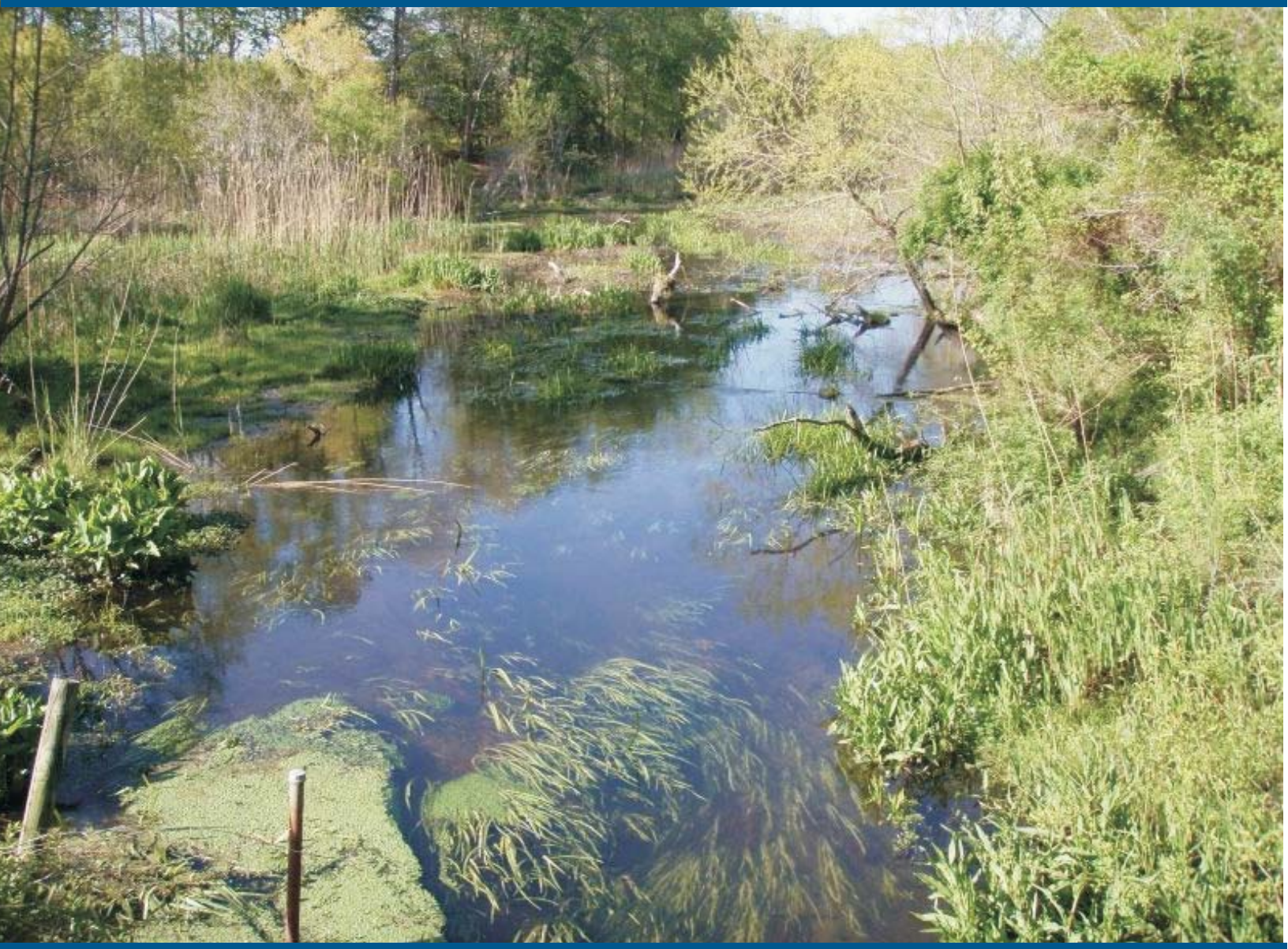
Broadkill River Watershed Pollution Control Strategy

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



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Prepared for the Broadkill River Tributary Action Team
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BROADKILL RIVER WATERSHED POLLUTION CONTROL STRATEGY

Introduction

The waters of the Broadkill River do not meet the standard of Water Act (CWA). Once the water quality has improved to the necessary extent, the waters can be removed from the 303d list. The Total Maximum Daily Load (TMDL) specified pollutants levels at required overall reduction of nitrogen and phosphorus in the waterways by 40% and reduce bacteria levels in the Broadkill watershed by 75%.

This pollution control strategy specifies a set of actions that will result in required nutrient and bacteria reductions. The contents of the Broadkill River 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 Broadkill River Pollution Control Strategy will specify actions to implement both the Broadkill River Pollution Control Strategy and Watershed Implementation Plan. The Pollution Control Strategy was developed utilizing information found with the following documents:

- Broadkill River 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
- 2006 Broadkill River TMDLs
- Surface Water Quality Monitoring Plan, 2007
- Broadkill Implementation Plan, 2008.

Watershed Background

Broadkill Watershed is located in Sussex County, Delaware, with a coastal border adjacent to the Delaware Bay and the Atlantic Ocean along its eastern most boundaries (see Figure 1-The 2002 Landuse of the Broadkill watershed). Sussex County is the southern-most county in Delaware, within the Coastal Plain physiographic Region, and has a land area of 938 square miles with a water area of 258 square miles. The population of Sussex County is 176,548 (circa 2005), with a population density of 188 people /square mile. Fifty-three (53%) percent of the total population of the county lives in rural areas.

Land Use

The Watershed is 1 of 13 watersheds in Sussex County (USGS HUC-10). The total area of the Watershed is 105 square miles and contains three (3) major municipalities: Milton, Lewes, and Georgetown. Milton, located in the center of the Watershed, at elevation 30 feet above sea level

has a land area of 1.06 square miles Milton's population is 1,792 (estimated in July 2006) and the population density is 1,692 people /square mile. Lewes, a coastal city on the eastern boundary of the Watershed, is at elevation 18 feet above sea level. The land area of Lewes is 3.66 square miles, with a population of 3,119 (estimated in July 2006) and population density of 850 people/square miles. The northeastern portion of the City of Georgetown is located within the Watershed. Georgetown is located on the western boundary of the Watershed. Georgetown has a land area of 4.13 square miles, at elevation 52 ft. The population of Georgetown is 4,927 (estimated in July 2006) and has a

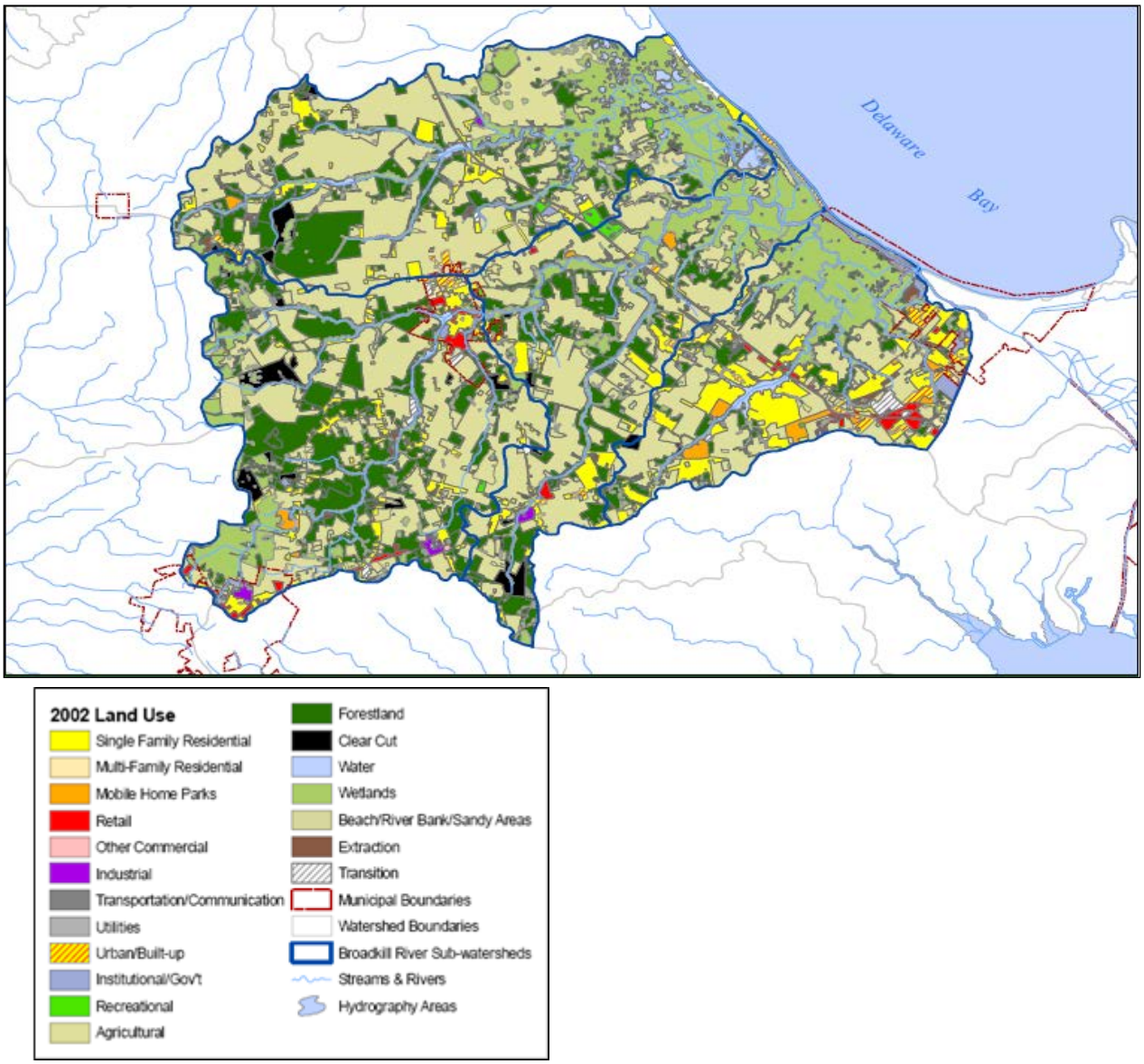

Figure 1 – 2002 Landuse in the Broadkill River Watershed

population density of 1,186 people/ square mile. According to 2007 land use data, water/marsh comprises 2.86% of the area in the Watershed while the largest land use area in the Watershed is agricultural lands (38.6). Animal farming is common within the Broadkill River Watershed. Animal counts within the Watershed show that poultry is the most common, followed by, in

decreasing order, dairy cattle, beef cattle, swine, and horses (DNREC, June 2005). Landuse has changed significantly since 1984, and in decreasing order of areal extent, are agriculture; forest land; wetland urban; and lastly, barren lands. The order of these land uses has not changed from 1997 to 2007 (Table 1). Other land use changes from 1997-2007 include a 4.27% increase in residential area; a 2.44% loss of forested land; and a 3.177 % loss of agricultural land. Wetlands/water decreased slightly in the last decade by 0.8%.

