater utility is an approach that can generate a stable source of funding for stormwater management within the region. The funds are made available by collecting user fees. Stormwater utility fees are generally set by the amount of impervious cover on each resident's property. The higher the impervious cover the higher the fee. GIS mapping will be utilized to measure impervious surface generated by residential and commercial development, and the utility fee will be charged based on the property's Equivalent Runoff Unit (ERU).

The Sediment and Stormwater Regulations serve as an enabling structure for the local ordinances needed in order to set up the utility. For example, the City of Wilmington has established a stormwater utility for residential and commercial customers in the municipality where all properties pay a stormwater charge based on their impervious cover.

Implementation Schedule: Implementing this goal will take some time because of current economy and is affected by the promulgation of the new stormwater regulations. Kent County may develop a stormwater utility program within a couple of years.

Expected Reduction: Nutrient reductions cannot be assigned to this recommendation, as it is a mechanism for funding practices, not for implementing a practice.

Nutrient Reducing Recommendation Effectiveness Criteria 7: Effectiveness will be measured by whether a stormwater utility is established in the watershed.

Cost: DNREC, Kent County and Kent Conservation District requested a level of service analysis and investigation of the stormwater service district for Kent County that was conducted. URS, Inc. received the contract for the analysis, which cost $75,000.

Potential Funding Source: Kent County and Sussex County

Action Needed: The Department will assist the County or any other municipality who may be interested in implementation of a stormwater utility in their jurisdiction.

8. Vegetated Buffers

- When land changes from agriculture to developed land, to reduce or eliminate nonpoint source pollution for lots abutting waters in the watersheds, require vegetated buffers of 100 feet from the top of the stream bank for the primary streams and 60 feet for the secondary streams.

- Develop an incentive program for existing developed land to install vegetated buffers.

Implementation Goal 8: Require 100 foot riparian buffer from top on bank.

Basis of Recommendation: Buffers help to filter nutrients and slow overland stormwater flow. Kent County has issued several ordinances related to development and buffers, however, County setbacks are not required to be vegetated. Vegetation of the buffer will slow water flow and increase nutrient uptake. Nutrient reduction is a function of buffer type (grassed, forested or combination) and the width of the buffer.

Kent County has promulgated several ordinances related to development and buffers, including an ordinance requiring 100-foot setbacks from tidal and blue line streams and a 50-foot setback from shoreline or top of bank of steep slopes, of any stream, creek or drainage ditch.

Sussex County requires a fifty foot buffer landward from the mean high a waterline of tidal waters, tidal tributary streams and tidal wetlands and from the ordinary high water line of perennial nontidal rivers and nontidal streams (§115-93 amended in 1991 by ordinance 774).

Table 12 – Kent County Ordinance (187-78) required setbacks from water bodies

Waterbody type	Distance in feet	Requirements	Planting required
Tidal	100 from shoreline (as defined by mean high – water line)	No Buildings, structures, paved surfaces, except stairs, ramps, patios, or docks less than 200 square feet	No
Non-tidal freshwater body, lake, pond or "blue-line stream"	Same as above	Same as above	No
Any non-blue line stream, creek or ditch	50 from shoreline or top of bank	Same as above	No
Any TMDL promulgated basin	100 from center line of stream	Requires preservation or reestablishment of riparian buffer	Maybe required

Developers should be required to protect existing and/or provide new buffers if necessary as community open space, however, the responsibility for buffer maintenance will fall to civic and homeowners associations or maintenance corporations, not individual homeowners. Buffers should be planted and designed to require minimal maintenance. In addition, buffers should be planted with native species in an effort to ease maintenance, reduce erosion and increase nutrient uptake capabilities. The developer must also guarantee all trees planted in the development remain living for the first year or offer replacement plants as individuals are lost.

From GIS analyses within two watersheds (Murderkill and St Jones) in Kent County, DNREC believes that requiring a 100 foot buffer from the top of bank for perennial streams and tidal waters and 50 feet from intermittent streams, that no additional land would be removed from development opportunities since the Kent County ordinance already requires this identical setback on non-TMDL watersheds, but are not required to be planted. DNREC believes that Kent County wanted to give TMDL waters a higher level of protection than non-TMDL waters by requiring100 setbacks from center line of streams and maintaining or re-establishing riparian buffers. As applied, however, the County's TMDL ordinance is less protective than its non-TMDL setback requirements.

In Sussex County, its fifty foot buffer requirement from the mean high a water line of tidal waters, tidal tributary streams and tidal wetlands and from the ordinary high water line of perennial-nontidal rivers and nontidal streams may not adequately protect water quality.

Sussex County should consider requiring a 100 vegetated buffer from the mean high water line.

Implementation Schedule: July 2013

Expected Reduction: Nutrient reduction is a function of buffer type (grassed, forested or combination) and the width of the buffer. Nitrogen reductions can range from 2.5 to 70%; reductions in phosphorus can range from 3.6 to 66%; reductions in bacteria can range from 43-57%. For each acre of 100 foot wide buffer installed, 0.004 lbs per day of total phosphorus and 0.18 lbs per day of total nitrogen could be reduced.

Nutrient Reducing Recommendation Effectiveness Criteria 8: Will be measured by the number of acres of riparian buffer established with appropriate vegetation.

Cost: One acre of riparian buffer costs $570 to implement.

Potential Funding Sources: Developers should be required to protect existing and/or provide new buffers if necessary as community open space: however, the responsibility for buffer maintenance will fall to civic and homeowners associations or maintenance corporations, not individual homeowners. Buffers should be planted and designed to require zero or minimal maintenance. The developer must also guarantee all trees planted in the development for the first year.

Action Needed: The Department will work with Kent and Sussex Counties and other municipalities within the Mispillion and Cedar Creek Watersheds to develop buffer regulations that would be protective of water quality.

9. Administer Smartyard Programs for Homeowners

Implementation Goal 9: Develop education program homeowners similar to Smartyards.

Basis of Recommendation: DNREC should work with landscape designers and the Delaware Nature Society to educate homeowners in the watershed on what Smartyards are and to provide incentives to and assist homeowners to conduct soil tests and to plant water friendly native landscaping to conserve water and reduce fertilizer and pesticide use. The Smartyard program would include rain barrels for interested and qualified homeowners according to set goals identified in each watershed. A concerted education and outreach effort needs to be implemented to make this recommendation most effective.

Smartyards is a unique component of the Delaware Nature Society's Backyard Habitat program, through which participants discover how to provide an oasis for local birds, butterflies, and other wildlife while helping to ensure the health of our streams and rivers. At no cost to participants, Smartyards provides official certification for properties where owners meet the four criteria necessary for wildlife habitat: food, cover, water, and places for wildlife to raise young. Certified habitats may range from those meeting the minimum requirements, such as a small urban balcony or rooftop, to extensive naturalized areas that meet a variety of wildlife needs. By adopting practices beneficial to wildlife such as planting native species, limiting use of chemical fertilizers and pesticides, reducing the size of lawn areas, and better maintaining small areas of forest or wetlands if located in backyards,

participants help to improve local water quality. Smartyards provide habitat for a greater diversity of wildlife species, prevent the pollution of runoff from urban and suburban yards, and reduce the quantity of runoff more than traditional turf grass landscapes. Participants begin to make the connection that the wildlife in their yards is a part of the natural environment of their community, which includes the Cedar Creek and Mispillion River and its streams and tributaries.

The Delaware Nutrient Management Commission (DNMC) is the controlling authority for fertilizer application on parcels of land greater or equal to 10 acres within the State. The Nutrient Management Law requires nutrient applicators of 10 acres or more to be certified. Requiring applicators to log the amount of nutrients they are applying will help to track the amount of nutrients being applied to individual non-agricultural properties. The DMNC has also recognized that significant contributions of nitrogen and phosphorous come from land parcels less than 10 acres in size. In response to this knowledge, the DNMC has produced a brochure on proper lawn maintenance. These brochures have been placed in most retail outlets that sell fertilizer in the watershed. In addition, an advertisement was broadcast on local television station reminding people about proper lawn nutrient application and urging people to get a soil test done prior to applying fertilizer.

Lawn care companies must be in compliance with the Nutrient Management Act requirement for turf management. Requiring soil tests by lawn service companies would ensure only the necessary amount of nutrients are being applied to lawns.

Another program that the Department has become a founding partner of is Delaware Livable Lawns. The Delaware Livable Lawns Program certifies lawn care companies that follow environmentally-friendly practices in fertilizer application while educating homeowners. While many homeowners may be unaware of how, when, and how much fertilizer to apply, professional lawn care staff have the expertise to fertilize lawns correctly. Certified Delaware Livable Lawns companies go a step beyond the current regulations that govern fertilizer use by following environmentally-friendly practices resulting in healthy lawns *and* healthy water. In addition, the Delaware Livable Lawns program has a residential education portion to educate homeowners as to their responsibility when it comes to fertilizer application and how what they do on their lawns can affect us all.

The Delaware Livable Lawns Program is administered by the Delaware Nursery & Landscape Association (DNLA), a leader in Delaware's $745 million Green Industry. The DNLA is a non-profit trade organization serving Delaware's horticultural related businesses and the companies that supply them. The DNLA's mission is to advance the common interests of its members and to promote the use, and enhance the quality, of the products and skills of the green industry. The DNLA also works in cooperation with the Delaware Department of Agriculture and Delaware Cooperative Extension to shape legislative and administrative policies and procedures on matters that are of interest to Delaware's Green Industry.

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- US Department of Agriculture Natural Resources Conservation Service
- University of Delaware Institute for Public Administration Water Resources Agency
- University of Delaware Cooperative Extension
- Delaware Grounds Management Association
- Delaware Nursery & Landscape Association

Expected Reduction: 0.11 of N and 0.04 lb per acre lot of P for Smartyard landscaping.

Nutrient Reducing Recommendation Effectiveness Criteria 9: Will be measured by the number dwellings received stormwater education within the watershed.

Cost: The average cost of installing Smartyard landscaping in residential lawns in the Appoquinimink watershed has been $956.20 per ¼-acre yard. This is an average of the total costs of 20 projects in the fall of 2004 and 20 projects in spring of 2005. Therefore, based on this initial cost, the cost of the nutrient reductions is $34,933/lb N and $95,272/lb P on an annual basis. These high costs are obviously excessive per pound of nutrients reduced because of the first year's cost of installation, staff time and educational materials. The annual maintenance and operation costs will undoubtedly be a small fraction of the original installation cost, so the nutrient reduction cost should decrease considerably in successive years.

Cost of the Delaware Liveable Lawns program was $40,000 for the first year and will be $25,000 each year thereafter.

Implementation Schedule: Delaware Liveable Lawns program started in January 2011.

Potential Funding Source: Delaware Liveable Lawns Program was funded initially through DelDOT. The Department will work with partners including the County and local governments to apply for grants for this work.

Action Needed: The Department will continue its education efforts for stormwater management and will assist Kent County and municipalities with their education efforts.

10. DNREC and the Sussex and Kent County Conservation Districts should educate Home Owners' Associations (HOAs) and their contractors regarding stormwater requirements and regulations and enforce the regulations.

Implementation Goal 10: Develop an education program for stormwater management throughout the watershed.

Basis of Recommendation: Provide educational resources (i.e. a detailed booklet) about proper maintenance for HOAs and other groups maintaining stormwater structures. Since 1991, stormwater runoff from new development is regulated under the Delaware Sediment & Stormwater Regulations, administered by the Division of Watershed Stewardship. As stormwater moves over land, it picks up natural and human-made pollutants from lawns, streets, parking lots, and industrial and commercial facilities, eventually depositing them into the waters of the Mispillion River and Cedar Creek . Stormwater management is the primary way to control nonpoint source pollution from developed areas. A variety of methods can be used to control and treat runoff from lawns, homes, parking lots, roads, and commercial and industrial facilities. Some of these methods reduce nutrient loading from stormwater more than others. Reducing stormwater impacts within the Greater Mispillion will require all stakeholders to implement innovative management techniques.

Implementation Schedule: Develop or institute a stormwater education plan by 2013 after the new Sediment and Stormwater Regulations are in place.

Expected Reduction: Nutrient reductions cannot be assigned to this recommendation, as it is a mechanism for education.

Nutrient Reducing Recommendation Effectiveness Criteria 10: Will be measured by the number of dwellings that received stormwater education within the watershed.

Cost: Unknown at this time and is a function of program developed.

Potential Funding Source: State and/or Federal grants.

Action Needed: The Department will continue its education efforts for stormwater management and will assist Kent and Sussex County as well as municipalities with their education efforts.

11. DNREC should increase compliance with regular inspections and required pump-outs of individual On-site Wastewater Treatment and Disposal Systems (septic systems).

Implementation Goal 11: Have all the septic systems within the watershed inspected once every three years.

Basis of Recommendation: Currently septic permits require that the systems be pumped out every three years, or when the system contains at least 30 percent solids. The Department's Groundwater Discharges Section in the Division of Water has the authority to implement this recommendation through a revision of the regulations governing the design, installation, and operation of on-site wastewater treatment and disposal systems (OSWDS).