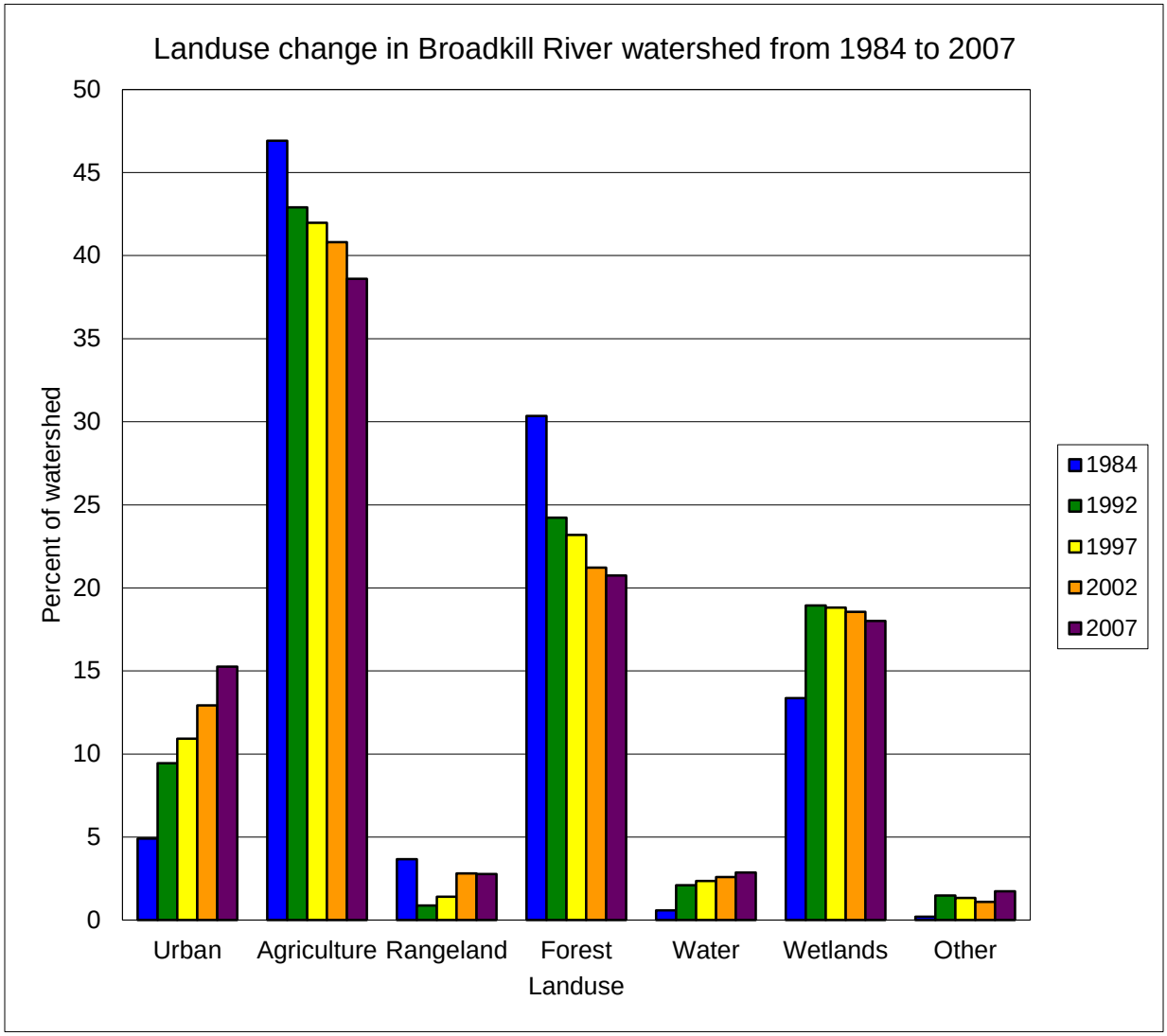

Figure 2 – Change of landuse in the Broadkill River Watershed from 1984 to 2007.

Summary of Existing Conditions

High levels of bacteria and elevated levels of the nutrients nitrogen and phosphorus impair the Broadkill River, its tributaries and ponds. As required by the Federal Clean Water Act, the Delaware Department of Natural Resources and Environmental Control (DNREC) is responsible for implementing water quality monitoring and assessment activities in the State and also for establishing Total Maximum Daily Loads (TMDLs) on impaired State surface waters as indicated on the State's 303(d) List. In addition, the State of Delaware is under a court-approved

Consent Decree (C.A. No. 96-591, D. Del 1996) that requires completion of TMDLs for certain impaired State waters by 2006. In order to complete these TMDLs, DNREC has contracted with the environmental modeling firm (HydroQual, Inc.) to develop mathematical models of the Broadkill River watershed to assist in developing the TMDLs. These mathematical models include a landside watershed model to calculate nonpoint source (NPS) runoff and quality, a hydrodynamic model to calculate the movement of water in the tidal reaches of the Broadkill River (below the City of Milton), and a water quality model that is coupled to the hydrodynamic model to calculate water quality in the tidal reaches of the river. As part of the Broadkill River watershed model development, data compilation and analyses were completed in addition to model development, calibration and validation. The data compilation/analysis and model development is presented in the following technical memorandum and report:

- Broadkill River Watershed TMDL Development, Data Analysis Technical Memorandum (HydroQual, 2004); and
- Broadkill River Watershed TMDL Model Development (HydroQual, 2005).

303(D) Listed Waterbodies

Table 1 – Broadkill River Watershed TMDL Segments

Water Body ID	Segment	Size Affected	Description	Parameters	Probable Source
DE060-001	Lower Broadkill	8.1 miles	From the confluence with Beaver Dam Creek to mouth at Delaware Bay, excluding Red Mill Pond.	Bacteria, DO, nutrients	NPS
DE060-002	Beaverdam Creek	8.3 miles	From the headwaters to the confluence with Broadkill River	Bacteria, DO, nutrients	PS, NPS
DE060-003	Upper Broadkill	5.0 miles	Broadkill River from below Wagmons Pond to the confluence with Beaver Dam Creek	Bacteria, DO, nutrients	PS, NPS
DE060-004	Round Pole Branch	5.2 miles	Tributary from the headwaters to confluence with Upper Broadkill	Bacteria, DO, nutrients	NPS
DE060-005	Ingrams Branch	7.6 miles	From the headwaters to Wagmons Pond, including Diamond Pond	Bacteria, DO, nutrients	PS, NPS
DE060-005	Ingrams Branch	1.7 miles	Ingrams Branch – western tributary of the headwaters	DO	PS, NPS
DE060-006	Pemberton Branch	5.0 miles	From the headwater to Wagmons Pond	Bacteria, nutrients	NPS
DE060-007-01	Lower Red Mill Branch	5.3 miles	From Red Mill Pond to the confluence with Lower Broadkill River	Bacteria, DO, nutrients	NPS
DE060-007-02	Martin Branch	1.5 miles	From the headwaters to Red Mill Pond	Bacteria, DO, nutrients	NPS
DE060-007-03	Heronwood Branch	1.0 miles	From the headwaters to Red Mill Pond	Bacteria, DO,	NPS
DE060-L01	Red Mill Pond	150.0 acres	Pond located on Martin Branch	Bacteria, DO, nutrients	NPS
DE060-L02	Wagmons Pond	35.0 acres	Pond adjacent to Milton	Nutrients	PS, NPS
DE060-L03	Waples and Reynolds Pond	88.8 acres	Ponds located on Sowbridge Branch of Primehook Creek	Bacteria, DO, nutrients	NPS

The water bodies listed (Figures 3 and 4) on the State of Delaware's 1998, 2002, 2004 and 2006 Draft 303(d) Lists in the Broadkill River Watershed are presented in Table 1. There are a total of 13 listed water segments: 3 tidal segments of the Broadkill River; 7 freshwater stream segments; and 3 freshwater lakes or ponds. These segments are listed for nutrients, DO and bacteria with the most probable source of pollutants identified as NPS except for a few segments where PS discharges are located. The TMDL development in the Broadkill River watershed was completed to address these water quality impairments (Figure 4) and present TMDLs that are aimed at improving water quality in the listed segments.

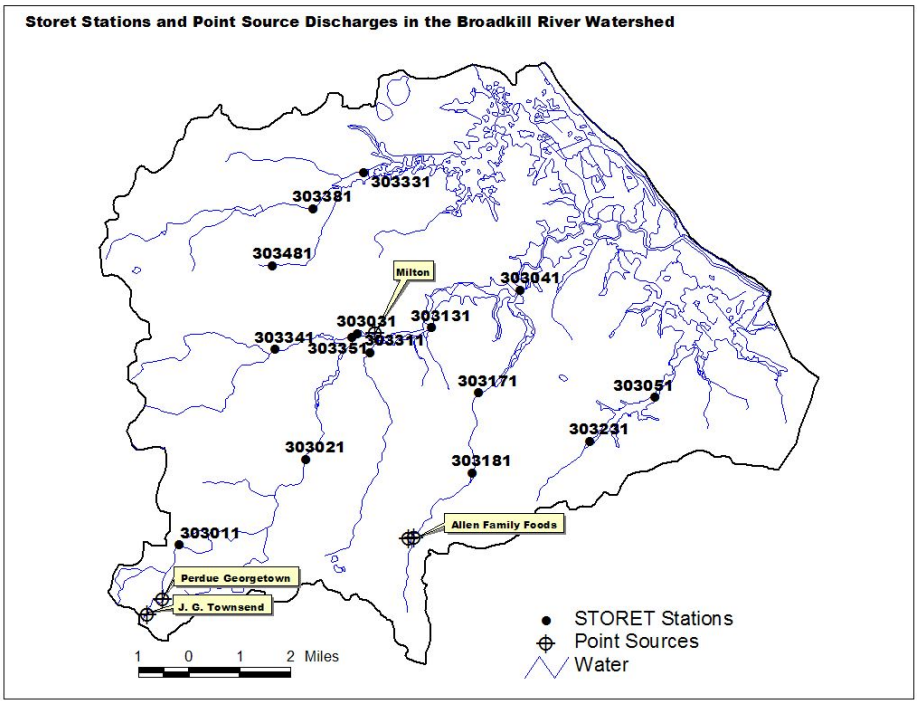

Figure 3 – Storet Stations and Point Source Discharges in the Broadkill River Watershed.

Designated Uses of the Broadkill River Watershed

According to the "State of Delaware Surface Water Quality Standards (Amended July 11,2004)", the designated uses that must be maintained and protected through the application of appropriate criteria are uses for industrial water supply; primary contact recreation; secondary contact recreation; fish, aquatic life and wildlife including shellfish propagation; and agricultural water supply in freshwater segments only. These designated uses are applicable to the Broadkill River and are achieved and maintained through the application of water quality standards and criteria as outlined in the next section.

Impairment Listings

According to the "State of Delaware Surface Water Quality Standards (Amended July 11,2004)", water quality standards (WQS) for dissolved oxygen (DO) and *enterococcus* exist. The DO WQSs in freshwater are a daily average of not less than 5.5 mg/L (minimum of 4 mg/L) and in marine waters are daily averages of not less than 5 mg/L (minimum of 4 mg/L). The

enterococcus WQS consists of two parts, a single sample value not to exceed and a monthly geometric mean. For primary contact recreation in freshwater, the *enterococcus* WQS is a single sample value of 185 colonies/100mL (col/100mL) and a monthly geometric mean of 100 col/100mL. For primary contact recreation in marine waters, the *enterococcus* WQS is single sample value of 104 col/100mL and a monthly geometric mean of 35 col/100mL. For nutrients, some site-specific or basin-specific standards exist but acceptable nutrient levels are determined based on their ultimate effect on DO or algal levels through nutrient-algal-DO relationships (eutrophication) and/or threshold levels. The nutrient standards are currently in narrative form for controlling nutrient over enrichment and are stated as:

> "Nutrient over enrichment is recognized as a significant problem in some surface waters of the State. It shall be the policy of this Department to minimize nutrient input to surface waters from point sources and human induced nonpoint sources. The types of, and need for, nutrient controls shall be established on a site-specific basis. For lakes and ponds, controls shall be designed to eliminate over enrichment."