Additionally, the Department has authority to regulate OSWDS. On July 11, 2003 the Governor signed House Bill 150 into law, which authorizes the Department to establish a license for persons who inspect systems and other OWTDS, and sets an annual license fee for septic system designers, installers, site evaluators, liquid waste haulers, inspectors and percolation testers, similar to other license fees charged by the Department. On January 1, 2006, DNREC developed and implemented the Class H license for a septic system inspector. Following the inspection, the inspector provides the homeowner/resident with educational materials and receipt of pump out.

The watershed currently has 8,441 OSWD systems within its boundaries. If all systems are pumped once every three years, as required by state regulations, then 2,814 systems are pumped annually. The soils in the watershed are mostly well drained, so the actual TP reduction will likely be significantly less. Each system pumped out would reduce TP and TN surface and/or groundwater load by 1.40 lbs/system/year and 3.62 lbs/system/year respectively.

Implementation Schedule: Have routine inspection occurring by July 2013.

Expected Reduction: Requiring all the septic tanks (8,441) to be pumped out once every three years would result in reductions of 19.47 lbs/day of TN and 7.80 lbs/day of TP.

Nutrient Reducing Recommendation Effectiveness Criteria 11: Effectiveness will be measured by the number of pumped-out systems within the watershed.

Cost: DNREC's Small Systems Branch (personal communication, 2006) revealed that the installation of best available technologies (BATs) to existing small (<2,500 gallon per day (gpd)) OWTDSs for advanced nitrogen removal would cost between $3,500 and $6,000 per system with an average of $4,750. These technologies require a service contract by a certified service provider with an estimated annual cost that ranges from $150 to $300, with an average cost of $225/system/year. In addition, the systems will still require pump-outs, which cost $64/system/year (DNREC small System Branch, personal communication, 2007), and will need periodic mechanical parts repaired, estimated to cost $50/system/year and the electric cost of running the system is likely to also cost about $50/system/year (DNREC Financial Assistance Branch, personal communication, 2007). Costs are not currently available for the retrofit of larger systems.

Potential Funding Sources: The landowner will pay the cost of these systems. Cost-share funds may be found to assist those of middle-income and below. At present, State Revolving Fund (SRF) money and Septic Rehabilitation Loan Program funds may be used to provide low interest loans to property owners that need to replace a failing system.

Action Needed: With the promulgation of the new proposed Regulations Governing the Design, Installation, and Operation of On-site Wastewater Treatment and Disposal System by the end of 2013, the Department believes that this recommendation will be met if the new regulations are promulgated. If the new on-site wastewater treatment and disposal system regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

12. A statewide ban on phosphorous in residential fertilizers should be enacted by the General Assembly.

Implementation Goal 12: General Assembly passes a statewide ban on phosphorous in residential fertilizers.

Basis of Recommendation: Most residential yards do not require additional phosphorous to be healthy and green. An exemption to the ban should be allowed if a soil test shows that the lawn has low levels of phosphorous. Laboratory analysis results show that the tons of P_2O_5 sold in Delaware for non-farm use have decreased from 810 tons per year in 2005 down to 66 tons per year in 2010, which is a 92% reduction. DNREC and DDA believe that the decline is due to the phosphorus ban in home use fertilizers implemented in neighboring states. Delaware is within the same marketing region as neighboring states and so benefits from the ban implemented in those states. A survey by staff as well as a survey conducted by the Livable Lawns Program in 2011, found that local suppliers of home-use fertilizers, such as Lowes, Home Depot and Southern States no longer carry just products with high levels of phosphorus.

In light of these results and based on availability of fertilizers and existing law and program in place, Delaware now feels that regulating residential fertilizer use is an unnecessary contingency. All available lawn fertilizers sold in Delaware comply with standards set by surrounding jurisdictions with P Bans.

Cost: Cost of fertilizers without phosphorous is similar to current fertilizer costs, there should be no significant cost impact to homeowners.

Potential Funding Sources: Not needed.

Action Needed: None.

13. Limit Impervious Cover

- Require all new residential and commercial development to have an impervious cover mitigation plan when surface imperviousness exceeds 20%.
- Require all commercial developments with a large percentage of total land in parking surface to have at least 50% of the parking area in pervious paving materials or achieve an equivalent level of permeability.

Implementation Goal 13: Implementation of new proposed Sediment and Stormwater regulations which will reduce impervious cover.

Basis for Recommendation: Impervious cover is any surface in the landscape that cannot effectively absorb or infiltrate rainfall. This includes: driveways, roads, parking lots, rooftops, and sidewalks. Effective impervious cover is the percentage of the total impervious cover that is directly connected to the storm drain system. Impervious cover that drains to vegetated areas where stormwater can infiltrate, or be filtered and stored, is not considered part of the effective impervious cover. The infiltration and filtering of stormwater runoff is dependent on the quantity and quality of the soils on site, while stormwater storage is

dependent on the design and capabilities of the constructed on-site stormwater management system.

Studies have shown that a strong relationship exists between increases in a watershed's imperviousness and decreases in the overall water quality of the streams and/or water bodies draining that watershed. Also, studies have consistently shown that water quality irreversibly declines when the critical threshold level of surface imperviousness in a watershed exceeds 10%. Therefore, local ordinances should be established to mitigate or limit surface imperviousness. DNREC and/or local governments will need to develop guidelines for impervious cover mitigation plans.

In 1992, The Cedar Creek Watershed impervious cover was estimated to be 2% which increased to 3.2% by 2007. Mispillion Watershed impervious cover was 5% in 1992 and 5.8% in 2007. Kent County Code presently allows 20 percent of each lot to be covered by impervious surfaces; however this allotment does not include streets or other impervious areas outside the lot boundary in the calculation. In Sussex County, impervious cover is limit to 15% or less and in excellent groundwater recharge areas and well head protection areas impervious cover is limited to 35%.

Recent research has revealed a strong relationship between impervious cover and various indicators of stream quality. When porous land cover is converted to impervious cover, a greater fraction of annual rainfall is converted to surface runoff, and a smaller volume recharges the groundwater. This increased surface runoff volume causes higher peak flows that erode stream channels and lower baseflow, which ultimately results in in-stream habitat degradation. In addition, surface runoff carries a suite of pollutants that can degrade water quality.

Stream research generally indicates that at about 10% impervious cover, sensitive stream elements are lost from the system. A second threshold appears to exist at around 25-30% impervious cover, where most indicators of stream quality consistently shift to a poor condition. The Center for Watershed Protection has developed the following stream classification (Table 13) based on the relationship between impervious cover and stream health.

Table 13 – Impervious Cover Classification
Sensitive ***Less than 10% Impervious Cover***
Typically high quality streams (though rurally-impacted watersheds will have low impervious cover).
Generally have stable channels, excellent habitat structure, good to excellent water quality, diverse communities of both fish and aquatic insects.
Do not see frequent flooding and other hydrological changes associated with urbanization.
Impacted ***From 11% to 25% Impervious Cover***
Show clear signs of degradation due to watershed urbanization.
Greater storm flows begin to alter the stream geometry.
Both erosion and channel widening are clearly evident.
Stream banks become unstable, and physical habitat in the stream declines noticeably.
Stream water quality shifts into the fair/good category during storms and dry weather.

Stream biodiversity declines to fair levels, fewer sensitive fish and aquatic insects.
Non-supporting ***Greater than 25% Impervious Cover***
Streams essentially conduits for conveying stormwater flows
Stream channel becomes highly unstable, and many reaches experience severe widening, down-cutting and streambank erosion.
Pool and riffle structure diminished or eliminated, and the stream substrate can no longer provide habitat for aquatic insects, or spawning area for fish.
Water quality often rated fair to poor, and water contact recreation not possible.
Subwatersheds generally display increases in nutrient loads to downstream receiving waters, even if effective urban stormwater treatment practices are installed and maintained.
Biological quality is generally considered poor, dominated by pollution tolerant species.
Source: CWP, 2005

With the potential for future growth to affect the water quality of the rivers, streams, and ponds of the Mispillion and Cedar Creek Watersheds, regulations need to include impervious cover limits for new subdivisions and major land disturbing activities. Regulations need to prevent impervious cover levels over 50% and for impervious cover levels over 20%, there needs to be an environmental impact assessment report and mitigation to ensure water quality protection.

The new State Sediment and Stormwater Regulations are expected to limit some of the negative effects of impervious cover by virtue of the requirement that stormwater must be infiltrated rather discharged through a conveyance system. If infiltration is not possible on the site, the stormwater treatment on site must have several best management practices designed to reduce the stormwater nutrient and bacteria load. As for existing property that will be redeveloped, unless new construction will be undertaken on the property, no reduction of impervious cover will result. The exact nature that impervious cover will be dealt with through the revised regulations.

The Department recommends that the effective impervious cover be reduced on redeveloped properties.

Implementation Schedule: By December of 2013

Expected Reduction: By limiting effective impervious cover as lands are developed, the impacts on water quality will be reduced. A specific numeric reduction is not currently available.

Nutrient Reducing Recommendation Effectiveness Criteria 13: Effectiveness will be measured by the number of practices and amount of impervious cover installed that are compliant with new stormwater regulations within the watershed.

Cost: Mitigation of impervious cover may be very expensive.

Potential Funding Source: In a study funded by DNREC (1997), the Brandywine Conservancy demonstrated that by reducing road and driveway widths and minimizing the disturbance boundary in developments in Kent County, the developer could reduce impervious cover 24% and at the same time reduce development costs by 39%.

Action Needed: With the promulgation of the new proposed Sediment and Stormwater Regulations by the end of 2013 the Department believes that this recommendation to establish watershed-wide limit for impervious coverage will be met.

Recommendations Providing Incentives for Additional Agricultural Practices

14. Animal Feeding Operations with inadequate land to apply animal waste to land and farms with high phosphorous soils should continue to relocate nutrients to farms in need of nutrients or send manure to alternative use facilities.

Implementation Goal 14: Maintain and improve Delaware's manure relocation program.

Basis for Recommendation: Relocating manure to farms in need of nutrients outside of the watershed or to alternative use facilities, such as the pelletizing plant in Seaford, eliminates all potential for nutrient runoff from the manure. Funding for this program needs to be increased or, at a minimum, maintained. In addition to manure relocation, the Department of Agriculture should increase its oversight of nutrient management plans, to ensure that the plans are being adhered to.

The Nutrient Management Law controls the minimum set of management practices that are included in nutrient management plans. In regard to phosphorus in soils, it is important to note that Delaware's NMP's are P-based and have been for many years. The application of phosphorus is limited on high phosphorus soils, and utilizes a three year crop removal policy to restrict P-application in certain conditions on high P-soils. High phosphorus soils are determined based on the P-Site Index analysis. In the absence of phosphorus data, yield based assessments are conducted using the four highest yield goals out of the last seven years. In addition to the phosphorus and nitrogen limiting plans, Delaware has a manure relocation program aimed at reducing phosphorus in soils. To obtain appropriate agronomic rates for application of manure, biosolids, and organic byproducts, the Nutrient Management Plan incorporates soil testing, manure testing, phosphorus index, and crop needs. Delaware allows three and one year NMPs, with the majority being one year plan. In addition, feedback from NMP writers indicates that most Delaware's producers and NM Consultants are utilizing yearly soil test data regardless of plan length. Winter application of nitrogen and phosphorous (organic or chemical based) is not permitted between the dates of December 7 and February 15.

Penalties for noncompliance with the provisions outlined in the Nutrient Management Law are listed within State of Delaware Code Title 3 Chapter 22, Nutrient Management Law Subchapter V. Enforcement, Suits for Enforcement, and Incentives. Fines range from $50 to $1,000 per violation. Final fines and penalties are addressed through the Delaware Nutrient Management Commission. Compliance audits are conducted in response to complaints made to the Delaware Nutrient Management Program.

Expected Reduction: 40% reduction in nitrogen, 70% reduction in phosphorous from manure relocation and alternative uses. As a result of the Delaware's manure relocation program, the Mispillion and Cedar Creek Watersheds exported 1,179 tons of manure and imported 1,163 tons of manure to address the nutrient needs of crops in non-high-phosphorus soils. This resulted in as net increase of 7.4 lbs of N per year and 0.013 of P per year being

imported into the watershed. The nutrients imported were under a nutrient management plan which restricts phosphorus applications high-phosphorus soils and the nitrogen was not in excess of crop needs.

Nutrient Reducing Recommendation Effectiveness Criteria 14: Effectiveness will be measured by the number of acres in participation in the Nutrient Relocation Program within the watershed.

Cost: $12.93/ton (100% cost share), which equates to $2.31/lb of TN reduced, $23.11/lb TP reduced.

Potential Funding Sources: NRCS, State of Delaware Cost Share, DNREC Watershed Assessment, and/or NPS Program 319 Funding.

Action Needed: Maintain current funding level for manure relocation program but increase funding over time.

15. The DNREC Non-Point Source Program should develop a plan that identifies prioritized locations to offer incentives for Riparian Forested Buffers and other agricultural BMPs.