Although national numeric nutrient criteria have not been established in Delaware, DNREC has used threshold levels of 3.0 mg/L for total nitrogen (TN) and 0.2 mg/L for total phosphorous (TP) for listing water bodies on the State's 303(d) listings and 305(b) assessment reports and, therefore, will be used as the target nutrient levels for completing nutrient TMDLs in addition to considering nutrient endpoints such as DO and algal levels (chlorophyll-a). Nutrient related algal effects typically require sufficient time for impacts to be noticed (i.e., impacts are long term in nature rather than instantaneous), therefore, the nutrient targets will be assessed based on monthly average nutrient concentrations.

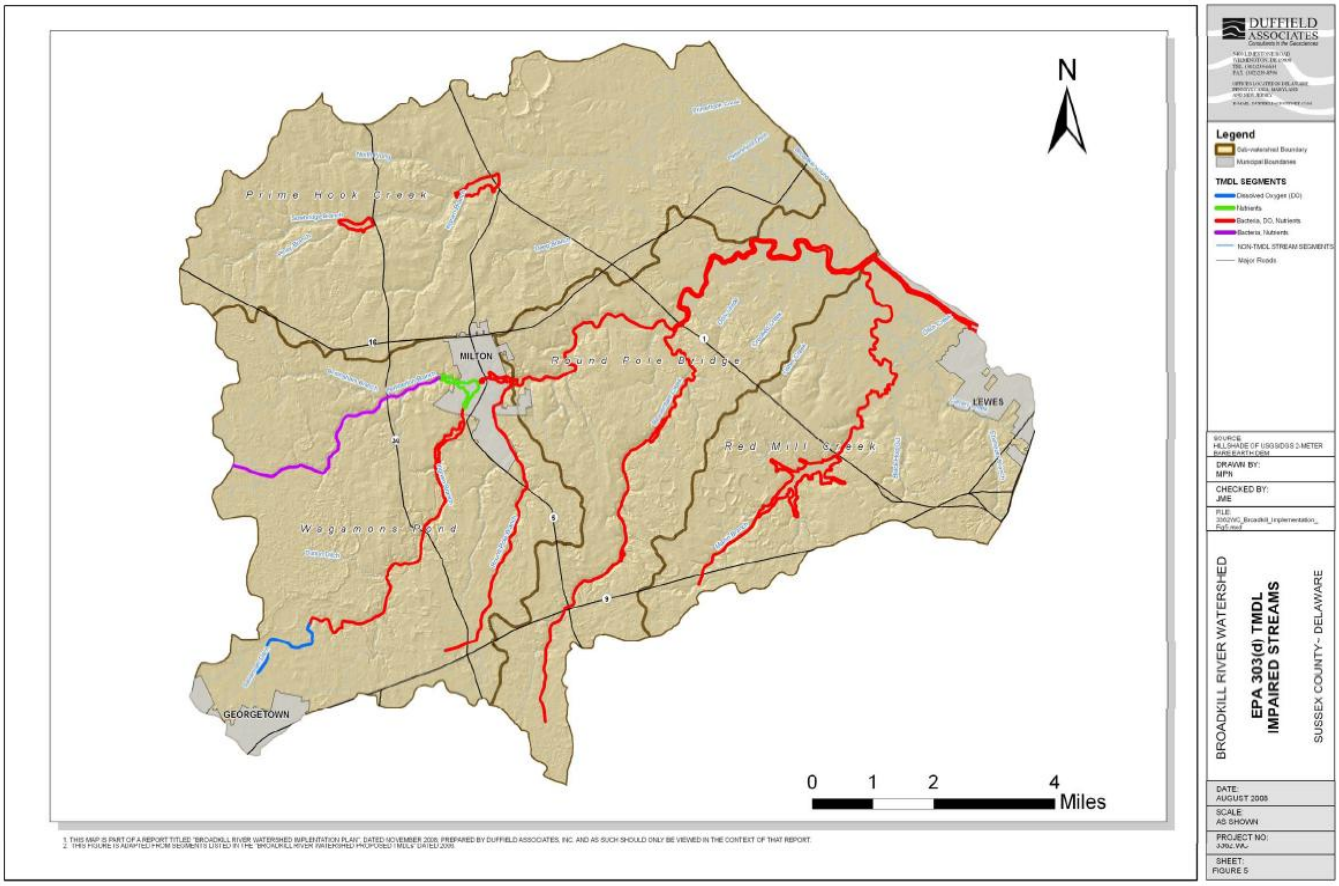

Figure 4 – Impaired Stream within Broadkill River Watershed Impairments

There are a total of 12 listed (Table 1) water segments within the Murderkill River Watershed: 3 tidal segments of the Murderkill River; 5 freshwater stream segments; and 4 freshwater lakes or ponds. These segments are listed for the following impairments:

- nutrients,
- DO, and
- Bacteria

TMDLs for the Broadkill Watershed

Total Maximum Daily Loads (TMDLs) were established for the Broadkill River Watershed in December 2006. The TMDL requires:

- A 40 percent reduction in non-point source nitrogen load (from the 2002-2003 baseline),
- A 40 percent reduction in non-point source phosphorus load (2002-2003 baseline),
- A 75 percent reduction in non-point source enterococcus bacteria (2002-2003 baseline), and

- Implementation of this TMDLs Regulation shall be achieved through the development and implementation of a Pollution Control Strategy.

Specific Goals

Originally, the Total Maximum Daily Load (TMDL) values specified in the regulation was developed to address pollutant loads based on 2002 land use values. The findings at that time targeted a nutrient reduction of 670.1 lbs per day nitrogen and 96 pounds per day of phosphorus. However, in the 10 years interim, the land use has significantly changed. As such, the PCS, as initiated in 2007, was more realistically amended to account for a 40% reduction of the original TMDL regulations as applicable to phosphorus. Using the PCS targeted reductions; this plan will address a nutrient reduction goal of 667.1 lbs per day for nitrogen and 29.4 pounds per day for phosphorus from nonpoint sources.

Table 2 – Required TMDL reductions for total nitrogen and phosphorus based upon 2007 landuse

	TN (lbs/day)	TP (lbs/day)	Bacteria
Total Needed NPS Reductions	667.1	29.4	75% reduction

Implementation Priority

Project Based

A preferred strategy for implementation will focus on project based strategies within sub-watershed. Targeted multi-faceted improvements can have significant impact on water quality improvement. This strategy has the benefit of providing "holistic" approach to implementation and satisfies requirements for various funding sources.

The identified Goals below can be assessed, ranked and prioritized within each sub-watershed. Ranking will be focused on the upland restorations because agriculture has significantly reduced its impact on water quality in the watershed.

DNREC hired Duffield Associates, Inc. to develop a Watershed Implementation Plan for the Broadkill River. The purpose of the Watershed Plan is to identify pollutant sources and outline methods to reduce pollutant loads to the established TMDLs. The Watershed Plan will ultimately provide the State and the residents with a prioritized list of pollution control opportunities within the Watershed. The opportunities presented will be based on an extensive screening process specific to the Watershed. The improvements are necessary to help meet TMDL reduction goals of 40% for Nitrogen and Phosphorous and 75% for bacteria. In addition, projects that may be eligible for 319b funds will be identified for DNREC's use in submitting grant applications.

In order to create a functional and defensible list of pollution control opportunities, the following objectives were identified for the Watershed Plan:

1. Identify appropriate technologies that are accepted approaches used to improve water quality (i.e., promote infiltration and volume reduction, construct or utilize BMPs);
2. Develop scoring criteria to be used to evaluate selected sites relative to the identified technologies;
3. Develop scoring values that are properly weighted to measure the value and feasibility of the sites;
4. Obtain sufficient desktop information to allow each site to be evaluated;
5. Perform a site reconnaissance for each site to gain additional site-specific insight and verify desktop assumptions

A goal of this project was to identify and prioritize potential restoration or preservation projects within the watershed for implementation by DNREC and others. The Watershed Implementation Plan was completed by October 2008.

Sub-Watershed Based

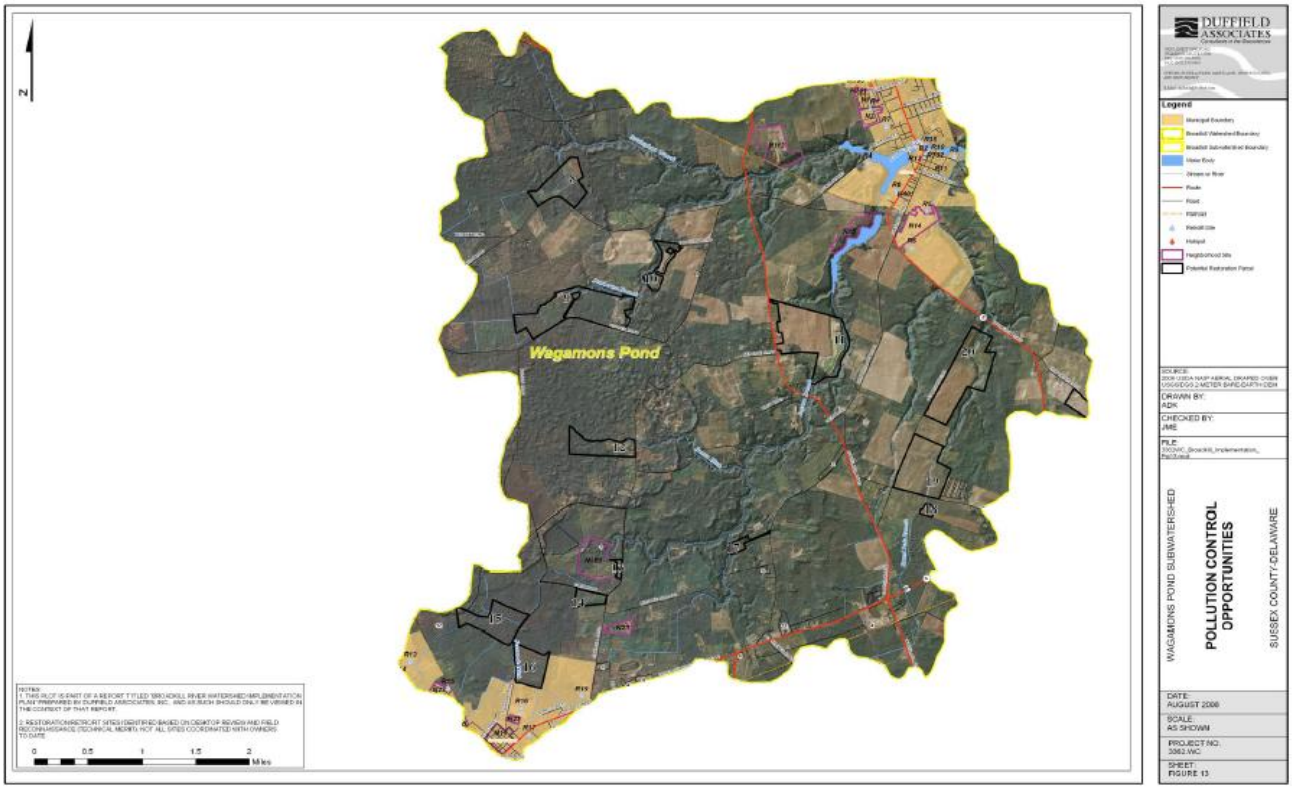

Figure 5 – Wagmons Sub-watershed with pollution control opportunities identified.

As part of a sub-watershed basis strategy, a second level of prioritization is ranking/prioritizing the sub-watersheds for implementation. Based on existing impairment, projected/expected land

use, and identified opportunities, the stream segment around Wagamons Pond and Broadkill River through Milton are identified. The greatest gain in pollution control meeting the goals of the stakeholders appear to be possible for these extended reaches.

Although a sub-watershed strategy is the recommended priority approach, it is also prudent to implement other high priority opportunities in other sub-watersheds as funding becomes available and willing landowners are identified. It is also recommended that specific sites for preservation in each sub-watershed be identified and subsequently evaluated for potential preservation/conservation opportunities.

Progress to Date

Six years have passed since the revised TMDL for the Broadkill River was promulgated using pollution levels from 2002. Since that time, population and pressures from development have increased throughout the watershed. However, stormwater and wastewater regulations have improved, and farmers have increased their use of best management practices (BMPs). Increased use of BMPs in all sectors reduces nutrient loading and contributes to progress towards achieving water quality standards.

Estimated water quality improvement resulting from the installation of best management practices after the TMDL baseline was calculated and the subsequent nutrient reductions from those BMPs are presented in the following sections. Scientists researched the nutrient load reduction efficiencies associated with these practices in order to estimate pollution reductions. Refer to Table 4 for details. The existing BMP implementation already accounts for 80 % of total nitrogen and 90% of total phosphorus reduction required 2006 TMDL.

Table 3 – Nutrients reduction resulting for Existing Best Management Practices as 2012

Current Load Reduction	TN (lbs/day)	TP (lbs/day)
Urban – Stormwater	17.23	2.90
Onsite Wastewater practices	18.54	1.89
Agricultural Practices	498.27	20.02
Current Sub-Totals	**523.26**	**24.61**

Agriculture

Since the baseline period, the agricultural community has reduced a significant amount of nonpoint source nitrogen and phosphorus, leading the efforts to curtail nonpoint source loadings. From the baseline to 2010, multiple BMPs have been implemented and the Delaware Nutrient Management Act was passed. As of January 2007, all farms that apply nutrients to 10 acres or more are required to have Nutrient Management Plans (NMPs). Subsequent Farm Bills have also led to increased funding levels of cost-share programs for BMPs that protect the environment, especially water quality.

Table 4 – Implemented Agricultural Best Management Practices (BMP)as of 2012			
	Current Acres	**TN reduced (lbs/day)**	**TP reduced (lbs/day)**
Grassed Filter Strips	13.80	0.84	0.02
Wildlife habitat	118.25	4.76	0.10
Wetland restoration	87.40	7.48	1.71
Riparian Buffers	14.40	1.23	0.03
Grass Buffers	151.5	9.24	0.22
Forest Buffers	191.5	16.38	0.41
Cover Crops	4563.1	106.58	0.25
Manure Relocation (tons)	1265	14.33	1.03
Nutrient Management Plans	26,476	337.30	17.41
Phytase			0.38
Total		**498.27**	**20.02**

Total Progress to Date:

Estimated Nutrient Reductions: 498.27 lbs/day TN; 20.02 lbs/day TP; a study done in Virginia in 2003 indicated that buffers can reduce bacteria by 43 to 57%, especially in agricultural watersheds.

Estimated Progress to Date – Implementation Cost: $10,694,243

Onsite Wastewater

Current septic system pump outs and conversion of onsite wastewater systems to central sewer systems, while not extensive, have helped to decrease the nutrient pollution entering the Broadkill watershed. Twenty-one holding tanks in the watershed are currently being pumped out a year, while 350 properties in the watershed have been converted from septic systems to central sewer systems.

Total Progress to Date:

Estimated Nutrient Reductions: 18.54 lbs/day TN; 1.89lbs/day TP

Estimated Progress to Date Implementation Cost: $5,129,880

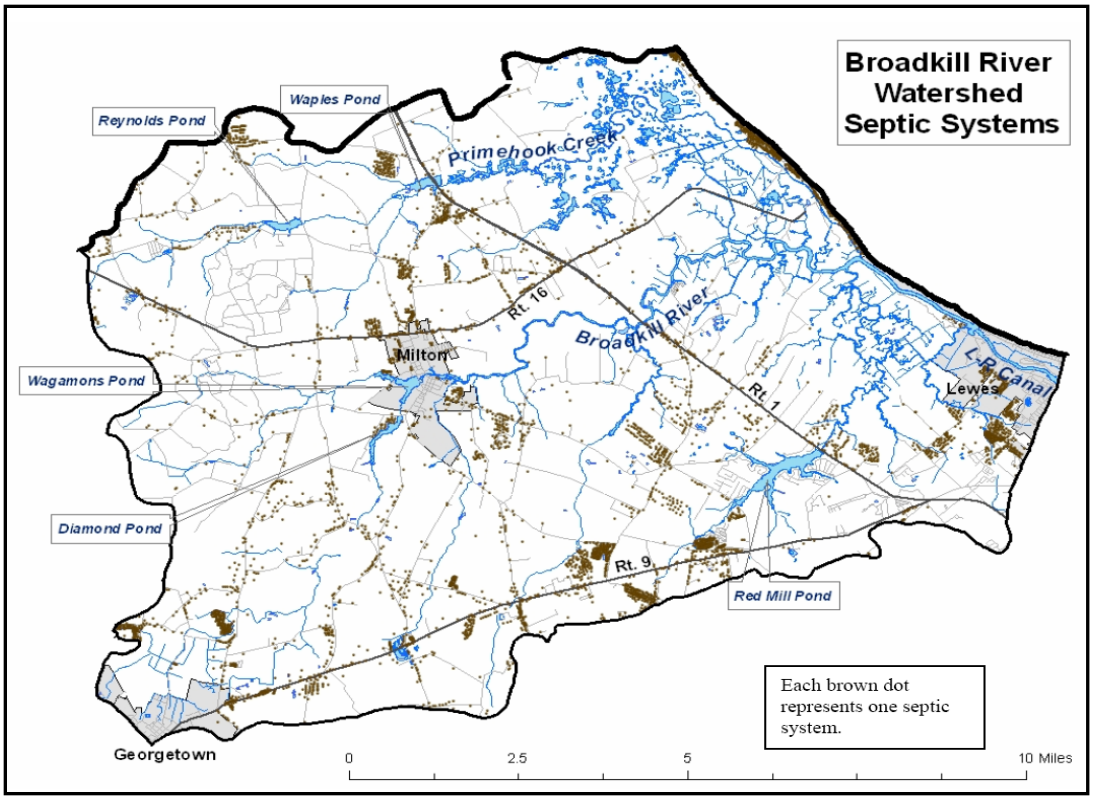

Figure 6 – Septic systems in Broadkill River Watershed

Stormwater

In June 1990, the Delaware Legislature passed the Sediment and Stormwater Law to help correct the State's water quality and quantity problems. Implementation was initiated in July of 1991, and addressed sediment control during construction and post-construction, stormwater quantity, and water quality control. Since this implementation, many BMPs for stormwater have been implemented and more are constructed each year. The Sediment and Stormwater Regulations are currently being revised to promote the use of stormwater management techniques that are more efficient at reducing nutrient loading, heightening awareness of green technology BMPs, and promoting stormwater management practices based on low impact development and conservation design.

Table 5 – Implemented Stormwater Best Management Practices (BMP) as of Spring 2012

BMP	Acres treated	TN Reduced (lbs/day)	TP Reduced (lbs/day)
Dry Pond	268.33	0.44	0.10
Wet Pond	1503.61	14.83	2.68
Infiltration practices	80.92	1.33	0.2
Total		16.60	2.97

Total Progress to Date:

Estimated Nutrient Reductions: 16.60 lbs/day TN; 2.7 lbs/day TP; Stormwater Best Management practices database (2001) indicated that sand filters are effective in removing from 36 to 83% of the bacteria in urban runoff.

Estimated Progress to Date Implementation Cost: $35,855,373

Bacteria reductions

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 6 illustrates typical bacterial reductions from commonly used BMPs.

The Broadkill watershed bacteria TMDL requires a 75% 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 Broadkill. The water quality standard for enterococcus bacteria in the Broadkill 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 Broadkill River are discussed in more detail below.

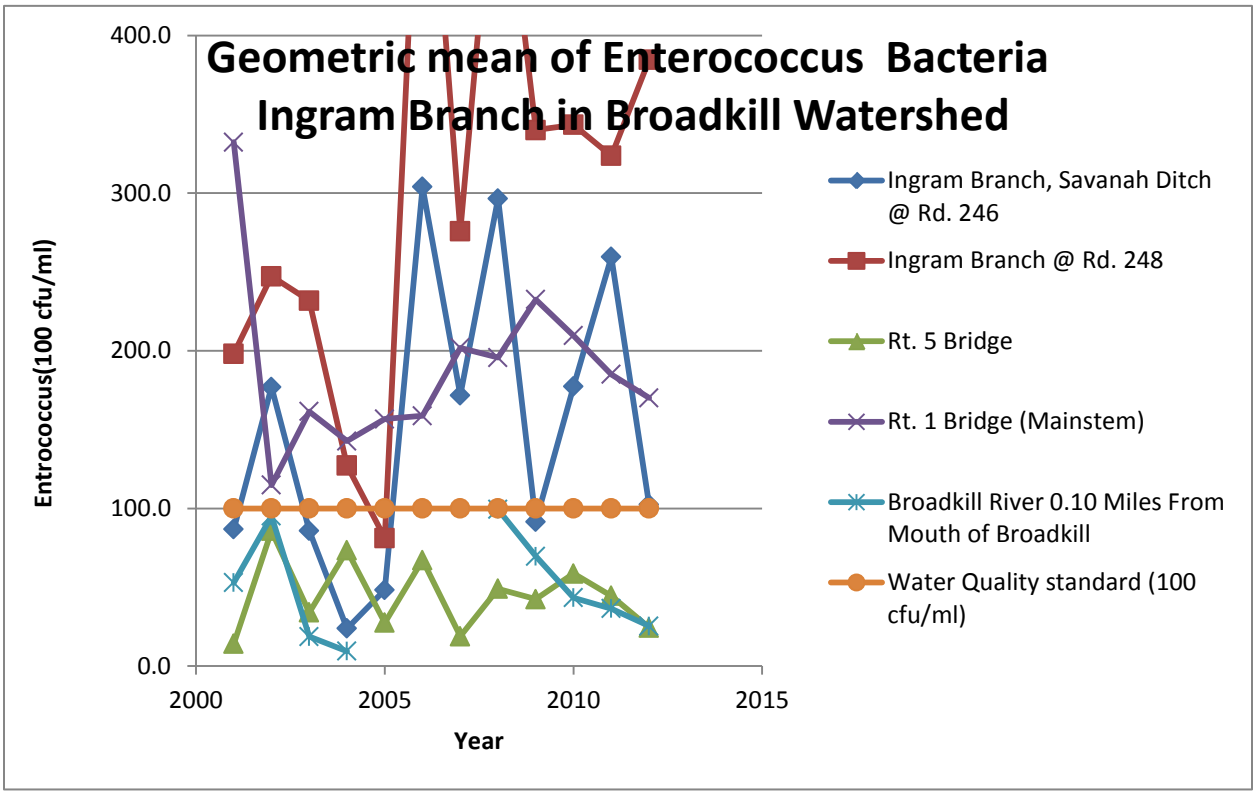

Figure 7 – The yearly geometric mean of Enterococcus Bacteria in Broadkill River.

The levels of enterococcus bacteria in Mispillion River show no apparent trend as was observed in Ingram Branch down to the mouth of the Broadkill. The levels continue to fluctuate in the Broadkill River as well as, Old Mill Creek which flows through Red Mill Pond and Beaverdam Creek. Figure 7 shows the geometric mean enterococcus bacteria levels in the Broadkill 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.

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Table 6 – Typical bacteria, suspended solids, and nutrient reduction from stormwater best management practices						
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	60	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	50	50	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	78 – 90

*if properly maintained

Goals – Broadkill River Watershed Recommendations

Broad Purpose

The broad purpose of this strategy is to return the impaired waters of the Broadkill River Watershed to a condition permitting use of the waterways as required by the Clean Water Act (33 USC §1251 et seq. (1972)) so it can be removed from the 303(d) list.