Riparian forested buffers are areas of trees and/or shrubs located adjacent to and up gradient from water bodies. They are very effective in reducing sediment-bound phosphorous from entering waterways. Lands should be prioritized based on the ability to achieve the most nutrient reductions if converted to riparian forested buffers.

Implementation Goal 15: Develop a Geographic Information System database of farm fields to improve their ability to coordinate and effectively manage agricultural NPS pollutant reductions.

Basis of Recommendation: Riparian forested buffers are areas of trees and/or shrubs located adjacent to and up gradient from water bodies. They are very effective in reducing sediment-bound phosphorous from entering waterways. Lands should be prioritized based on the ability to achieve the most nutrient reductions if converted to riparian forested buffers.

The establishment of best management practices on agricultural land will address nutrient inputs from all facets of agricultural operations, including the use of manure from animal operations and fertilizers for crops. The environmental and quality of life benefits of agriculture should be recognized as a way to encourage and enforce BMP implementation. Encourage the use of buffers on agricultural lands where best nitrogen and phosphorous uptake is likely. By targeting areas for BMP implementation geographically, more effective and efficient nutrient reductions can be expected.

The Kent Conservation District with funding from Delaware's 319 Non-Point Source Program developed a Geographic Information System database of farm fields to improve their ability to coordinate and effectively manage agricultural NPS pollutant reductions. The spatial database will facilitate a more efficient:

- Consolidation of information from the numerous agricultural agencies that develop and administer BMP and conservation practices;
- Approach to highlighting the geographic location of all existing BMP and conservation practice locations in a designated watershed; and
- Utilization of watershed planning tools capable of targeting and ranking farm field properties for various BMP and conservation practice implementation.

This Geographic Information System database was developed to identify and target farm field sites for potential enrollment in various state and federal agricultural voluntary cost-share programs that address nutrient nonpoint source pollutant loading. This Tool will allow the District and its state and federal partner agencies to maximize the limited implementation funds and planning resources earmarked for potential agricultural NPS loading sources within the Mispillion and Cedar Creek Watersheds.

Implementation Schedule: Have a Geographic Information System database of farm fields in place by the fall of 2013.

Expected Reduction: Specific BMPs that are used in the Mispillion and Cedar Creek Watersheds have many beneficial nutrient reducing capabilities as follows:

- Cover crops protect soil when row crops are not being grown. This practice helps retain nitrogen in the soil for the next crop reducing fertilizer costs to the farmer.
- Grassed filter strips and grassed buffers trap sediments in surface runoff and take up excess nutrients.
- Ponds capture nutrient losses from upland or cropped acreage.
- Riparian forested buffers reduce nutrient losses from upland acres and reduce sediment bound phosphorous from entering waterways.
- Wetland restoration reduces nutrient loss from upland acres.
- Field border plantings trap sediment in surface runoff and take up excess nutrients.
- Manure relocation removes significant amounts of excess manure, consequently removing excess nutrients.

As of July 2012, agricultural best management practices on the ground in the Mispillion and Cedar Creek Watersheds have reduced phosphorus loads by 21.0 lbs per day or 58 percent of the way towards the total phosphorus load goal and 777.9 lbs per day of total nitrogen or 58 percent of the way towards the nitrogen TMDL reduction load goal.

Nutrient Reducing Recommendation Effectiveness Criteria 15: Effectiveness will be measured by the number of acres of riparian forested buffers and other agricultural BMPs installed within the watershed.

Cost: $176.51/ac/yr (87.5% cost share plus rental and maintenance reimbursements), $4.20/lb to reduce nitrogen, $126.33/lb to reduce phosphorous.

16. Increase the cost share for grassed filter strips and evaluate the pros and cons of allowing the grass to be cut for hay.

Implementation Goal 16: Increase acres of grass filter and buffers within the watershed.

Basis of Recommendation: Grassed filter strips are areas of vegetation between cropland and other land uses such as grazing land, disturbed lands, forests, pasture and environmentally sensitive areas. They are designed to trap sediments in surface runoff and take up excess nutrients. Increasing the number of grassed filter strips is advantageous, and increasing the cost share would provide incentives to create more strips. Similarly, allowing the grass to be cut for hay increases financial incentives for grassed filter strips.

Some USDA programs allow grass filter strips to be mowed and the grass removed as hay as required to maintain moderate vegetation height. Mowing two to three times per year may be necessary. The vegetation should not be mowed closer than 6 inches. If haying is not desirable (or allowed), more frequent mowing may be needed to prevent thatch buildup and smothering of vegetation. To avoid destruction of wildlife nesting areas, delay mowing until after mid-July. Fall mowing of the filter no closer than 6 inches will provide adequate winter habitat for wildlife.

Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) grassed filter strips and grassed buffers trap sediments in surface runoff and take up excess nutrients. These CRP/CREP practices are estimated to cost $300/acre for installation. The cost can be capitalized over the 10 year contract at a 3% interest rate to yield a cost of $35.17/acre/year. Land is rented for $65/acre/year and maintained at $5/acre such that the total expenses equal $105.17/acre/year. This equates to $12/lb TN and $524/lb TP reduced for both best management practices. The installation of these BMPs is cost shared at a total rate of 87.5%, such that the farmer must pay $4.40/acre/year of the capital costs. Reimbursement for land rental and maintenance provides for virtually zero cost to the farmer.

Implementation Schedule: Annual sign-up

Expected Reduction: TN: 10.1 lbs/day and TP: 0.24 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria 16: Effectiveness will be measured by the number of acres of grass filter strips and grassed buffers installed within the watershed.

Cost: $93.45/ac/yr (87.5% cost share plus rental and maintenance reimbursements), which equates to $11.01/lb Nitrogen reduced, $465.50/lb Phosphorous reduced.

Potential Funding Sources: FSA CRP/CREP and/or Delaware CREP Program

Action Needed: Maintain current funding level for grass filters and try to increase funding over time.

Education Recommendation

17. Develop and implement a comprehensive education program for homeowners, schools, churches, and other land owners for management of open spaces, yards, wastewater and stormwater. (High Priority)

Implementation Goal 17: Implement a comprehensive homeowner education program.

Basis of Recommendation: Based on 2007 land use data, a significant portion of Mispillion and Cedar Creek Watersheds is urban (13.3 percent) and much of it is turf. Over 10,322 acres of residential turf exists in the watershed and 58 percent of it is fertilized, usually with little forethought. The Greater Mispillion Tributary Action Team has identified residential activities as an important origin for nutrients in the Mispillion and Cedar Creek Watersheds and thus has made several recommendations to address this issue. Residential behavior is a difficult source to regulate, thus the Team's recommendations focus on providing education and outreach activities to change residential behavior and increase environmental awareness.

Changes in landowner behavior resulting from effective education efforts can result in a reduction in the amount of nutrients ending up in the Mispillion River and Cedar Creek. Education should include things such as the following:

- Educating residents on where their stormwater goes and what they can do to help reduce pollutants in their runoff.
- Education regarding the use of soil tests to the urban/suburban homeowner.
    - Work with the University of Delaware to revise their soil test results sheet for homeowners to make it easier to be understood and provide specific fertilizer application recommendations based upon existing fertilizer blends found within the State.
- Education regarding the negative impact of garbage disposals on septic systems and encouraging composting, both individually and regionalized.
- Water conservation measures, such as the ones listed below, to help reduce the amount of nutrients leaving individual properties.
    - Rain collection systems such as rain barrels and rain gardens.
    - Directing stormwater runoff from roofs and impervious surfaces onto grassy areas.
    - The use of water saving devices in and around the home.
    - The overall reduction of water usage in households and on lawns.
- In conjunction with the Delaware Nutrient Management Commission, Delaware Nature Society and the Master Gardeners, provide education and programs for homeowner's on lawn and garden best management practices., such as:
    - Proper mowing practices.
    - Leaving lawn clippings on the lawn.

- Encourage proper lawn care maintenance-leave a buffer along stream edge.
- Water conservation measures and stormwater BMPs for the lawn and garden.
- Encourage planting of native species.
- Discourage ideas that lawns need chemicals to be green.
- Proper use of lawn and garden chemicals (including natural fertilizers and compost).
- Use of compost rather than chemicals as a means of reducing synthetic chemical fertilizers.
- A demonstration project/workshop for homeowners on application of fertilizers and composting methods.

- DNREC and USDA Natural Resource Conservation Service should promote and provide education on their landowner programs such as CRP, CREP, etc.

DNREC's Sediment and Stormwater Program developed and completed a handbook for homeowners associations that can be used to learn how to maintain their stormwater plan. DNREC, as well as the agencies with delegated authority from the Sediment and Stormwater Program, are working with homeowners in forwarding this concept. The Kent and Sussex County Conservation Districts with cooperation from DNREC's Sediment and Stormwater Program and NEMO has held workshops for homeowners associations and residents in Kent and Sussex Counties.

The plan should consist of the following parts:

1. Identify values that are affecting residential activities and target those that will affect behavior change.
2. Encourage educational facilities with turf athletic facilities where nutrients are applied to develop nutrient management plan for their facility.
3. Develop an advertising strategy that promotes the use of soil tests to the urban/suburban homeowner.
4. Work the University of Delaware to revise their soil test results sheet for homeowners to make it easier to be understood and provide specific fertilizer application recommendations based upon existing fertilizer blends found within the State.
5. Education of fertilizer retailers such that retailers will pass out educational materials with purchase of fertilizer and will have available soil testing materials at their location.
6. Educate homeowners and homeowner associations on stormwater BMPs that can be used around the home to reduce impact on water quality.
7. Integrate education into various (State and local) permitting processes.
8. Create public information campaigns based upon goal of behavior change.
9. Support a demonstration project/workshop for homeowners on application of fertilizers and composting methods.

10. Support and encourage the use of water conservation measures like those below by individuals to help reduce the amount of nutrients leaving individual properties.
    - Gray water recycling (use of gray water around the home on plants and gardens, etc.).
    - Rain collection systems such as rain barrels and rain gardens.
    - Directing stormwater runoff from roofs and impervious surfaces onto grassy areas.
    - The use of water saving devices in and around the home.
    - The overall reduction of water usage in households and on lawns.
11. Work with the Delaware Nutrient Management Commission and the Master Gardeners to provide education and programs for homeowner's on lawn and garden best management practices such as:
    - Proper mowing practices.
    - Leaving lawn clippings on the lawn.
    - Leaving a buffer along stream edge.
    - Reduce lawn size.
    - Water conservation measures and stormwater BMPs for the lawn and garden.
    - Encourage use of native species and noninvasive species.
    - Discourage ideas that lawns need chemicals to be green.
    - Proper use of lawn and garden chemicals (including natural fertilizers and compost).
    - Use of compost rather than chemicals as a means of reducing synthetic chemical fertilizers.

Implementation Schedule: A plan should be developed by fall 2013 and implementation should start shortly thereafter.

Expected Reduction: Nutrient reductions cannot be assigned to this recommendation as it is a mechanism for education.

Cost: Unknown at this time and is a function of program developed and resources needed.

Potential Funding Source: To be determined.

Action Needed: The Department will continue to work with country and municipalities on providing educational outreach. The program could be operated from DUPONT Nature Center at mouth of the Mispillion River.

Recommendation Summary

	Nitrogen Load Reduction	Phosphorus Load Reduction
HIGH PRIORITY DEVELOPED LAND RECOMMENDATIONS		
1. A statewide ban on phosphorous in residential automatic dishwasher detergents should be enacted by the General Assembly.	NA	100%
2. Prioritize areas where failing individual, large, and community wastewater treatment and disposal systems can be eliminated by connecting to a Waste Water Treatment Plant or retrofitted to meet wastewater treatment plant performance standards	100%	100%
3. Require Nutrient Management Plans for open space greater than 10 total acres within a development.	10-15%	10-15%
4. DNREC should conduct a proactive search for and systematically eliminate cesspool and seepage pits	100% or 90%	100% or 90%
5. Identify areas where stormwater retrofits would effectively reduce sediment and nutrients	70%	65%
6. Require Low Impact Development (LID) in new construction and development, including requiring any new development to achieve a stormwater flow and nutrient loading equal to or less than pre-development conditions.	NA	NA
DEVELOPED LAND RECOMMENDATIONS		
7. Implement a Stormwater Utility	Varies	Varies
8. Vegetated Buffers 8a. When land changes from agriculture to developed land, to reduce or eliminate nonpoint source pollution for lots abutting waters in the watersheds, require vegetated buffers of 100 feet from the top of the stream bank for primary streams and 60 feet for secondary streams. 8b. Develop an incentive program for existing developed land to install vegetated buffers	2.5 – 70%	3 - 66%
9. Administer Smartyard Programs for Homeowners	Depends upon number and size of yards	Depends upon number and size of yards
10. DNREC and the Sussex and Kent County Conservation Districts should educate Home Owners' Associations (HOAs) and their contractors regarding Stormwater requirements and regulations and enforce the regulations	Ensures achievement of reductions associated with specific BMPs	Ensures achievement of reductions associated with specific BMPs
11. DNREC should increase compliance with regular inspections and required pump-outs of individual On-site Wastewater Treatment and Disposal Systems (septic systems)		NA
12. A statewide ban on phosphorous in residential fertilizers should be enacted by the General Assembly.		
13. Limit Impervious Cover 13a. Require all new residential and commercial development to have an impervious cover mitigation plan	Difficult to document	Difficult to document

when surface imperviousness exceeds 20%. 13b. Require all commercial developments with a large percentage of total land in parking surface to have at least 50% of the parking area in pervious paving materials or achieve an equivalent level of permeability.		
AGRICULTURE RECOMMENDATIONS		
1. Animal Feeding Operations with inadequate land to apply animal waste to land and farms with high Phosphorous soils should continue to relocate nutrients to farms in need of nutrients or send manure to alternative use facilities.	40%	70%
2. The DNREC Non-Point Source Program should develop a plan that identifies prioritized locations to offer incentives for Riparian Forested Buffers	62%	62%
3. Increase the cost share for grassed filter strips and evaluate the pros and cons of allowing the grass to be cut for hay	46%	54%
HIGH PRIORITY EDUCATION RECOMMENDATION		
1. Develop and implement a comprehensive education program for homeowners, schools, churches, and other land owners for management of open spaces, yards, wastewater and stormwater.	Unknown	Unknown

Analysis for TMDL Achievement and Cost

Promulgation of this Pollution Control Strategy and full implementation of its elements should lead to the achievement of the TMDLs for Total Nitrogen (TN) and Total Phosphorus (TP). Because of the lag time between seeing improvements in ground and surface water quality, estimated to be up to 30 years, improved water quality conditions will not be realized immediately. The Department will continue to monitor water quality as will many citizen volunteers. The Department is committed to revisit this Pollution Control Strategy in 10 years to ensure that water quality is improving with implementation of the regulations and voluntary practices called for within this document.

Analysis using a basic land use loading rate model shows that, to date, nonpoint sources of TN and TP have been reduced by 53% and 108%, respectively (See Figures 8 and 9) but when the reductions from implementing the proposed PCS are included 100% of the required TMDL reductions will be achieved. Voluntary programs for installation of agricultural best management practices have been extremely successful as well as the County's and local governments' efforts to protect open space and riparian buffers. Implementation of the Delaware Sediment and Stormwater Law has also led to decreases in nutrient loading; however, the full impact is not shown here because some sediment and stormwater practices known to be in place are not yet captured in a database and therefore, not considered in these calculations.

The Total Phosphorus reduction is easily achieved in the Mispillion and Cedar Creek Watersheds, but the required Total Nitrogen reduction is much more difficult to achieve. The existing best management practices only reduced the total nitrogen load to the Mispillion River and Creek by 804 pounds and an additional 760 pounds of total nitrogen is still needed in order to meet required TMDL of 1703 pounds per day reduction. Those additional 660 pounds will come from converting dry ponds into bioretention facilities, by requiring the septic systems to

meet performance standards, significantly by increasing cover crop acreage, and by increasing acreage of wetland restoration and grass buffers and filter strips on creation on both public and private lands. Connecting septic systems to the Kent County wastewater treatment facility will also reduce the nitrogen load to the St. Jones. Table 14 lists the acreage needed from the various best management practices in order to achieve the required TMDL reduction.

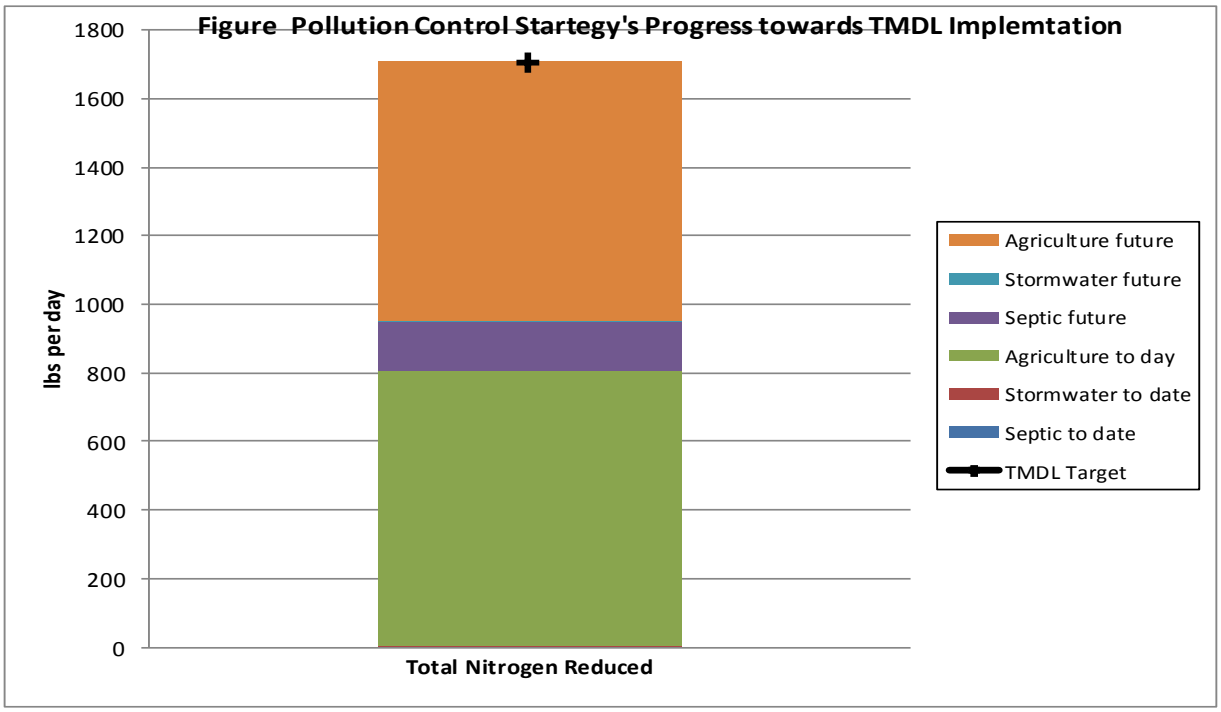

Figure 8 – Nitrogen TMDL Progress

Figure 9 – Phosphorus TMDL Progress

While current implemented practices have done a lot to reach the required reductions, it is important to note that there are practices that are still necessary to keep the watershed healthy and meeting it's TMDL. The most important area for future implementation is wastewater. This includes requiring existing septic tanks to be pumped out at time of property transfer and preferably once every three years, continuing to connect existing septic tanks to sewer systems and implementing technologies that will allow systems to meet performance standards to remove nutrients. In addition, realizing that development is still occurring throughout the watershed and stormwater best management practices are required, future BMP implementation must move away from practices that only deal with water quantity, but also provide significant water quality benefits. Also, the strategy is based on the maintenance of agricultural practices currently in place as well as the continued push towards open space and riparian buffer preservation. Adding these future practices help the Mispillion waters to reach their TMDL reductions as seen in Figures 8 and 9 and Table 14.

Table 14 – Best Management Practices Goals for Achieving the Mispillion and Cedar Creek Watersheds TMDL Reductions

Best Management Practice	Acres	Total Nitrogen Reduced (lbs/day)	Total Phosphorus Reduced (lbs/day)
Urban			
Dry Pond conversion to Bioretention practice	514	3.47	0.19
Implement performance standards of septic system on all systems		143.61	8.21
Total proposed reduction		**147.08**	**8.40**
Agriculture			
Cover Crops	20,417	605.92	1.10
Grass buffers and filter strips on public and private land	1081.5	42.66	4.77
Forested buffers on public and private lands	1500	21	4.5
Wetland Restoration	875	122.26	2.62
Total proposed reduction		**760**	**10.38**

Overall, this strategy costs close to $166,950,000 including capital expenditures plus annual operation and maintenance costs of various best management practices. Of this strategy total, about $20,000,000 has already been paid for the installation of current practices. Figure 10 shows the total strategy costs for each category of BMP including current and future practices.

Every effort has been made to make the Strategy fair and equitable. It impacts everyone in the watershed given that all activities contribute to nutrient loading. And, it attempts to take cost into consideration through promoting the least expensive actions and cost-share for those actions that are more expensive. The Department intends to review the Strategy in 10 years and update it if further actions are needed to improve water quality.

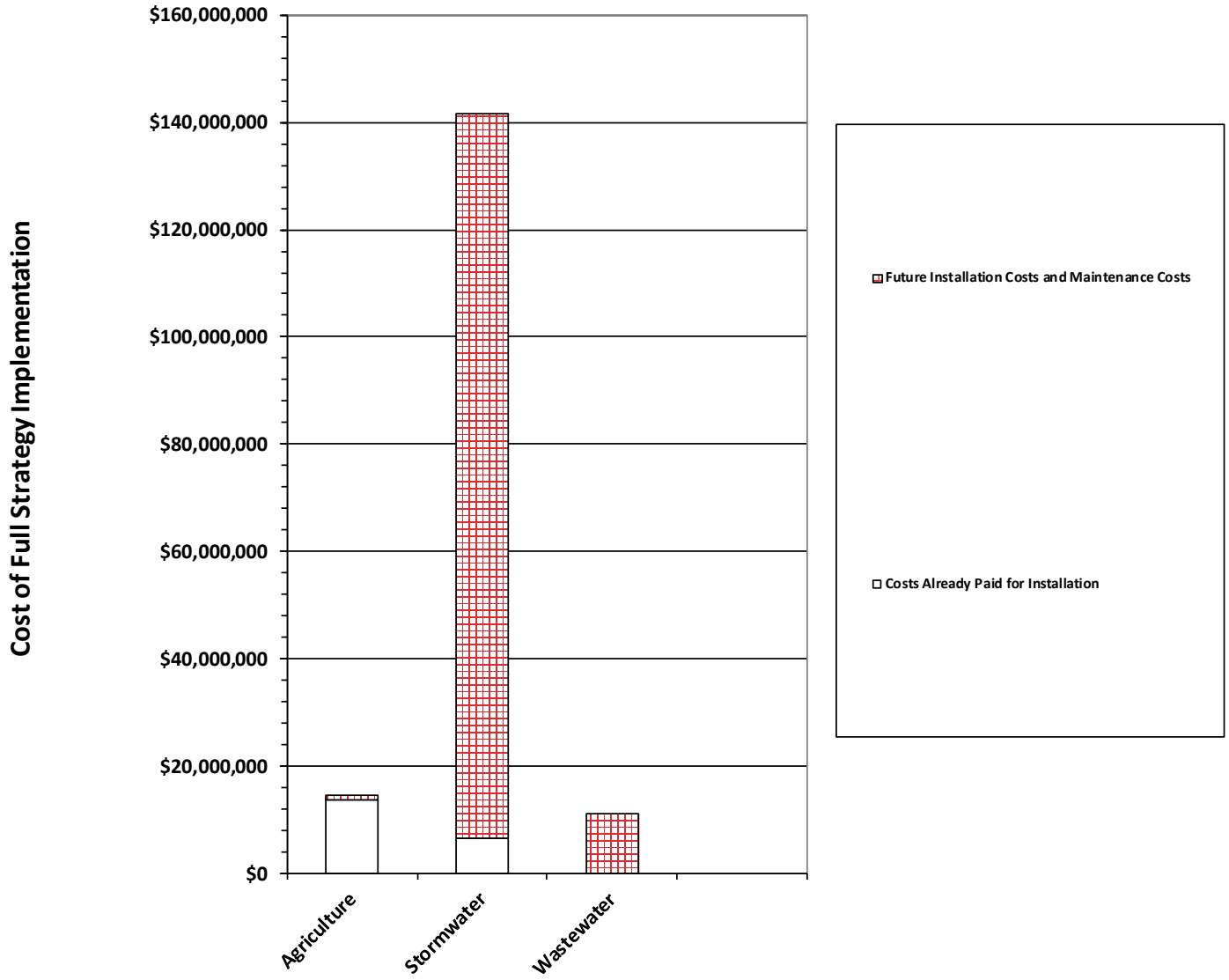

Figure 10 – Total Strategy Costs for BMPs, Current and Future

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Appendix A – 7419 TMDLs for the Cedar Creek Watershed, Delaware

1.0 Introduction and Background

Water quality monitoring performed by the Department of Natural Resources and Environmental Control (DNREC) has shown that the waters of Cedar Creek and several of its tributaries and ponds are impaired by high levels of bacteria and elevated levels of the nutrients nitrogen and phosphorous, and that the designated uses are not fully supported due to levels of these pollutants in these waterways.

Section 303(d) of the Federal Clean Water Act (CWA) requires States to develop a list (303(d) List) of waterbodies for which existing pollution control activities are not sufficient to attain applicable water quality criteria and to develop Total Maximum Daily Loads (TMDLs) for pollutants or stressors causing the impairment. A TMDL sets a limit on the amount of a pollutant that can be discharged into a waterbody and still protect water quality. TMDLs are composed of three components, including Waste Load Allocations (WLAs) for point source discharges, Load Allocations (LAs) for nonpoint sources, and a Margin of Safety (MOS).

DNREC listed Cedar Creek on several of the State's 303(d) Lists and proposes the following Total Maximum Daily Loads regulation for nitrogen, phosphorous, and *enterococcus* bacteria.