Specific Goals

More specific goals of this strategy include limiting pollutants to levels at or below the Total Maximum Daily Load (TMDL) values specified in the recommendations as follows in Table 7:

Table 7 – Specific Goals for the restoration of the Broadkill Watershed		
Future Load Reductions by Sector	**TN (lbs/day)**	**TP (lbs/day)**
Urban Stormwater Goals	6.1	1.03
Urban Buffer Goals	34.2	0.85
Agriculture Goals	Maintain existing implementation rate	Maintain existing implementation rate
Onsite Wastewater Goals	81.9	2.16
Future Sub-Totals	**134.49**	**4.51**
Current Sub-Total	533.41	24.89
Totals	**667.39**	**29.40**

To achieve these specific goals, a pollution control strategy was developed by DNREC in concert with the Tributary Action Team, other stakeholders, and the public.

Guiding Principles

The Team worked to improve the water quality of the Broadkill River watershed using sound science as a basis for decisions, developing solutions that are integrative, creative and innovative, with due consideration given for the private property rights of individuals in the community and for the welfare of present and future generations who live and work in the watershed.

The Team operated by consensus, and effort was made to meet the interests of all the participating stakeholder groups. We defined "consensus" to mean that there is no dissent by any member. Members were advised by facilitators not to block or withhold consensus unless they had serious reservations with the recommendation or approach. If members disagreed with the recommendation or approach selected by the rest of the group, they were asked to offer an alternative. If there was still disagreement after discussion and consideration of alternative approaches, we have noted that member(s) withheld consent. Within the PCS recommendations we note where Team members dissented with majority as a "veto".

Agriculture

Agriculture is by far the largest land use in the watershed representing approximately 40% of the land area. In 1999, the Delaware Nutrient Management Act was established to improve water quality while maintaining agricultural profitability. It established a certification program that encourages the implementation of best management practices (BMPs). Currently, all agricultural operations in the Broadkill watershed have developed nutrient management plans. BMPs installed through 2006 include: Nutrient Management Plans; cover crops; Conservation Reserve Program practices; Conservation Reserve Enhancement Program (CREP) practices; manure relocation/alternative use; and the use of Phytase in poultry feed. These BMPs have produced reductions of approximately 498.27 lbs/day of nitrogen (80% of total target reduction) and 20.02 lbs/day of phosphorus (90% of total target reduction). Annually, these BMPs cost approximately $282,000, making them a very cost effective means of reducing nutrients to local ground and surface waters; however these reductions are estimates based on assumptions for each BMP efficiency. These reductions in N and P are impressive. These voluntary cost share programs seem to be accomplishing the intended purpose. In comparison to other pollution control strategies in urban sectors, these approaches are relatively inexpensive to implement. Even more could be done if all citizens were willing to share in the cost; the issue is one of fairness and who pays.

The team noted that some agricultural operations in the watershed are in environmentally sensitive areas and if further reductions are recommended, then the following criteria should be considered:

> Target BMP types and target locations based on farm (***site***) specific criteria (proximity to impaired waterbodies, soil types, BMPs in place, BMPs in compliance and BMPs needed). (NOTE: Points to consider include: profit margin-don't throw

another cost burden on farmer; inspections-lose cost share support if not following rules); evaluation component-how many inspectors/frequency of inspections/compliance rate).

Because these BMPs may be cost prohibitive for the individual farmer to bear, increase cost share program funds for best management practice strategies that produce significant results in the most sensitive areas. These BMPs may include: cover crops, conservation tillage, riparian buffers, manure storage sheds, etc.

Continue to refine Nutrient Management Plans for all agricultural operations in the watershed, such as providing more assistance with implementation for Pre-Sidedress Nitrogen Tests (PSNTs), NMP soil sampling, education, outreach, and measurable outcomes.

Search for ways to improve real-time assistance to farmers. For example: email digital pictures of pests to farmer to improve efficiency/response time.

The team notes that the conversion of agricultural land for non- agricultural purposes will change nutrient runoff in ways that should be closely monitored.

Non-Agriculture Stormwater

In 2002, there were more than 8,867.4 acres of developed lands in the watershed as of 2007 there is 10, 462 acres of developed land. Any development that occurred prior to 1990 was not subject to the State's Sediment and Stormwater Law, which requires any land disturbing activities of a certain size to address water quantity and water quality issues specifically related to sediment. Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing nutrients than others. The Sussex Conservation District, who oversees the planning, construction, and maintenance of stormwater facilities in the county, is in the process of updating a database that will track BMPs by type and location. Until that data is available, a visual reconnaissance of subdivisions in the Broadkill Watershed in spring 2007 revealed that approximately 268.33 acres are treated by dry ponds and that approximately 1,503.61 acres are treated by wet ponds. These BMPs produce reductions of 15.27 lbs/day of Nitrogen and 2.78 lbs/day of Phosphorus. Annually, these BMPs cost approximately $455,000.

As noted in the Agriculture recommendations, the Team notes that conversion of Agriculture to non-agricultural land uses can impact the nutrient reductions made by the Agriculture sector. There are currently 15,000 (approx.) new residential units approved by municipal and county government in the watershed. The types of development and use of stormwater best management practices can have either positive or negative effects on nutrient reductions.

The Team recommends:

- Development activities that are subject to Delaware's Sediment and Stormwater Law shall provide stormwater management that includes nutrient reductions consistent with TMDL load reductions, or shall utilize 'best available technologies' (BATs) in the project design where TMDL load reductions are not feasible.

- Enforce sediment control measures during construction phase. TAT recommend enforcement provisions that are adequate and appropriate. This may include larger penalties, such as fines and stop work orders, and require remediation in addition to mitigation. We recommend the review and approval of sediment control measures during the pre-construction phase, and enforcement responsibilities.

- Encourage site specific, streamside vegetated buffers throughout the watershed through open space designations and incentives, as well as through targeted outreach/education programs. (2 vetoes)

- Provide incentives for the use of pervious materials and strategies (to take the place of traditional impervious ones) for sidewalks, parking lots, and roadways should be provided to developers by all governmental entities.

- Encourage the use of conservation design principles that reduce surface water runoff of nutrients, such as those that promote infiltration, narrower roads and sidewalks, swales and grassed waterways, water conservation and recycling, natural resource protection, open space preservation, and park creation, among other practices.

- The County, State and local governments should create codes and regulations that provide for incentives that allow and promote "conservation design" principles with a goal of reducing nutrient loads. Require stormwater maintenance plans for new development.

- Develop manuals on residential stormwater system maintenance to address new and older developments. Existing documents should be disseminated to homeowners.

- Develop a program or means to provide outreach/education to homeowners served by a stormwater management system. This program should address maintenance plans, funding obligations, legal obligations, resource agencies, etc.

- Require Realtors to provide disclosure information regarding stormwater management requirements to the buyer in writing at time of contract (1 veto).

- Establish stormwater retrofit requirements for direct discharge to the Broadkill River, ponds, and tributaries.

- Require DNREC to develop a stormwater retrofit strategy for communities built before 1991 so they can reduce the quantity of nutrients, bacteria, and sediment that they deliver to ponds and streams (e.g. rain gardens, vegetative buffers).

- As part of DelDOT highway maintenance program, plant trees ***(vegetated buffers)*** along all roads and highways to absorb water and reduce run–off, consistent with highway safety standards (2 vetoes).

- Encourage county and municipal authorities to reduce the number of required parking spaces at shopping malls, break up the parking areas with planted islands, and use of porous surface.

- Encourage municipal and county authorities to mail stormwater pollution prevention information.

- Encourage municipal and state authorities to prevent or remediate the silting in of public pond systems to assure their ongoing existence.
- Investigate the possibility of converting ditches to shallow ponds that could remove nutrients from the runoff stream by holding up low flow rates to permit time for nutrient reduction (1 veto).
- Investigate and propose modalities for financing future stormwater needs.
- Use cost-benefit analysis to help set priorities for stormwater management projects.
- Require stormwater maintenance plans for new commercial properties. (1 veto)
- Develop manuals on stormwater system maintenance to address commercial properties. Existing documents should be disseminated to commercial property owners.

Wastewater

Within the Broadkill Watershed, several initiatives have led to nutrient reductions to date. A state-wide Holding Tank Compliance Program assists the 21 holding tanks in the watershed with monthly pump-outs, which reduces the nutrients entering groundwaters. In addition, approximately 350 individual onsite wastewater treatment and disposal systems (OWTDS) in the Red Mill Pond area were eliminated when they were connected to a central sewer district. These actions have resulted in estimated reductions of 18.54 lbs/day of Nitrogen and 1.89 lbs/day of Phosphorus and annually, had a cost of approximately $333,000. (Note that this cost is annualized over the life of the loan and/or BMP).

- Require new and replacement onsite wastewater treatment and disposal systems (OWTDS) larger than 2,500 gpd to use technologies that achieve specific performance standards for TN and TP. Typically, phosphorus reducing technologies are only recommended where site specific conditions warrant.
- Investigate and report state-of-the-art best available technologies for the non-water management of waste, including pilot demonstration projects.
- Require enforcement of existing individual OWTDS regulations. (1 veto)
- Provide incentives and financial assistance when needed for repair and upgrade of individual OWTDS, (particularly for low income households).
- Develop a program or means to provide outreach/education to homeowners served by an OWTDS. This will require a dissemination strategy.

Potential Targeted Opportunities

The Wagamons Pond and Broadkill River through Milton sub-watershed could benefit from restoration/enhancement/preservation. The Watershed Implementation Plan has identified these water quality improvements for:

- Additional preservation targeted around Savannah Ditch;

- Retrofits in the urbanized sections of Cities of Milton and Georgetown;
- Retrofits in older neighborhoods around the Cities of Milton and Georgetown;
- Reduction of point sources of pollutant discharges from Allen Family Foods, SAW Georgetown Plant, Purdue Georgetown Plant, and City of Milton WWTP; and
- Watershed Management Water Quality throughout the sub-watershed in non-urban areas.

The specific projects are identified in the following table:

Table 8 – Recommended Upland Sites by Rank and Project Status For Wagamons Pond sub-watershed

Rank for water quality Improvements	Project ID	Name	Project status
High	N21	Briggs Development	
	N1	Shipbuilders Village 1	
	N2	Shipbuilders Village 2	
	N113	Harvest Run	
	N19	Laurel Street	
	N15	Su Sax Acres (aka Diamond Overlook)	
	N20	Race Street	
	N109	Sandhill Acres	
Medium		Delmarva Christiana	**Initiated**
	R18d	High School	
	R07a	H.O. Brittingham Elementary	**Completed**
	R17b	Georgetown Square	
	H700	Sherman Heating Oil	
Low		Ace Hardware	
	H701	Shipping	
		Downtown Public	
	R02a	Parking	
	R702a	Town Hall	
	R701c	Sussex County Library	**Completed**
	R17c	Georgetown Square	
	R17a	Georgetown Square	
	R701b	Sussex County Library	**Completed**
	R701d	Sussex County Library	**Completed**
	R701a	Sussex County Library	**Completed**
	R10a	Milton Firehouse/Police Auxiliary Parking	**Grant Funding obtained**
	R34a	ACE Hardware/Strip Mall/Recycling Center	
	R700a	Iguana Grill	
	N20	Race Street	
	N109	Sandhill Acres	
	N24	Harborview	
	N28	Devries Circle	
	N14	Cannery Village	

Summary of Urban Recommendations

Load Reduction: 195.24 lbs/day TN and 7.5 lbs/day TP

Table 8 – Summary of Urban Goals over 10 years				
	Goal (Treated Acres)	**Cost**	**Load Reduction TN Goal (lbs/day)**	**Load Reduction TP Goal (lbs/day)**
Urban Stormwater	602.9	$172,643	5.9	0.94
Urban Buffers	400	$44,745	34.2	0.85
Totals			**40.1**	**1.79**

Stormwater

Retrofit Strategy recommendations:

- Establish stormwater retrofit requirements for direct discharge to the Broadkill River, ponds, and tributaries. Retrofit projects should focus on volume management by increasing emphasis on recharge and infiltration of stormwater, where it is technically and environmentally feasible.
- Require DNREC to develop a stormwater retrofit strategy for communities built before 1991 so they can reduce the quantity of nutrients, bacteria, and sediment that they deliver to ponds and streams
- Use cost-benefit analysis to help set priorities for stormwater management projects

The goal of the Broadkill Watershed Implementation Plan was to identify and prioritize potential restoration or preservation projects within the watershed for implementation by DNREC and others. In order to create a functional and defensible list opportunities, the following objectives were identified for the Watershed Plan:

- Identify appropriate technologies that are accepted approaches used to improve water quality (i.e., promote infiltration and volume reduction, construct or utilize BMPs);
- Develop scoring criteria to be used to evaluate selected sites relative to the identified technologies;
- Develop scoring values that are properly weighted to measure the value and feasibility of the sites;
- Obtain sufficient desktop information to allow each site to be evaluated;
- Perform a site reconnaissance for each site to gain additional site-specific insight and verify desktop assumptions.

DNREC believes that the Broadkill Watershed Implementation Plan achieves the three retrofit recommendations listed above. The Plan indicated that there are 2367 acres of impervious surface that are not treated by any stormwater management practices and within Wagamons pond subwatershed there are 602 acres of impervious surface which is not treated.

- Implementation Rate: 602 acres in 10 years
- Cost: Estimated $172,643
- Funding: NPS Program Section 319
- Load Reduction: TN: 6.1 lbs/ day and TP: 1.03 lbs/day

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

Buffer recommendations

Encourage site specific, streamside vegetated buffers throughout the watershed through open space designations and incentives, as well as through targeted outreach/education programs. (2 vetoes). The Broadkill Watershed Implementation Plan also addressed streamside buffer and floodplain projects which prioritize projects. In the Wagmons subwatershed 10 potential projects were identified.

- Implementation Rate: 400 acres in 10 years
- Cost: Estimated $44,475
- Funding: NPS Program Section 319, Delaware Clean Water Advisory Council
- Load Reduction: TN 34.2 lbs/ day and TP: 0.85 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Will be measured by the number acres of streamside vegetated buffers established within the Broadkill watershed.

Regulatory stormwater recommendations:

a) Development activities that are subject to Delaware's Sediment and Stormwater Law shall provide stormwater management that includes nutrient reductions consistent with TMDL load reductions, or shall utilize 'best available technologies' (BATs) in the project design where TMDL load reductions are not feasible.

b) Enforce sediment control measures during construction phase. TAT recommends enforcement provisions that are adequate and appropriate.

c) Encourage the use of conservation design principles that reduce surface water runoff of nutrients, such as those that promote infiltration, narrower roads and sidewalks, swales and grassed waterways, water conservation and recycling, natural resource protection, open space preservation, and park creation, among other practices.

d) The County, State and local governments should create codes and regulations that provide for incentives that allow and promote "conservation design" principles with a goal of reducing nutrient loads. Require stormwater maintenance plans for new development.

e) Require Realtors to provide disclosure information regarding stormwater management requirements to the buyer in writing at time of contract.

f) Require stormwater maintenance plans for new commercial properties.

g) Investigate and propose modalities for financing future stormwater needs.

DNREC believes that most of these recommendations will be achieved when the new Sediment and Stormwater regulations are promulgated in 2012.

- Implementation Rate: NA
- Cost: Regulatory Requirement for New Systems
- Funding: NA
- Load Reduction: NA

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

Impervious surface recommendation Strategy:

- Provide incentives for the use of pervious materials and strategies (to take the place of traditional impervious ones) for sidewalks, parking lots, and roadways should be provided to developers by all governmental entities.
- The County, State and local governments should create codes and regulations that provide for incentives that allow and promote "conservation design" principles with a goal of reducing nutrient loads.

DNREC believes that these two recommendations will be achieved when the new Sediment and Stormwater regulations are promulgated in 2012 but additional impervious surface reductions can be achieved if local governments require few parking areas. DNREC will make recommendations to the local governments when their comprehensive plans are updated.

- Implementation Rate: NA
- Cost: Estimated $0
- Funding: NA
- Load Reduction: NA

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

Educational recommendation strategies:

a) Develop a program or means to provide outreach/education to commercial property owners served by a stormwater management system. This program should address maintenance plans, funding obligations, legal obligations, resource agencies, etc.

b) Develop manuals on residential stormwater system maintenance to address new and older developments. Existing documents should be disseminated to homeowners.

c) Encourage municipal and county authorities to mail stormwater pollution prevention information.

d) Encourage municipal and state authorities to prevent or remediate the silting in of public pond systems to assure their ongoing existence.

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 Sussex County Conservation Districts with cooperation from DNREC's Sediment and Stormwater Program and NEMO has held workshops for homeowners associations and residents in Sussex County.

A comprehensive education plan to teach the public how their actions impact the Murderkill Watershed (and specifically water quality) should be implemented. Some suggestions include:

a) Public service announcements.

b) Brochures distributed through real estate agents, retailers, and school children

c) Face to face education with Home Owners Associations and other organizations

d) Coordination with Master Gardeners' education

e) Integration of education into the state and local permitting processes

f) Education on purchasing of water conserving appliances

g) Education of school children on water quality

- Implementation Rate: NA
- Cost: Estimated $0
- Funding: NA
- Load Reduction: NA

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the homeowners that received stormwater management education

Summary of Septic Recommendations

Best Management Practices (BMPs) for septic systems (OWTDS) are encouraged and supported. New funding sources should be sought and financial incentives should be increased. The BMPs listed in the table below should be considered.

Desired Load Reduction: 86.89 lbs/day TN and 2.16 lbs/day TP

Table 9 – Summary of Septic Recommendations

	Goal	Cost	Load Reduction TN Goal (lbs/day)	Load Reduction TP Goal (lbs/day)
Inspection and Pump Out all OWTDS	As properties are sold	NA	5.63	2.16
Require all OWTDS over 2500 gpd to meet performance standards	8	NA	81.26	0
Totals			**86.89**	**2.16**

A. Require enforcement of existing individual OWTDS regulations**.**

Basis of Recommendation: Currently septic permits require that the systems be pumped out every three years or when the system contains 30 percent or more of solids. The County and/or Department should institute a program that enforces the inspection and pump-out requirement for onsite septic systems. A notification system should be developed such that homeowner's would be notified of this requirement in the year their system is due to be inspected. The County and State should use computer software to track the occurrence of inspections and cooperate to ensure compliance with regulations. The program should assist residents who have not had their septic pumped in the previous two years to have their system pumped and inspected. The State and County should subsidize the cost of inspection and pump out. Following the inspection, the inspector should provide the homeowner/resident with educational materials and receipt of pump out.

By requiring this before closing, new property owners will be educated on their system and gain a better understanding of maintenance and operation requirements, thus reducing long term or future problems with the system. Section 8.0000 of the *"Regulations Governing the Design, Installation and Operation of On-site Wastewater Disposal and Treatment Systems"* dictates owner responsibility for maintaining and operating on-site wastewater treatment and disposal system.

The watershed currently has 8,328 septic (OWTDS) systems within its boundaries. If all systems are pumped once every three years, as required by state regulations, then 2,776 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 Rate: NA
- Cost: Estimated $0 (Regulatory mandate)
- Funding: NA
- Load Reduction: TN: 5.63 lbs/ day and TP: 2.16 lbs/day

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

B. Require new and replacement onsite wastewater treatment and disposal systems (OWTDS) larger than 2,500 gallons per day to use technologies that achieve specific performance standards for TN and TP. Typically, phosphorus reducing technologies are only recommended where site specific conditions warrant.

With the promulgation of the new proposed Regulations Governing the Design, Installation, and Operation of On-site Wastewater Treatment and Disposal Systems by the end of 2012, the Department believes that existing and new systems greater than 2500 gpd will be required to performance standards.

- Implementation Rate: NA
- Cost: Estimated $0 (Regulatory mandate)
- Funding: NA
- Load Reduction: TN: 81.23 lbs/ day and TP: 0.0 lbs/day

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

Summary of Agriculture Recommendations

Based upon the implementation rate of existing agricultural best management practices, that implementation rate must be maintain in order for the Broadkill watershed to achieve the require TMDL nutrient and bacteria loading reductions associated.

A. Target BMP types and target locations based on farm (site) specific criteria (proximity to impaired waterbodies, soil types, BMPs in place, BMPs in compliance and BMPs needed).

The Broadkill Watershed implementation plan has identified and ranked 30 Watershed Management Water Quality projects. The ranking took into consideration:

- creation/restoration of upland buffers
- wetland/floodplain creation and/or restoration
- Infiltration
- stream channel improvements
- preservation of streams, wetlands and buffers
- and flood control.

The property owners of parcels where these projects were identified have not been contacted about their willingness to undertake the proposed project and no funds have been specifically targeted for these projects. Delaware's 319 NPs program has set aside some of their federal funds for so these projects, if initiated. These thirty projects were chosen because of their immediate impact to water quality in the Broadkill watershed.

B. Increase cost share program funds for best management practice strategies that produce significant results in the most sensitive areas. These BMPs may include: cover crops, conservation tillage, riparian buffers, manure storage sheds, etc.

Since the baseline period (2002), the agricultural community has reduced a significant amount of nonpoint source nutrient loading, leading the efforts to curtail nonpoint source nutrient loading. From 2002 to 2010, multiple Best Management Practices (BMPs) have been implemented. The 2002 Farm Bill has led to unprecedented funding levels of cost-share programs for BMPs that protect the environment, especially water quality, and with the 2008 Farm Bill, additional BMPs were constructed to further improve water quality within the watershed.

Cover crops to protect soil when row crops are not being grown. This practice helps retain nitrogen in the soil for the next crop which reduces fertilizer costs to the farmer. Incentive payments for cover crops range between $30 and $40/acre and averages $35/acre (personal communication, 2006). Several years ago, the Wye Research Center estimated that it cost $27/acre to seed and plant cover crops each year, however, this value has likely increased in recent years due to inflation and rising fuel costs. The current incentive payment likely covers the cost of implementing this BMP. Additionally, farmers are allowed to harvest the cover crop for on farm use, so that there is no cost to the farmer. This practice costs $2.81/lbs TN reduction and $890/lbs TP reduction.

- Implementation: 5200 acres cover crops annually
- Cost: Estimated Up to $14,973 planting
- Funding: NRCS, Delaware Cost Share Program, DNREC Watershed Assessment, and/or NPS Program 319 Funding

- Load Reduction: TN: 121.65 lbs/ day and TP: 0.28 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the annual number of acres of cover crops within the watershed.

CRP/CREP Grassed filter strips and grassed buffers to trap sediments in surface runoff and take up excess nutrients. These CRP 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/lbs TN and $524/lbs 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: 165.3 acres of filter strips
- Cost: Estimated Up to $11,571 annual rental rate
  Estimated Up to $5,814 annual installation
- Funding: FSA CRP/CREP and/or Delaware CREP Program
- Load Reduction: TN: 10.1 lbs/ day and TP: 0.24 lbs/day

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

CRP/CREP Shallow water areas established to capture nutrient losses from upland or cropped acreage. The cost of designing and establishing CRP Shallow water areas is high if extensive earth movement is required. Costs may range from $1,500/acre to $3,000/acre. The average costs of actual restoration have been $1,702/acre. Capitalized over 15 years, representing a single contract period, the actual cost per acre becomes $142.57. Annual rental ($138/acre/year) and maintenance ($5/acre/year) fees bring the total cost of implementing a shallow water area to $285.57/acre/year. For nutrient reduction calculations, this BMP is treated as a land use change from agriculture to wetlands and each wetland acre is additionally assumed to treat two upland acres of cropland. Using reduction estimates, the above figure equate to $6.80/lb TN reduced and $204/lb TP. Assuming that established cost share levels for capital costs from FSA (50%) and the State (37.5%) remain the same as they were in 2003, the farmer will only be responsible for $17.82/acre/year. After receiving the land rental and maintenance fees and incentives, the farmer pays nothing.