2.0 Total Maximum Daily Loads (TMDLs) Regulation for Cedar Creek

Article 1. The nonpoint source nitrogen load in the entire Cedar Creek Watershed shall be reduced by 45 percent from the 2001-2003 baseline level. This shall result in a yearly-average total nitrogen load of 587.6 pounds per day.

Article 2. The nonpoint source phosphorous load in the entire Cedar Creek watershed shall be reduced by 45 percent from the 2001-2003 baseline level. This shall result in a yearly-average total phosphorous load of 23.25 pounds per day.

Article 3. The nonpoint source *enterococcus* bacteria load in the entire Cedar Creek watershed shall be reduced by 96 percent from the 2001-2003 baseline level. This shall result in a yearly-mean *enterococcus* bacteria load of 7.15E+10 colony forming units (CFU) per day.

Article 4. Based upon water quality model runs and assuming implementation of reductions identified by Article 1 through Article 3 above, DNREC has determined that, with an adequate margin of safety, water quality standards will be met in the Cedar Creek.

Article 5. Implementation of this TMDLs Regulation shall be achieved through the development and implementation of a Pollution Control Strategy. The Strategy will be developed by DNREC in concert with the Tributary Action Teams, other stakeholders, and the public.

10 DE Reg. 1038 (12/01/06)

Appendix B – 7423 TMDLs for the Mispillion River Watershed, Delaware

1.0 Introduction and Background

Water quality monitoring performed by the Department of Natural Resources and Environmental Control (DNREC) has shown that the waters of Mispillion River and several of its tributaries and ponds are impaired by high levels of bacteria and elevated levels of the nutrients nitrogen and phosphorous, and that the designated uses are not fully supported due to levels of these pollutants in these waterways.

Section 303(d) of the Federal Clean Water Act (CWA) requires States to develop a list (303(d) List) of waterbodies for which existing pollution control activities are not sufficient to attain applicable water quality criteria and to develop Total Maximum Daily Loads (TMDLs) for pollutants or stressors causing the impairment. A TMDL sets a limit on the amount of a pollutant that can be discharged into a waterbody and still protect water quality. TMDLs are composed of three components, including Waste Load Allocations (WLAs) for point source discharges, Load Allocations (LAs) for nonpoint sources, and a Margin of Safety (MOS).

DNREC listed Mispillion River on several of the State's 303(d) Lists and proposes the following Total Maximum Daily Loads regulation for nitrogen, phosphorous, and *enterococcus* bacteria.

2.0 Total Maximum Daily Loads (TMDLs) Regulation for Mispillion River

Article 1. The nonpoint source nitrogen load in the Mispillion River watershed shall be reduced from the 2001-2003 baseline level by 88 percent for King's Causeway Branch and 57 percent for the remaining parts of the watershed. This shall result in a yearly-average total nitrogen load of 756.5 pounds per day.

Article 2. The nonpoint source phosphorous load in the Mispillion River watershed shall be reduced from the 2001-2003 baseline level by 88 percent for King's Causeway Branch and 57 percent for the remaining parts of the watershed. This shall result in a yearly-average total phosphorous load of 13.23 pounds per day.

Article 3. The nonpoint source *enterococcus* bacteria load in the Mispillion River watershed shall be reduced from the 2001-2003 baseline level by 87 percent. This shall result in a yearly-mean *enterococcus* bacteria load of 2.92E+11 colony forming units (CFU) per day.

Article 4. Based upon water quality model runs and assuming implementation of reductions identified by Article 1 through Article 3 above, DNREC has determined that, with an adequate margin of safety, water quality standards will be met in the Mispillion River.

Article 5. Implementation of this TMDL Regulation shall be achieved through the development and implementation of a Pollution Control Strategy. The Strategy will be developed by DNREC in concert with the Tributary Action Teams, other stakeholders, and the public.

10 DE Reg. 1038 (12/01/06)

Appendix C – Public Talk – Real Choices

Public Talk – Real Choices: A Model for Public Engagement in Creating Pollution Control Strategies

Bill McGowan[5], Joe Farrell[6], Ed Lewandowski[7], Kathy Bunting-Howarth[8], Lyle Jones[9]

Introduction

Public issues are complex, "wicked" problems. Poverty, education, land-use, environment and others are issues not easily resolved. Delaware for example is a national leader in welfare reform, education reform, land use legislation and the environment but those close to these issues know the reforms are stalled locally and nationally. Why? We believe a lack of public engagement in creating public policy is a fundamental reason. We have become a technocratic society, resulting in the public abdicating it's role as participants in creating public policy to a bureaucracy. It is generally accepted by both parties, the public and bureaucracy, that the public does "not have the capacity" to work through complex issues. It is incumbent on those who work with the public to create a better way to engage the public in creating sustainable public policy.

A Common Model for Public Engagement

One model found frequently when public agencies need public input is the "workshop" model. The model begins with a selection of a small group of people, a citizens advisory committee or "blue ribbon" panel. The group, usually with the help of the public agency, goes through an education process, writes a report, and delivers it to the agency. The agency holds "tell and sell" workshops, followed by public hearings and possible promulgation of regulation. The model more often than not fails to give the public a significant chance to participate in policy formation, resulting in disillusionment, and failed policy. Both the public and public agencies need and deserve a better way to work together that produces sustainable decisions.

A Preliminary Approach

Losing Ground: What Will We Do About Delaware's Changing Landscape? A series of issue forums or public conversations, throughout the state in 1996, introduced deliberative dialogue to 340 Delawareans. Deliberative Dialogue is a conversation in which people, the public, weigh the cost and consequences of their thinking and make choices based on their deliberations. It was the first time for many where in a public meeting citizens had the opportunity to both listen and talk to each other in an environment conducive to learning. It was not a public hearing where comments are taken for the record or workshop with information presented by experts. Comments after the forums indicated citizens would come out and discuss issues of importance, people want a way to engage issues personally, and will engage each other in questioning and learning. The results of *Losing Ground* appear to indicate the public wants a better model to engage public issues. It is from the conversations heard from citizens that participated in *Losing Ground* that the model *Public Talk – Real Choices* emerged.

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Why Develop Another Model?

Two major citizen efforts assisted by DNREC, the Inland Bays Monitoring Committee and the Citizens Advisory Committee of the National Estuary Program, produced action plans for restoration of the Inland Bays. The plans are very similar to each other, in fact a matrix of the two plans attempts to avoid duplication of effort (CCMP, 1995). Citizens spent over nine years of work between the two plans. Both plans emerged from a visioning model asking the questions "What do we want the Bays to look like?" and "How can we get there?" The action plans are broad recommendations that lack specific suggestions for implementation. There remains a tremendous amount of frustration from citizens who have engaged in one or the other or both of the Bay protection efforts (Citizen Advisory Committee Minutes, 1997) and the public agency, DNREC, whose mission is to preserve and protect the natural resources of Delaware. Both parties want the same thing, healthy bays, and still there is no solution or commitment.

A Caveat

There is a difference between then and now and that is TMDL's are regulations. Both the Inland Bays Monitoring Committee and the National Estuary Program were voluntary. The regulatory community can argue TMDL's are promulgated regulation that demand action through pollution control strategies. That is true to a point. The State met the requirement of the settlement by establishing the TMDL's for the watershed. The pollution control strategies are self-imposed requirements. Without significant public engagement in creating strategies that potentially impact all residents in the watershed, the strategies will die in the political arena. By taking time on the front end, and working through a truly public process, the State stands to gain more in the end product of a sustainable public policy.

The Model: Public Talk – Real Choices

The purpose of *Public Talk – Real Choices* is to move formulation and creation of a major public policy decision from a public agency to the public for dialogue and deliberation. *Public Talk – Real Choices* builds on what happened in *Losing Ground* forums. Using deliberative dialogue as the core, *Public Talk* goes further by engaging the public in learning about the issue, weighing the costs and consequences of what is important through dialogue with each other, and coming to public judgment. The model consists of six steps; Organization of Work Team, Education, Issue Framing, Evaluation of the Issue Framework, Public Forums/Choice Work, Recommendations.

Model Components

Organization - is a structural component that brings the public agency and public, the work team, into agreement as to what needs to be accomplished. Without preliminary understanding and agreement by both parties, the effort will fail. **Education -** further enhances this arrangement by building upon the knowledge of the process shared in the organizational discussions and then adding information necessary to frame the issue. A good portion of technical information will come from the public agency e.g. the Inland Bays Whole Basin Assessment Report.

Issue framing - is the critical piece necessary for public engagement. Issue framing lays out in an organized fashion for public consumption three or four choices. The framework must be unbiased, represent the under girding values embedded in policy choices and articulate the basic costs and consequences of the choices. It should represent the voices of all impacted by the issue.

The framework sets the stage for our conflicting motives – those things we consider valuable and that pull us in different directions when we have to decide how to act. The issues need to be stated in ways that compel the public to make their views known.

Evaluation of the Framework - This piece gives insight into how successfully the teams framed the issue. The use internal deliberation, focus groups, etc. enhances the success of the framework. For successful public deliberation all voices need to heard within the framework. The choices must be neutral and offer a positive approach for issue resolution.

Public deliberation **-** is the cornerstone of *Public Talk – Real Choices*. A significant representation of the public must deliberate the issue. This occurs through successful planning and selection of venues for forums. The forums must result in some form of common ground for action.

Recommendations - The work teams sift through and analyses the public voice they heard from the forums. From this public voice the work team develops the pollution control strategies.

Why This Model?

National Issues Forums
National Issues forums are "town meetings" that bring people together to deliberate "wicked problems," problems that won't go away, with the help of moderator. The medical analogy of a broken arm versus diabetes describes wicked problems. The broken arm can be set and heals. Diabetes requires life -changing alterations. Participants use an issue book that offers three to four choices for resolution. Within the choices are basic values, cost and consequences of the choice. With the help of a moderator the public works through the choices, by looking at four things: What is valuable? What are the costs and consequences of the choice? Where is the tension? Where is there common ground for action? Participants must consider "It's not what I want to do but what we ought to do."

Why Are These Models Effective?

The Harwood Group in a report *Meaningful Chaos- How People Form Relationships with Public Concerns,* found nine factors necessary for public engagement.
Connections – People tend to enlarge rather than narrow their views of public concerns, making connections among ideas and topics that society tends to fragment.
Personal Context – People relate to concerns that "fit" with their personal context, moving beyond self-interest to what is meaningful
Coherence – People want to hear the whole story. They want to understand what it means.
Room for Ambivalence – People do not immediately see black and white. They want a gray area to question, discuss, test ideas, and become comfortable with their opinions.
Emotion – Too many processes try to remove emotion from decisionmaking. Emotions are necessary to sustain relationships with public concerns.
Authenticity – People and information must "ring true".
Sense of Possibilities – People really want something to happen and they might play a role in it.
Catalysts – Everyday people, not just experts and elite, are critical in helping people form relationships with public issues.
Mediating Institutions – Places where people come together to talk and act on public concerns. (Harwood, 1993)

National Issues Forums and *Public Talk – Real Choices* adhere to these tenets.

The Facilitator Team

Public Talk – Real Choices uses a neutral, third party facilitator. By using a neutral, third party as the facilitator, the facilitator becomes an advocate for the process (Kaner, 1996). Third party facilitation avoids the perception of bias that can occur when the facilitator is personally associated with the issue.

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Appendix D – BMP Nutrient Reduction Calculations

BMP Nutrient Reduction Calculations

Calculating the Required Total Maximum Daily Load Reductions Based on Land-use

The Total Maximum Daily Load (TMDL) for receiving waters in the Mispillion calls for a 57% reduction in total nitrogen (TN) and a 57% reduction in total phosphorus (TP) (EPA, 2005). The baseline period for this TMDL was established from 2002 land use data used to determine the acreages of each of the following land uses: Urban, Agricultural, Forest, Wetland, Water, and Other, which includes land uses like rangeland and barren land. The Total Maximum Daily Load (TMDL) for receiving waters in the Creek Cedar calls for 45% reduction in total nitrogen (TN) and a 45% reduction in total phosphorus (TP) (EPA, 2005). The results are tabulated below (Table 1).

Table 1 – 2007 Mispillion and Cedar Creek Watersheds Land-use Acreages

Urban	Agricultural	Forest	Wetland	Water	Grasslands	Other	Total acreage
10,956.6	38,259.4	10,949.7	17,522.6	2121.6	492.9	1124.5	82,331.4

In order to calculate nutrient loads from non-point pollution sources, the land use acreages from Table 1 were combined with the land use loading rates in Table 2, which were determined based on results of research conducted by experts in the Mispillion and Cedar Creek Watersheds to produce daily nutrient loads according to land use, as displayed in Table 3.

Table 2 – The Landuse Loading Rates for Mispillion and Cedar Creek Watersheds Based Upon TMDL Data

	TN (lbs/acre/yr)	TP (lbs/acre/yr)
Developed	19.35	0.53
Agriculture	24.79	0.30
Grasslands	5.0	0. 30
Forests	1.71	0.1
Wetlands	1.47	0.08
Other	5.0	0.30

Table 3 – Greater Mispillion Nutrient Loads Based Upon Land Use and Landuse Load Rates

	Urban	Agricultural	Forest	Wetland	Grasslands	Other
TN (lbs/day)	525.69	2598.2	51.5	70.4	6.8	11.9
TP (lbs/day)	14.8	31.2	2.85	4.06	0.4	0.7

I. Baseline load calculation for land-use type by reduction area:

Using the land use loading rates listed in Table 2, the nutrient loads coming from non-point sources during the baseline period are determined using the equation below. It should be noted that the grassland loading rate was used to determine the loads from the "Other" land use category.

Nutrient load lbs/yr & lbs/day (Table 3)	=	Acreage of specific land-use (Table 1)	X	Loading rate for specific land-use (lbs/acre/yr) (Table 2)

EX: TN load for urban land use:

TN load	=	1124.5 acres	X	5 lbs TN/acre/yr	=	**11.9 lbs TN/day**

II. Required TMDL reduction on a land-use basis:

The annual and daily nutrient load reductions needed from non-point sources to achieve the reductions outlined in the TMDL are calculated using the following equation. For the Mispillion and Cedar Creek Watersheds, the TN load needs to be reduced by 1703.7 lbs/day and the TP load by 28.1 lbs/day. In order to achieve these reductions, the best management practices (BMPs) discussed in the Pollution Control Strategy must be implemented.

Required TMDL reduction (lbs/day)	=	Baseline load (lbs/day)	X	Percent reduction

EX: TN TMDL required load reduction for Mispillion watershed:

Required TMDL reduction (lbs/day)	=	1956.9 lbs TN/day	X	57%	=	**1115.4 lbs TN/day**

Onsite Wastewater Disposal System (OWTDS) BMP Calculations

In order to determine the nutrient loading by OWTDS to groundwater, local watershed data and knowledge has been utilized.

Twelve OWTDS existing near Red Mill Pond in Lewes, Delaware were monitored in 1993 (DNREC, 1994). The average total phosphorus concentration of the effluent from these systems was 15.7 mg/L, while the total kjeldahl nitrogen (TKN) concentration was 58.5 mg/L and the nitrate/nitrite concentration was 0.8 mg/L. The total nitrogen concentration of the average effluent from this study was summed to equal 59.3 mg/L. Conversations with professionals in

this industry have suggested that 50.0 mg/L is a more appropriate value of TN concentrations in on-site effluent and this value has been used in subsequent calculations.

Small systems, which are typical individual household systems, have flows less than 2,500 gallons per day(gpd). The average design flow for individual residential OWTDS is 221 gpd.

The nutrient load to the watershed from drain fields can be established by determining the product of the above concentrations and respective flow rates.

Robertson and Hartman (1999) found that 85% of the total phosphorous in the effluent will be retained in the vadose zone or the unsaturated soil above the water table, most of which is within 12 inches of the drain field (Gold and Sims, 2000). Initial calculations presented by the Department, also based on the Red Mill Pond study, assumed that 87% of TP and 52% of TN is assimilated in the soils once the effluent leaves the septic tank.

The final loading rates from OWTDS to groundwater can be determined using the following equations:

Small systems (<2,500 gpd):
[Conc. (mg/l) x (lb/453,592 mg)] x [(221 gal/system/day) x (3.7854 l/gal)] x (1-soil assimilative capacity)

Thus, the OWTDS nutrient loading rates to groundwater in the Mispillion and Cedar Creek Watersheds are:

- 0.052 lbs TN/system/day and 0.004 lbs TP/system/day for individual small systems less than 2,500 gpd

Nutrient Load reduction (lbs/day)	=	OWTDS loading rate (lbs/system/day)	X	# of systems in Mispillion and Cedar Creek Watersheds

EX: TN Load due to OWTDS:

TN load reduction (lbs/day)	=	0.052 lbs TN/system/day	X	8841 OWTDS	=	**4389.3 TN lbs/day**

II. Holding Tank Inspection and Compliance Program

On average, holding tanks have a 2,800 gallon capacity. Metcalf and Eddy (1991) reported that holding tanks typically hold 2,596 gallons of effluent and 204 gallons of septage (solids). Recent observations from the compliance program indicate volumes of 2,464 gallons of effluent and 336 gallons of septage volume. The average effluent concentrations previously discussed (50.0 mg TN/L and 15.7 mg TP/L) have been used to determine the effluent loads from holding tanks. The nutrient load contribution from septage in holding tanks will be determined using the nutrient concentrations in septage from holding tanks (600 mg TN/L and 250 mg TP/L), as reported in Wastewater Engineering, Third Edition (Metcalf and Eddy, 1991). The nutrients

removed per holding tank pump-out are shown in Table 5, calculated using the above concentrations.

Table 5 – Nutrient Reductions from a Holding Tank Pump-Out		
	Total N (lbs/tank/pump-out)	Total P (lbs/tank/pump-out)
Holding Tank Effluent	1.03	0.32
Holding Tank Septage	1.68	0.70
Total	2.71	1.02
Effluent: *Nutrients Removed (lbs/tank/pump-out) = Conc. (mglL) x (lb/453,592 mg) x (2,464 gal/tank) x (3.7854 l/gal)* ***Septage****: Nutrients Removed (lbs/tank/pump-out) = Conc. (mglL) x (lb/453,592 mg) x (336 gal/tank) x (3.7854 l/gal)*		

There are 15 holding tanks currently in the Mispillion and Cedar Creek Watersheds. Each time a holding tank is pumped, 2.71 lbs TN and 1.02 lbs of TP do not enter the Murderkill.

Initially, the Department assumed that tanks are pumped-out 16 times per year. The Small Systems Branch, Groundwater Discharges Section of the Division of Water Resources determined this number to be high. Records from the Holding Tank Compliance program indicate that on average, holding tanks are pumped-out about 12 times per year, or once a month (DNREC Groundwater Discharges Section, personal communication, 2001). Thus, this latter figure was used for subsequent calculations to determine the annual load reduction using the equation below.

Nutrient load reduction (lbs/yr)	=	Reduction rate (lbs/tank/pump-out)	X	12 pump-out/year	X	# of tanks

EX: TN reduction due to Holding Tank Pump Out

TN load reduction (lbs/yr)	=	2.71 lbs TN/tank/pump-out	X	12 pump-out/year	X	15 tanks	=	**416.1 TN lbs/yr or 1.14 lbs TN/day**

III. OWTDS Pump-outs

Using a GIS, an analysis was conducted that determined as of July 2012, there were 8441 OWTDS in the Mispillion and Cedar Creek Watersheds.

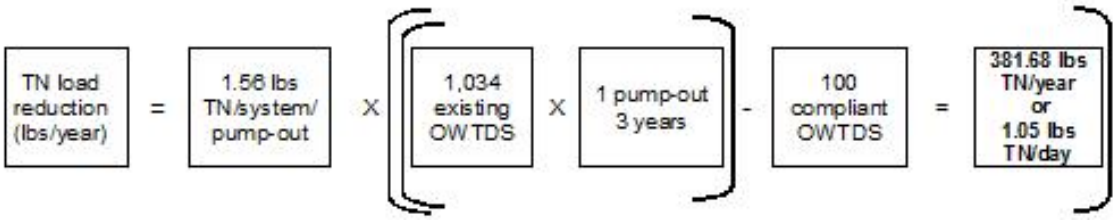
Waste haulers usually deliver waste to the nearest wastewater treatment plant. For example, according to information from the Wilmington Treatment Facility, 53 tanks were pumped from the Murderkill Watershed in 2001. In addition, it was estimated that 47 tanks from the Murderkill Watershed were pumped from the Kent County Treatment Facility in 2001 because they could not give exact information on the number of systems pumped. This equals 100 tanks

being pumped out a year in the Murderkill Watershed based on a 1,000 gallon tank capacity. By assuming that after three years, a septic tank will contain 750 gallons of effluent and 250 gallons of septage (volumes based on local inspector-hauler observations), and using the concentrations of effluent and septage given above, the effluent load reductions per system achieved by a pump-out program are shown below in Table 6.

Table 6 – Nutrient Reductions from an OWTDS Pump-Out		
	Total N (lbs/system/pump-out)	Total P (lbs/system/pump-out)
OWTDS Effluent	0.31	0.10
OWTDS Septage	1.25	0.52
Total	1.56	0.62
Effluent: *Nutrients Removed (lbs/system/pump-out) =* *Conc. (mg/l) x (lb/453,592 mg) x (750 gal/system) x (3.7854 l/gal)* *Septage:* *Nutrients Removed (lbs/system/pump-out) =* *Conc. (mg/l) x (lb/453,592 mg) x (250 gal/system) x (3.7854 l/gal)*		

The load reduction in the water column achieved by this practice can be calculated using the following equation.

EX: TN reduction due to OWTDS pump-out program.



IV. OWTDS Performance Standards

Wastewater pretreatment technologies exist to remove nitrogen, phosphorus, or both from wastewater prior to soil dispersal of the effluent. A consultant hired by the Department evaluated the performance efficiencies of these technologies then recommended performance standards for OWTDS in Delaware and several levels of performance efficiencies for nitrogen and phosphorus (The On-Site Wastewater Corporation, draft written communication, 2003).

A recommendation in the Greater Mispillion Pollution Control Strategy surrounding small septic systems requires new and replacement subdivisions in areas outside of sewer districts to be equipped with systems that can reach standards such as “Performance Standard Nitrogen 3”

(PSN3) to reduce nutrients. Technologies that can achieve PSN3 will produce a 50% reduction of effluent TN concentration when compared to the TN influent concentration. The nutrient load reduction can be determined using the following equation.

Nutrient load reduction (lbs/day)	=	OWTDS loading rate (lbs/system/day)	X	# of existing OWTDS in program	X	Reduction efficiency

EX: TN reduction due to upgrading to performance based systems:

TN load reduction (lbs/day)	=	0.052 lbs TN/system/day	X	22 OWTDS	X	50%	=	**0.74 lbs TN/day**

Stormwater BMP Calculations

I. Stormwater BMPs

Several types of structures that treat stormwater runoff are used throughout the Mispillion and Cedar Creek Watersheds. The efficiencies associated with common stormwater BMPs are listed in Table 7. In order to calculate the load reduction to the receiving water body, the calculation outlined below is used. The nitrogen urban loading rate is 0.053 lbs/acre/day, while the phosphorus loading rate is 0.00027 lb/acre/day.

Nutrient load reduction (lbs/day)	=	Total drainage area treated by structures (acres)	X	Urban loading rate (lbs/acre/day)	X	Reduction efficiency

EX: TN reduction due to wet ponds:

TN load reduction (lbs/day)	=	748.1 acres treated on average	X	0.053 lbs TN/acre/day	X	30%	=	**11.89 lbs TN/day**

Table 7 – Stormwater BMP Reduction Efficiencies (Chesapeake Bay Program, 2009)

BMP	TN (%)	TP (%)
Wet ponds	30	50
Dry pond (extended detention)	5	10
Infiltration (swale, infiltration basin/trench)	50	70
Biofiltration	50	70
Filtering Practice (bioretention)	50	70

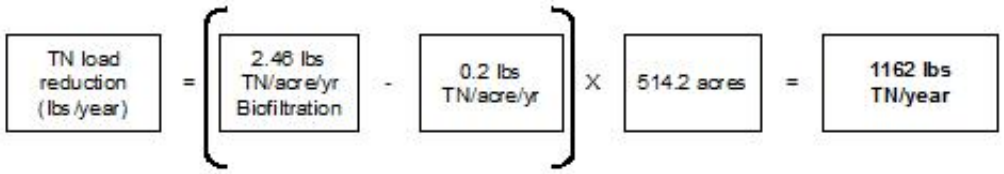
II. Potential Future Stormwater Retrofit Projects:

It is anticipated that an additional 514.3 acres of urban area in the Mispillion and Cedar Creek Watersheds will be retrofitted in the future. It is difficult to project, however, the exact number and type of treatment structures that will be used. The majority of stormwater practices currently in use in the watershed are wet and dry ponds, while infiltration, biofiltration, and filtration structures together are less likely to be used. It is unlikely that these same proportions will be used in future retrofit projects since the construction of ponds will require a considerable amount of space and it may be unfeasible to create these structures in areas that are already developed. Because of this, it has been assumed that future retrofits will be more equitable with equal implementation of ponds and other practices.

The load reductions achieved from the stormwater BMPs currently on the ground have been summed into two categories, "Dry Ponds " and these values were divided by the total area treated in each category to calculate nutrient reduction rates. For "Dry Ponds," the reduction rates are 0.2 lbs TN/acre/yr and 0.02lbs TP acre/yr, while the reduction rates for "Biofiltration" are 2.46 lbs TN/acre/yr and 0.15 lbs TP acre/yr.

The potential future loading reduction to the stream as a result of retrofitting 514.3acres of urban lands can thus be determined using the equation below.