- Implementation: 62.9 acres of shallow water areas
- Cost: Estimated Up to $8,995 annual rental
  Estimated Up to $10,706 establishment
- Funding: FSA CRP/CREP and/or Delaware CREP Program
- Load Reduction: TN: 1.4 lbs/ day and TP: 0.01 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of acres of shallow water areas installed within the watershed.

CRP/CREP Hardwood plantings to reduce nutrient losses from upland acres and to reduce sediment bound phosphorous from entering waterways. The cost of installing CREP hardwood plantings is estimated to range between $125- $725/acre, and averages about $425/acre. If you capitalize that figure over 15 years at 3%, the annual cost is $35.60/acre. Land rental ($138/acre/year) and maintenance ($5/acre/year) fees bring the total cost to $178.60/acre/year. Total cost per pound of nutrient reduction is $4.25/lb TN and $128/lb TP reduced. Construction costs are cost shared at a rate of 87.5%, so that the cost to the farmers for BMP installation is $4.45/acre/year. Once the farmer is compensated for taking the land out of production, reimbursed for maintenance and given incentives, the farmer bears no costs.

- Implementation: 191.5 acres of hardwood planting
- Cost: Estimated Up to $34,202 annual rental rate
  Estimated Up to $81,388 for hardwood plantings
- Funding: FSA CRP/CREP and/or Delaware CREP Program
- Load Reduction: TN: 16.4 lbs/ day and TP: 0.41 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of acres of hardwood plantings within the watershed.

Wetland Restoration reduces nutrient loss from upland acres. The cost of restoring farmed wetlands is high if extensive earth movement is required. Costs may range from $1,500/acre to $3,000/acre. The average costs of actual restoration have been $1,702/acre. Capitalized over 15 years, representing a single CREP contract period, the actual cost per acre becomes $142.57. Annual rental ($138/acre/year) and maintenance ($5/acre/year) fees bring the total cost of wetland restoration to $285.57/acre/year. For nutrient reduction calculations, this BMP is treated as a land use change from agriculture to wetlands and each wetland acre is additionally assumed to treat 2 upland acres of cropland. Using reduction estimates, the above figure equate to $6.80/lb TN reduced and $204/lb TP. Assuming that established cost share levels for capital costs from FSA (50%) and the State (37.5%) remain the same as they were in 2003, the farmer will only be responsible for $17.82/acre/year. After receiving the land rental and maintenance fees and incentives, the farmer pays nothing.

- Implementation: 87.4 acres of wetland restoration
- Cost: Estimated Up to $12,498 annual rental
  Estimated Up to $148,755 restoration
- Funding: USFW, FSA CREP, Delaware CREP Program, DNREC Wetland Restoration Program
- Load Reduction: TN: 7.5 lbs/ day and TP: 1.7 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of acres of restored wetlands within the watershed.

CREP Wildlife Plantings (field and drainage borders) to trap sediments in surface runoff and take up excess nutrients. This practice could cost as much as $300/acre for installation depending upon vegetative mix. The cost can be maximized over the 10 year contract to increase long term efficiency. 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 could provide virtually zero cost to the farmer.

- Implementation: 165.9 acres of Wildlife Plantings (field and drainage borders combined)
- Cost: Estimated Up to $11,613 annual rental
  Estimated Up to $49,770 installation
- Funding: FSA CREP, Delaware CREP Program, DNREC Watershed Assessment, and/or NPS Program 319 Funding
- Load Reduction: TN: 10.5 lbs/ day and TP: 0.25 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of acres of wildlife plantings within the watershed.

Manure relocation has removed significant amounts of excess manure from the Delaware's impaired watersheds, consequently removing excess nutrients. Thus, the NPS Program recommends that all excess manure (per the Nutrient Management Plan) be removed from the Broadkill Watershed. If funds are lacking, the NPS Program recommends that additional state and federal funds be applied to the manure relocation program. The cost per ton of manure relocated is roughly $13.00/ton. The cost per pound of removing total nitrogen and total phosphorus was thus, $2.32/lb and $22/lb, respectively. The Delaware Nutrient Management Commission designs their relocation cost-share program to fully subsidize the cost of the manure transfer, including the clean out so that the farmer bears no cost.

- Implementation: 1900 acres equivalent participation in the Nutrient Relocation Program
- Cost: Estimated Up to $13.00/ton
- Funding: Delaware Nutrient Management Commission, DNREC Watershed Assessment, and/or NPS Program 319 Funding
- Load Reduction: TN: 14.33 lbs/day and TP: 1.03 lbs/day

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

Although it is difficult to quantify the nutrient reductions associated with Structural BMPs **(**such as manure structures, pads, sheds and composters) the NPS Program recommends that these BMPs be as fully funded as possible because they insure proper management and storage of manure and dead animals so that they do not become an additional problem for the environment.

- Implementation: TBD
- Cost: Estimated Up to $100,000
- Funding: NRCS, State of Delaware Cost Share, DNREC Watershed Assessment, and/or NPS Program 319 Funding
- Load Reduction: TBD

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of Structural BMPS constructed within the watershed.

Continue to refine Nutrient Management Plans for all agricultural operations in the watershed, such as providing more assistance with implementation for Pre-Sidedress Nitrogen Tests (PSNTs), NMP soil sampling, education, outreach, and measurable outcomes.

Nutrient Management Planning to encourage farmers to comply Nutrient management planning to encourage farmers to comply with the Nutrient Management Act (NMA) and to actively participate in establishing nutrient reducing best management practices (BMPs) on their farms.

As of 2007, all lands over 10 acres that have nutrients applied must be in compliance with Nutrient Management Act. The Nutrient Management Act requires all farms over 10 acres or with 8 animal units to establish a nutrient management plan, which includes the use of fertilizers and the fate of manure. Assessing the impact of this requirement will help quantify the efficiency and reduction of nitrogen and phosphorus.

In the Broadkill, like many watersheds, polluted runoff from cropland, manure-disposal sites, and concentrated animal-feeding operations (CAFOs) are some of the important sources of phosphorus to surface waters. As of 2002, there were 29 poultry operations, which produce approximately 2,490,684 birds annually, 2 dairies, 8 beef cattle operations, 13 equine and 4 goat operations in the Broadkill Watershed. Potential nutrient inputs are related to manure, runoff, erosion, and atmospheric deposition of nutrients. In 2007, 51.85% of the Broadkill Watershed was used for agriculture, which equates to approximately 35,426 acres.

There are 35,426 acres of crops in the watershed that require nutrients in order to produce an economic yield. Crops produced in the watershed can include soybeans, potatoes, barley, wheat, corn, and vegetables. Nutrient inputs include fertilizer and manure application, which if applied improperly may contribute to nutrient over-enrichment in streams and tributaries in the Murderkill Watershed.

- Implementation: 26,476 acres NM Planning annually
- Cost: Estimated Up to $93,900 annual
- Funding: Delaware Cost Share Program, NRCS, and/or NPS Program 319 Funding

- Load Reduction: TN: 337.3 lbs/ day and TP: 17.41 lbs/day

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by number of enforcement actions undertaken for failure to comply with NMA within the watershed.

Maintaining Current Implementation at the existing rates for agriculture, stormwater and wastewater

Chesapeake Regulatory and Accountability Grant impact on the Broadkill Watershed.

Delaware received a Regulatory and Accountability (R&A) grant from the Chesapeake Bay. The R&A grant addressed four objectives. The first was the development of the TMDL Watershed Implementation Plan, which will detail the necessary steps to minimize pollutant inflow to the Bay and achieve the TMDL set by EPA. The second objective is to improve and expand regulation of sources of nitrogen, phosphorus, and sediment delivered to the Bay. As a result of the 2010 grant, Delaware's regulations for industrial stormwater sites will be revised to address the Chesapeake Bay TMDLs, as well as other TMDLs established within the State of Delaware. The regulations will also establish new guidelines that reflect new federal mandates, implement stricter standards such as the inclusion of effluent limitations, and require stricter reporting requirements. In addition, the grant is providing funds to develop Technical Standards for Sediment and Stormwater Regulations which will:

- Incorporate runoff reduction approaches in the new DURMM model to provide a tool that is both unique to Delaware and serve as a practical tool for the stormwater designer. Professional engineers and designers will be more successful in meeting regulatory requirements utilizing tools that enable them to take advantage of the available science and technology.
- Provide technical specifications for Green Technology Practices that will be utilized to optimize land development toward the goal of 0% effective imperviousness for new development. The technical specifications will be consistent with other Bay area specifications that are being utilized to maximize pre-development hydrology.
- Provide training functions each year for agency review personnel to ensure they are consistently applying the standards based approach in the new regulations, provide training functions annually for the regulated design community to transfer technology associated with the new design approaches and standards. New projects associated with the use of these practices should achieve the percent load reduction to meet the TMDL as well as meet runoff reduction goals of 0% effective imperviousness.

Thirdly, the R&A grant will provide for enforcement and compliance assurance. Compliance inspectors will make certain that agricultural, wastewater, and storm water related practices have been installed properly and are being maintained to achieve adequate nutrient or sediment goals. This grant will provide:

- A compliance inspector in Sussex County to inspect every acre to ensure that cover crops are planted at the appropriate time and that no manures or fertilizers are spread on the cover cropped fields. In the spring, the inspector will again inspect each field for compliance for approved destruction methods and to ensure that no manure or fertilizer applications occurred. In the fall of 2011, the Broadkill had 4278 acres of cover planted.

Lastly, a portion of funding from the grant is improving tracking and accountability. Sussex and Kent Conservation Districts have delegation over the Sediment and Stormwater Program. The Conservation Districts' responsibilities include review and approval of sediment and storm water management plans, construction inspection, maintenance inspection, and outreach and education. Funding will provide for:

- Inspection of all closed out projects constructed in the Chesapeake Bay Watershed since 1991 and provides storm water maintenance report/technical guidance on how the BMP is designed to function and its proper maintenance. Recommendations will be generated on improvements that can be made to increase removal of nutrients through the implementation of practices such as buffers, meadows, native landscaping, and other practices.
- Inspection of all 59 tax ditch systems in Kent County.
- An up-to-date GIS data layer for industrial storm water sites within the State, and the creation of a "map book" for inspection sites within the State.

Section 106 Grant

Delaware and EPA have developed work plans for the Section 106 NPDES Permit/Enforcement activities under this grant. These work plans seek to initiate a closer coordination and integration of EPA and state permitting/enforcement activities. Several of the activities are focused on the Chesapeake while others are focused statewide and will have a benefit in the Chesapeake. Below is a summary state wide activities that will take place the Broadkill watershed:

a. State Activities:

   1. DNREC will work with EPA to ensure that DE's CAFO program is consistent with the intent of federal regulations for CAFOs. If needed, DNREC will submit a schedule to revise its program to address any inconsistencies between the DE program and federal CAFO regulations;
   2. DNREC will submit relevant supplemental information to ensure EPA has a complete technical standard for review and respond to comments. If needed, DNREC will submit a schedule to revise the technical standard to address any inconsistencies between the DE standard and federal requirements;
   3. DNREC will develop and submit a permit strategy for ensuring applicable CAFOs obtain permit coverage. The strategy will include an initial list of all known CAFOs identified by DNREC, and their permit status;

4. DNREC will provide a complete draft permit and permit application package including the nutrient management plan for EPA review and comment unless waived by EPA;
5. DNREC will develop a FY 2012 Compliance Monitoring Strategy (CMS) that ensures CAFOs comply with permit application and permit requirements. DNREC will update its CMS on an annual basis including a list of CAFOs and operations where CAFO determinations are planned;
6. DNREC will work with EPA to develop a CAFO violation classification and prioritization policy;
7. DNREC will identify, document, and track the compliance status of known CAFOs and provide semi-annual compliance reports to EPA;
8. DNREC will work with EPA to identify minimum data elements and develop a reporting mechanism to track CAFO compliance monitoring, enforcement, and permitting activities;
9. DNREC will work with EPA to identify NPDES program priority activities in DE's Watershed Implementation Plan;
10. DNREC will participate in QEM calls to provide necessary information to support compliance and permitting activities.