EX: TN reduction from future stormwater retrofits:



Open Space Calculations

Riparian Buffer

It is assumed that for every one acre of land where riparian buffers are employed, that two upland urban acres are treated. This approach is similar to the practice employed by the Chesapeake Bay Program (CBP, 1998). The efficiencies for nutrient load reductions are an average of the range presented by J.T. Sims and J.L. Campagnini (written communication, 2002). Thus, the agreed efficiencies are as follows:

Forested buffers: TN-- 62% and TP-- 62%

For these BMPs, the actual acre of the practice will be treated as a land use conversion and the reduction efficiencies will be applied to two acres of affected upland for each acre of practice.

EX: TN reduction due to riparian buffer requirements:

Agriculture BMP Calculations

The following calculations are provided as a result of the Agricultural Pollution Control Strategy Workgroup's efforts in gathering the best available science for nonpoint source pollution prevention from agricultural sources. The workgroup began meeting in April 2002 to gather the best available data on nutrient efficiencies for various agricultural best management practices. These recommendations and calculations are based on averages over several years from different studies and are dependent on weather conditions, soil type, crop production intensity, excess manure generation, topography and other site specific conditions. In addition, a lag time likely exists between practice implementation and benefit observation, which can not currently be estimated since all nutrient fate and transport processes are not well understood at this time.

I. Cover Crops

Nitrogen reduction efficiencies for cover crops were calculated using a weighted average method for each year. The data used in this calculation came from ranges of cover crop TN efficiencies for several plant species presented by J.T Sims and J.L. Campagnini (written communication, 2002). The Workgroup chose a single efficiency, often an average of the range, for the commonly used species in Delaware (Table 8). The United States Department of Agriculture, National Resource Conservation Service provided information on each cover crop planted in the 2008-2009 season in the Murderkill Watershed (shown in bold). This information was used to calculate a weighted average efficiency of the crops planted, determined to be 54.9% for the 2008-2009 season. It should be noted that with this approach, the efficiency will change from year to year, depending on the acreage of each cover crop species planted. For TP, the Workgroup referred to the best professional judgment presented by Sims and Campagnini, which was "less than 5%," and will be considered for these purposes as 4.9%. The nutrient load reduction is calculated with the equation shown below.

Table 8 – Cover Crop Efficiencies for TN	
Cover Crop Species	**Work Group BMP Efficiency (%)**
Barley	70
Hairy Vetch	6
Annual Rye	65
Cereal Rye	54.5
Oats	55
Wheat	55

Nutrient load reduction (lbs/yr)	=	Agricultural loading rate (lbs/acre/yr)	X	Acres of cover crop	X	Reduction efficiency (%)

EX: TN reduction due to 3,432.4 acres of cover crops:

TN load reduction (lbs/year)	=	25 lbs TN/acre/yr	X	3,432.4 acres	X	54.9%	=	**47,110 lbs TN/year**

II. Ponds, Grassed Waterways, Grassed Filter Strips, Wildlife Habitat

The Conservation Reserve Program (CRP) practices are treated as a land use change from agricultural cropland to grassed waterways or grassed filter strips, or wildlife habitat. Thus, the acres that undergo change will receive a lower loading rate. Since the Conservation Reserve Enhancement Program (CREP) was implemented, any new grass filter strips created will be treated as a CREP practice and will receive a reduction calculated by the method described later. The loading reduction is calculated as follows.

Nutrient load reduction (lbs/yr)	=	[Agricultural loading rate (lbs/acre/yr)	-	Grass loading rate (lbs/acre/yr)]	X	Acres of CRP practices

EX: TN reduction due to 157.2 acres of wildlife habitat:

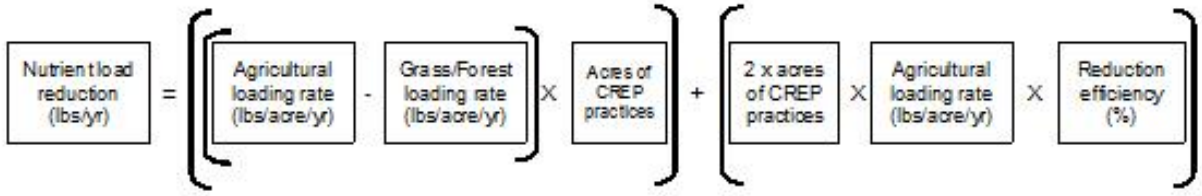
TN load reduction (lbs/yr)	=	[24.79 lbs TN/acre/yr	-	5 lbs TN/acre/yr]	X	157.2 acres	=	3,111 lbs TN/year

III. Filter Strips, Forest Buffers, Riparian Buffers, Wetlands

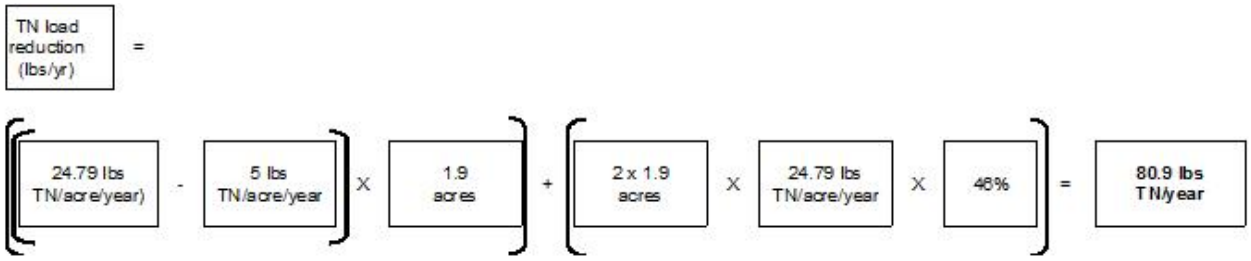
The Conservation Reserve Enhancement Program (CREP) practices (CP21-grass filter strips) are assumed to act as grassed buffers. CREP practices (CP22-riparian buffer, CP23-wetland restoration and CP3A-hardwood trees) are all assumed to act as forested buffers. The Workgroup assumed that for every one acre of land where these practices are employed, that two upland acres are treated. This approach is similar to the practice employed by the Chesapeake Bay Program (CBP, 1998). The efficiencies for nutrient load reductions are an average of the range presented by J.T. Sims and J.L. Campagnini (written communication, 2002). Thus, the agreed efficiencies are as follows:

Grassed buffers: TN-- 46% and TP-- 54%
Forested buffers: TN-- 62% and TP-- 62%

For these BMPs, the actual acre of the practice will be treated as a land use conversion and the reduction efficiencies will be applied to two acres of affected upland for each acre of practice.



EX: TN reduction due to 1.9 acres of CREP filter strips:



VII. Nutrient Management Plans

To reduce agriculture's impact on water quality, Delaware legislated a nutrient management program in 2002 to oversee nutrient applications within the State. In 2003, 20% of farmers applying nutrients to 10 acres or more or those who manage 8 or more animal units within the state were required by the Nutrient Management Act to create and submit a nutrient management plan (NMP) to the Nutrient Management Commission (NMC). Each year between 2004 and 2007, another 20% of eligible farmers were required to have NMPs, with 100% implementation by January 1, 2007. These plans are routinely updated and modified to meet the nutrient needs of the future cropping rotations and practices.

The Delaware Conservation Partnership (DCP) conducted a survey in July 2007, after the deadline requiring all eligible farm operations to have a plan, to evaluate nutrient management planning in the state. The DCP consists of the Delaware Conservation Districts, the Natural

Resources Conservation Service, and the Delaware Department of Natural Resources and Environmental Control, and strives to work together to meet the needs of Delaware Farmers by providing cost-share programs, educational opportunities, and nutrient management planning services. The survey was designed to inform those programs by identifying gaps in information and education and opportunities to spend cost-share dollars more effectively. In short, the purpose of the project was to make nutrient management work better for farmers in Delaware.

The surveys were sent out to everyone who has been certified by the Nutrient Management Program- 2,034 people in all. The Delaware Conservation Partnership received 698 responses- about a 34% response rate. The following is the breakdown of responses among different sizes of farms:

1-10 acre farms – 9% response rate
11-99 acre farms – 29% response rate
100-499 acre farms – 25% response rate
500 + acre farms – 20% response rate
Animal only farms – 10% response rate

Responses varied only slightly among different farm sizes and types, with the exception of whether or not nutrient management provided an economic benefit to their farm. Larger farms and those whose plans were written by a private consultant were most likely to agree that nutrient management provides an economic benefit to their operation. Small farms, animal operations and those whose plan was written by someone on staff were least likely to agree.

The surveys indicated that fertilizer application rates have decreased the most among farmers who till at least 500 acres, while manure applications have decreased most among farmers who till between 11 and 99 acres. When fertilizer application rates are evaluated by county, Sussex farmers reduced the rate of N and P applications the most, Kent reduced N applications the least, whereas New Castle deceased P applications the least.

Table 5 – Change in Fertilizer and Manure Application Rates Due to 2002 Nutrient Management Law

County	*Farm Acres*	*% Change in nitrogen fertilizer applications*	*% Change in phosphorus fertilizer applications*	*% Change in manure application*
Kent	173,808	13.4	26.9	5.4
New Castle	66,981	16.0	20.1	13.6
Sussex	269,464	18.5	37.1	24.2
Weighted Average		16.4	31.4	19.9

The efficiencies based on the DCP survey can be compared to other estimates of nutrient management planning effectiveness. An Agricultural Workgroup was established to gather the best available science on nonpoint source pollution prevention for agricultural sources. The Workgroup operated off the basic assumption that if fewer nutrients are being applied to the land, fewer nutrients will be lost to Delaware's water bodies. From this premise, the Workgroup determined nutrient efficiencies for various agricultural best management practices including the effectiveness of nutrient management planning.

Initially, the Workgroup addressed the impact of nutrient management planning (NMP) in the Inland Bays and Nanticoke watersheds from a study by McGowan and Milliken (1992). This study listed the reductions associated with various management practices observed over a three year period, with a total of 103,736 lbs TN reduced by 2,328 acres under nutrient management planning. To determine a general NMP TN reduction, the Workgroup decided that the reductions and acreage associated with manure allowance and cover crops should be removed from further calculations since reductions for both of these items are determined separately and all NMPs will not include manure relocation. This subtraction gave a total of 1,224 acres of nutrient management planning and a load reduction of 70,136 lbs of TN, resulting in a reduction rate of 57.3 lbs/acre per 3-year planning cycle. McGowan and Milliken (1992) reported that the TN application rate prior to the introduction of NMPs was 280 lbs/acre per 3-year planning cycle, so NMPs produced a 20.5% reduction in TN. This estimate falls in the lower range reported by the State of Maryland (MDNR, 1996), which was 20-39% for nitrogen. The corresponding phosphorus range reported by the Maryland DNR was 9-30%. However, due to the absence of a report similar to the McGowan and Milliken study in Delaware for P, there is not enough information available to determine an appropriate reduction efficiency to apply to NMPs for phosphorus in these two watersheds.

In the Murderkill watershed, one representative farm within the watershed volunteered to allow the Workgroup to analyze the nutrient data they routinely gather. This particular farm tracks nutrient application rates to each crop field within a database that goes back to 1999, prior to the passing of the Nutrient Management Act. The data were separated into two groups, pre-Nutrient Management Plans (NMPs) (1999-2002) and post-NMPs (2003-2004), and entered into Statgraphics Software for statistical analysis. It was determined that there was a statistically significant difference between the mean application rates at the 95% confidence level for nitrogen. The average nitrogen application rate decreased by 12.4% from the pre-NMP level and this value will be taken as the NMP reduction efficiency; unfortunately, no reduction could be calculated for phosphorus from this data.

At the request of the NMC, Sims et al. (2008) conducted extensive nutrient mass balance calculations for the State for the years 1996 through 2006. They calculated both input/output and management–oriented mass balances for nitrogen and phosphorus. The Sims et al. (2008) approach included calculations for manure relocation and estimates of biological fixation of nitrogen by leguminous crop and clearly demonstrated that fewer nutrients are being applied to Delaware's cropland.

DNREC Watershed Assessment Section (WAS) has worked with the NMC and the University of Delaware Cooperative Extension to determine the impact of the Nutrient Management Act on the amount of nutrients applied to Delaware's agricultural fields. Using an input-output type analysis using fertilizer sales data and crop yields, WAS determined that on a state-wide basis, 47% less nitrogen and 62% less phosphorus has been applied to Delaware's cropland. Both the WAS and Sims et al. (2008) approach produced similar results.

The DCP values, which are based on the reductions in nutrient applications actually reported by Delaware farmers, fall within the range of efficiencies determined by the numerous other methods and data sets discussed above. As a result, DNREC proposes to use the DCP efficiencies to estimate the reduction in nutrient application rates resulting from the promulgation of the Nutrient Management Law.

There were 35,425.86 acres of nutrient management planning in the Murderkill Watershed in 2008. The Chesapeake Bay Program (2009) has aggressively establish nitrogen and phosphorus reductions associated with various urban and agricultural best management practices including nutrient management planning. The Program applies a 13% reduction to nitrogen and a 27% reduction to phosphorus for every acre of cropland that has a nutrient management plan. Those nutrient reductions were applied to every acreage of cropland in the Murderkill Watershed. Using the Bay program reductions TN and TP efficiencies and the agricultural loading rate reported earlier, the annual and daily load reductions due to these acres can be calculated as follows.

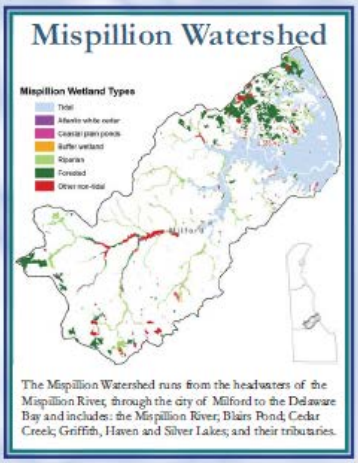
TN load reduction (lbs/yr)	=	38,259.6 acres under NMPs	X	Agricultural loading rate (24.79 lbs TN/acre/yr)	X	Reduction efficiency (13.4%)	=	**127,093 lbs TN/year**

Appendix E – Public Forum

Mispillion Watershed

The waterways of the Greater Mispillion River Watershed are considered impaired because of high levels of pollutants – nitrogen, phosphorus and bacteria. The waterways do not meet water quality standards for recreational use, such as swimming, fishing, boating and ecotourism activities.

Water pollution is a difficult and complex problem. Pollution can come from many sources: failing septic systems; farming practices; lawn fertilization; and runoff from surfaces, such as driveways, parking lots, roads and ditches.



The Mispillion Watershed runs from the headwaters of the Mispillion River, through the city of Milford to the Delaware Bay and includes: the Mispillion River; Blairs Pond; Cedar Creek; Griffith, Haven and Silver Lakes; and their tributaries.

In March 2008, the Mispillion and Cedar Creek Tributary Action Team – a volunteer group of concerned citizens, business owners, legislators, scientists and others – was formed. The team developed three approaches that could be used to improve water quality in the watershed.

This brochure outlines the possible "pollution control strategies" that were developed by the team. Each approach represents a different philosophy to solve the problem.

Approach A – Prevent pollution from entering the waterways
Approach B – Plan for and implement river-friendly growth and development
Approach C - Encourage and support beneficial uses of the river

DELAWARE TRIBUTARY ACTION TEAMS

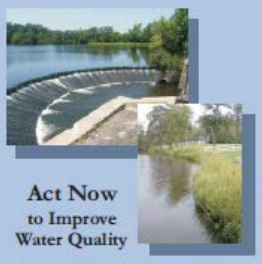
Delaware Department of Natural Resources and Environmental Control
Division of Water Resources
Watershed Assessment Section
820 Silver Lake Blvd.
Suite 220
Dover, Delaware 19904
302-739-9939

Milford Department of Parks and Recreation
City of Milford
207 Franklin Street
Milford, Delaware 19963
302-422-1104

The Mispillion and Cedar Creek Tributary Action Team
invites you to:

An Open Public Forum

Wednesday, Nov. 4
7 – 9 p.m.
Carlisle Fire Hall
615 N.W. Front Street
Milford



Act Now to Improve Water Quality

The future of the MispillionWatershed depends on your help!

We need your input to finalize a Pollution Control Strategy!

What do you think needs to be done to improve water quality? What steps need to be taken? Please tell us what you believe will work and what won't. Your thoughts and opinions are important!

Approach A

Prevent pollution from entering the waterways

Approach B

Plan for and implement river-friendly growth and development

Approach C

Encourage and support beneficial uses of the river

Approach A

Prevent pollution from entering the waterways

Possible solutions

- Educate landowners on proper septic system use
- Reduce nutrient levels from septic systems
- Provide low-interest loan/cost share programs to replace/repair septic systems
- Require additional quality control of runoff from streets, driveways and other impervious surfaces
- Monitor agricultural plans for animal wastes -Nutrient Management Plans (NMPs) and Best Management Practices
- Implement improved residential landscaping practices (reduce fertilizer use and runoff)
- Recommend vegetated buffers for all water bodies
- Educate residents and tourists about proper solid waste disposal and enforce regulations
- Control riverbank erosion due to boat wakes

In Support of this Approach

- Results in a healthier environment and improved public health
- Biggest bang for the buck
- Prevention of pollution means less cleanup later

In Opposition to this Approach

- May need to regulate
- People may feel their rights are impacted
- Will require behavioral changes

Approach B

Plan for and implement river-friendly growth and development

Possible solutions

- Recognize and incentivize "green" development that limits nutrients and bacteria from entering the waterways
- Increased regulation of stormwater runoff from developments
- Retrofit older developments and roadways to provide management of storm-water runoff
- Require vegetated buffers along water bodies
- Promote water reclamation
- Expand farmland and forest preservation
- Protect environmentally sensitive areas
- Expand sewer districts into developed areas currently using septic systems
- Implement targeted education initiatives

In Support of this Approach

- Improves quality of life
- Presents opportunities for design and technological approaches
- Deals with residential sources of pollution
- Presents economic opportunities for incentivizing green technology
- Preventing pollution is easier than removing it later

In Opposition to this Approach

- May not be effective in achieving pollution reduction goals
- May impact individual rights
- If done to extreme could negatively impact economic development

Approach C

Encourage and support beneficial uses of the river

Possible solutions

- Increase awareness and marketing of existing recreational facilities and opportunities
- Market and expand river cleanups
- Develop an ecotourism plan and attract visitors and operators
- Organize trips and activities on the river
- Expand existing educational programs
- Educate the public on how actions affect the environment and provide environmentally-friendly alternatives
- Develop fish and wildlife consumption advisories as appropriate (in both English and Spanish)

In Support of this Approach

- Education and publicity are key components
- Economic development aspects have a financial benefit
- Can result in improved public health

In Opposition to this Approach

- Overuse could negatively affect water quality
- It's a warm, fuzzy approach where a direct relationship to pollution levels would be difficult to evaluate
- People who live on the river may object

Appendix F

This document describes the cost-effectiveness of urban and agricultural best management practices (BMPs) that reduce nutrients. Although the costs for Total Phosphorus (TP) removal appear high, they may be thought of as ancillary benefits of Total Nitrogen (TN) removal. In addition, they show the relative cost effectiveness of TP removal by each practice.

On-site Wastewater Treatment and Disposal System (OWTDS) BMP Cost Calculations

Connecting OWTDS to Sewer Districts

According to DNREC's Financial Assistance Branch (personal communication, 2007), the average cost of constructing a sewer system is $8,500 per equivalent dwelling unit (EDU). In the future, this cost is expected to increase to $10,000/EDU. The debt service, or cost of financing these systems, at roughly an average 2% rate is currently $1,867/EDU and will be $2,194/EDU for future septic eliminations and sewer connections. Additionally, system owners must pay for the final septic system pump-out, crushing and filling the tank, and the connection costs associated with building the lateral line running from the building to the right of way. These three expenditures together run approximately $1,000/EDU. Finally, operation and maintenance (O&M), including repair fees, of roughly $200 per EDU per year will also be added to these values for an average 20 year lifespan of a connection (DNREC Financial Assistance Branch, personal communication, 2007) (Table 1).

Table 1. OWTDS Elimination Costs

	Past Conversions	Future Conversions
Construction of sewer system	$8,500/EDU	$10,000/EDU
Debt service	$1,867/EDU	$2,194/EDU
Additional expenditures	$1,000/EDU	$1,000/EDU
Operation and Maintenance (over 20 year lifespan)	$4,000/EDU	$4,000/EDU
TOTAL	**$15,367/EDU**	**$17,194/EDU**

Holding Tank Inspection and Compliance Program

The cost of pumping-out a 2,800 gallon holding tank averages around $250 per system per pump-out (DNREC Small Systems Branch, personal communication, 2007). As a result of the holding tank inspection and compliance program, they have been shown to be pumped-out roughly 12 times a year. This information reveals that the owner of a single holding tank will spend $3,000 each year. In addition to this cost, there is an annual inspection fee of $60 per system (DNREC Small Systems Branch, personal communication, 2007), so that the total expenditure for holding tank inspection and compliance is $3,060/system/year and over a 20 year lifespan the cost is $61,200/system.

OWTDS Pump-outs

The cost of pumping-out OWTDS ranges from $185-200 per system, with an average cost of $192.50 per system (DNREC Small Systems Branch, personal communication, 2007). It is proposed that septic systems be pumped once every three years and inspected during that time period as well. These proposed inspections will be performed by licensed inspectors at an estimated cost that ranges from $200 to $400 with an average cost of $300 at the time of pump-out (DNREC Small Systems Branch, personal communication, 2007). The total cost of the OWTDS inspection and compliance program will cost the system owner $164.17/system/year and over a 20 year lifespan this equals $3,283.33/system.

OWTDS Performance Standards

Licensed installers and members of DNREC's Small Systems Branch (personal communication, 2007) revealed that the installation of best available technologies (BATs) to existing small (<2,500 gallon per day (gpd)) OWTDSs for advanced nitrogen removal would cost between $3,500 and $6,000 per system with an average installation of $4,750. These technologies are believed to last for approximately 20 years. These technologies require a service contract by a certified service provider with an estimated annual cost that ranges from $150 to $300, with an average cost of $225/system/year. In addition, the systems will still require pump-outs, which costs $64/system/year (DNREC Small Systems Branch, personal communication, 2007), and they will need periodic mechanical parts repaired, estimated to cost $50/system/year and the electrical cost of running the systems is likely to also cost about $50/system/year (DNREC Financial Assistance Branch, personal communication, 2007). Taking all of this into account, the total cost of this strategy is $12,530/system.

Stormwater BMP Cost Calculations

Wet and Dry Ponds

Typical costs for retention basins were retrieved from Chapter 6.0, "Costs and Benefits of Storm Water BMPs," of an EPA on-line document (EPA, 1999). In this document, it states that a retention basin treating a 50-acre residential site in 1999 costs about $100,000, such that the cost per unit area was $2,000/acre. All values reported in the document need to be divided by an adjustment factor to account for regional differences. Delaware falls in Region 2, which has a 0.90 adjustment factor (EPA, 1999). Thus, retention basins in Delaware in 1999 cost approximately $2,222.22/acre. Using the average annual federal inflation rate for the time period of 1913-2007 (3.42%), the capital cost of Delaware retention basins in 2009 is $2,982/acre. To this value, the annual operation and maintenance costs over a 25 year lifespan must be added. Operation and maintenance costs for retention basins can range from 3-6% of the construction costs (EPA, 1999). We have used an average value of 4.5% which is $134.19 and applied this to the regionally adjusted construction cost over the 25 year lifespan. The total cost for this strategy is $6,336.75/acre.

Infiltration Structures

The 1999 construction costs of infiltration trenches and infiltration basins treating 5-acre commercial sites were averaged to represent the range of infiltration structures utilized as stormwater BMPs throughout Delaware. These costs were $45,000 for trenches and $15,000 for basins (EPA, 1999), which equates to $9,000/acre and $3,000/acre, respectively, and averages $6,000/acre. Once adjusted for the regional variability in cost (0.90 factor), and inflated to 2009, this value becomes $8,946.67/acre treated by infiltration structures. Annual O&M costs for infiltration structures range anywhere from 1-20% of the construction cost (EPA, 1999), and average 10.5%. This produces an annual O&M cost of $939.40/acre/yr which when calculated over a 25 year lifespan and added to construction costs equals $32,431.68/acre.

Filtering Practices

Cost data for filtering practices was obtained from a publication of the Environmental and Water Resources Institute of the American Society of Civil Engineers (ASCE, 2001). Since filtering practices treat runoff from pavement and impervious areas, the construction cost was reported for the early 1990s as $10,117.36 per impervious acre. The 2009 cost can be estimated using the average federal inflation rate and the early 1990s values to be $17,008.41/acre. The O&M costs typically range from 11-13% of the construction costs (EPA, 1999), which on average, is $2,041.01/acre/year. Calculating the O&M costs over a 25 year lifespan and adding to construction costs provides a total cost of $68,033.64/acre.

Biofiltration

The EPA on-line document reported that the construction costs for biofiltration devices in 1999 were $60,000 for a 5-acre commercial site (EPA, 1999), which equates to $12,000/acre. This value must also be divided by the 0.90 adjustment factor to account for regional cost differences, which yields $13,333.33/acre, and then adjusted to the 2009 value, $17,893.33/acre. The annual O&M costs range from 5-7% of the construction cost (EPA, 1999). When using 6% as the average, annual O&M costs $1,073.60/acre/year and are further calculated over a 25 year lifespan. Thus, total costs for biofiltration equals $44,733.33/acre.

Table 2 – Stormwater BMP Costs

	Wet and Dry Ponds	**Infiltration Structures**	**Filtering Practices**	**Biofiltration**
Construction/acre	$2,982.00	$8,946.67	$17,008.41	$17,893.33
O&M (% of Construction)	4.5%	10.5%	12%	6%
Annual O&M per acre over a 25 year lifespan	$3,354.75	$23,485.00	$51,025.25	$26,840.00
Total Cost/acre	**$6,336.75**	**$32,431.67**	**$68,033.66**	**$44,733.33**