Clean Water State Revolving Fund Program (CWSRF)

The Federal Water Pollution Control Act (Clean Water Act), as amended in 1987, established the Clean Water State Revolving Fund (CWSRF) program. The CWSRF program offers low interest financing agreements for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.

CWSRFs offer**:**

- Low interest rates, flexible terms
- Significant funding for nonpoint source pollution control and estuary protection
- Assistance to a variety of borrowers
- Partnerships with other funding sources

Wastewater Infrastructure Loans

Clean Water State Revolving Fund (CWSRF) programs combine the federal and state capitalization funds with other program resources including tax-exempt revenue bond proceeds, fund investment earnings, and loan repayments to provide low-interest loans for eligible projects. Some of the programs include:

Green Project Reserve

- Reduced CWSRF Interest Rates are used as incentives to encourage borrowers to submit projects for funding consideration
- Energy Efficiency – technologies and practices to reduce the energy consumption for water quality projects
- Water Efficiency – technologies and practices to deliver equal or better services with less water
- Green Infrastructure – practices that manage and treat stormwater, and that maintain and restore natural hydrology by infiltrating, capturing and using stormwater
- Environmentally Innovative Projects – practices that demonstrate new/innovative approaches to managing water resources in a more sustainable way, including projects that achieve pollution prevention or pollutant removal with reduced costs.

Non-point Source Loan Program

- Septic Rehabilitation Loan Program (SRLP) -- The SRLP provides financial assistance to moderate to low income homeowners to replace failing septic systems
- Agricultural Non-Point Source Loan Program (AgNPSLP) – AgNPSLP funds are leveraged with Federal and State Cost Share assistance from Conservation Districts, to provide loans to poultry and dairy producers for manure storage/management, dead bird composters, and front end loaders.
- Leaking Storage Tank Remediation Loan Program (LSTRLP) – The LSTRLP provides loans to remove, retrofit, clean up contaminated sites, and corrosion protection for leaking underground storage tanks

Land Conservation Loan Program

- The LCLP is an innovative financing approach to fund land conservation easements and fee simple land purchases with CWSRF wastewater loans

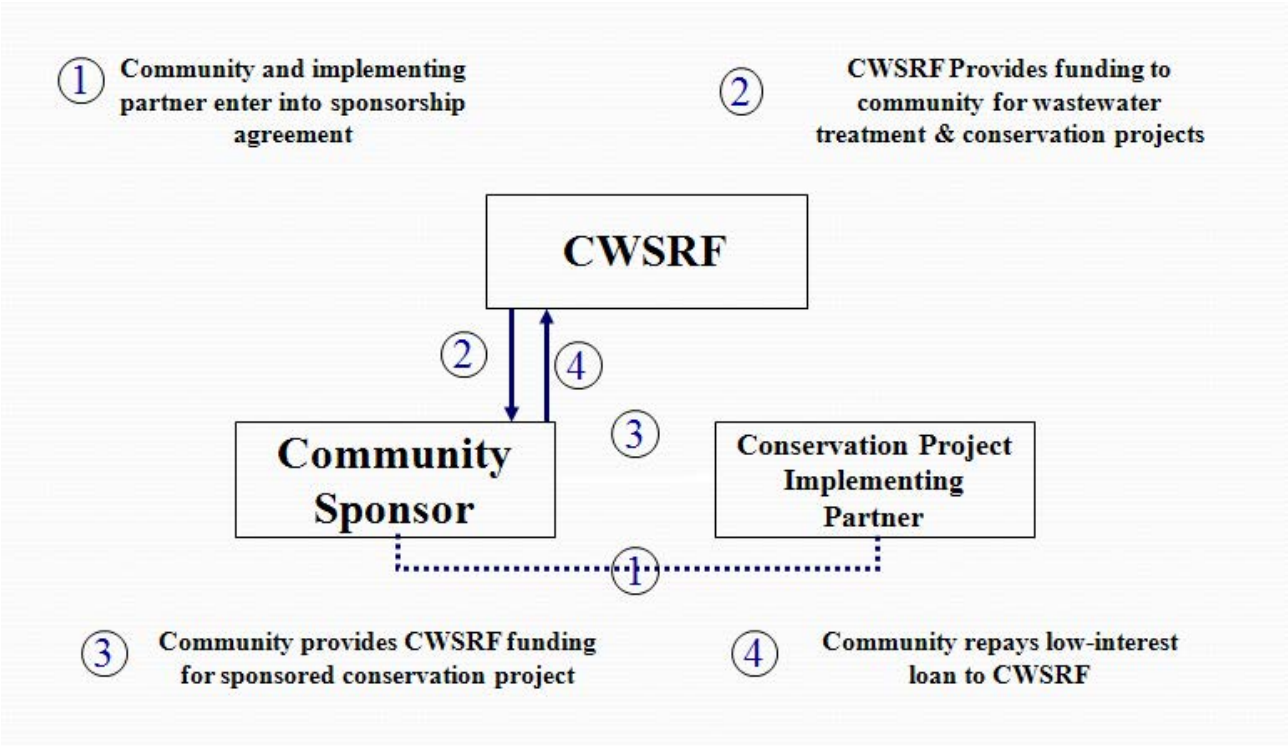

Figure 8 – Diagram explaining how CWSRF funds are utilized.

Another water infrastructure funding source is the Non-Federal Administrative Account (NFAA). The NFAA consists of:

- Septic System Extended Funding Option Program (SEFO)
  - SEFO is innovative solution to ensure that moderate to low income homeowners who are denied SRLP loans are able to receive financial assistance to replace failing septic systems
- Wastewater Facility Planning Matching Grants
  - Wastewater Facility Planning Matching Grants are designed to assist municipal and county wastewater utilities to prepare wastewater projects for funding through the CWSRF Program.
- Surface water Matching Planning Grants
  - Surface Water Matching Planning Grants are designed to support the planning, preliminary engineering, feasibility analysis for surface water improvement projects and activities that focus on the developed landscape to improve water quality in impaired watersheds in Delaware.
- Community Water Quality Improvement Grants
  - Community Water Quality Improvement Grants support water quality improvement projects in impaired Delaware watersheds. Competitive grant

proposals focus on the developed landscape to improve water quality and address one or more of the following goals:

- Improve water quality in designated impaired watersheds
- Consistent with specific plans developed for watershed improvements
- Demonstrate innovative and sustainable methods, techniques, and/or practices
- Cost effective and measurable results

The Wagamons subwatershed in Broadkill Watershed has already received $100,000 from Community Water Quality Improvement Grant.

Septic Systems

An initiative that improves water quality and protects the health of streams and rivers in Sussex County by reducing the number of failing septic systems in the Chesapeake Bay and Inland Bays Watersheds is underway. The initiative will replace 100 failing septic systems in 2012 by identifying and securing qualified loan applicants for the Delaware Clean Water State Revolving Fund's Septic Rehabilitation Loan program and the Septic System Extended Funding Option program. This initiative will use the services of First State Community Action, a non-profit grassroots organization with a proven ability to access the needs of homeowners in low-to-moderate communities.

Financial Assistance Branch (FAB)

The Financial Assistance Branch (FAB) of DNREC provides planning, engineering and financial assistance to a broad range of customers that request help in preventing or eliminating activities that cause water pollution. Branch activities include:

- Providing wastewater planning grants for the development of general wastewater facility plans, long range wastewater facility plans, and regional wastewater facility plans.
- Providing engineering and technical assistance for developing new sanitary sewer districts and/or solving problems in existing sewer districts. The Branch provided assistance that has led to the development of the Ellendale Sanitary Sewer District. Sanitary sewer systems are either under design or construction for each of these communities. Assistance is currently being provided for two additional areas.
- Providing financial assistance in the form of economic feasibility studies, low interest loans, and grants for wastewater projects that eliminate sources of pollution or prevent future sources of pollution. Financing is available to municipalities for community wastewater management facilities, to individuals for the rehabilitation of failing septic systems, to dairy and poultry farmers for the implementation of manure management practices on their farms, and to individuals and businesses for underground storage tank sites that need groundwater cleanup. Financial assistance

in the form of determining the economic feasibility of a project is also provided to communities with water utilities.

The Delaware Nonpoint Source Program

The Delaware Nonpoint Source (NPS) Program administers a competitive grant made possible through Section 319 of the Federal Clean Water Act. The grant provides funding for projects designed to reduce nonpoint source (NPS) pollution in Delaware. NPS pollution may be defined as any pollution that originates from a diffuse source (such as an open field or a road) and is transported to surface or ground waters through leaching or runoff. Reduction of NPS pollution may often be achieved through incorporation of specific best management practices (BMPs) into project workplans. Projects may target any source of NPS pollution, but most frequently involve agriculture, silviculture, construction, marinas, septic systems, and hydromodification activities.

Eligibility for NPS Program Funding

A project can be sponsored by both public and private entities, including local governments, tribal authorities, cities, counties, regional development centers, local school systems, colleges and universities, local nonprofit organizations, state agencies, federal agencies, watershed groups, for-profit groups, and individuals. Project grants to individuals are limited to demonstration projects.

Priority will be given to those projects whose goal is to improve the water quality of water bodies identified as having nonpoint source pollution impairments, as documented in:

- The current 303(d) List as impaired due to a nonpoint source pollutant;
- The current 305(b) Report as not fully supporting a designated use due to a nonpoint source; or
- Any other documentation of nonpoint source pollution

The NPS Program may also prioritize funding according to additional environmental factors, such as land use and existing best management practices, if these factors can help determine where projects will be most effective at reducing nonpoint source pollution. Projects are usually one to three years in length. Grant recipients that failed to meet program requirements in the past may be ineligible to receive additional project funding.

The table below summarizes the programs described above and the levels of funding available for TMDL.

- Coordinate and leverage restoration expenditures with the Forest Service, NRCS, DelDOT, mitigation funds, in-lieu funds, penalty funds, etc.

Table 10 – Known Funding Sources and Levels of Funding (FY10)		
Source of Funds	**Funding Amount**	**Activities to be funded**
State General Funds	$2,028,386	Implementation, Education/Outreach, Program Administration, Technical Assistance, Monitoring
CWA 319	$500,000	Implementation and Program Administration
CWA 106	40,000	Monitoring
CWA 117: Implementation Grant FY10	$500,000	Implementation
CBP Regulatory and Accountability	$729,090	Regulatory Development, IT Support, Planning, permitting, technical assistance
Farm Bill	$1,000,000	EQIP, CRP, CREP, etc.
Private	UNKNOWN	Match of federal projects and cost share
Local	UNKNOWN	Match for federal and state projects including BMP, restoration, etc.

Wastewater

There is a need for State and Federal funding resources to include grants to make upgrades to existing waste water treatment facilities affordable for the local communities.

Onsite Wastewater

In order to improve compliance and increase participation rates by 20%, funding should be increased to provide greater outreach, staffing, and technical resources. Three FTEs wee recently vacated and need to be re-filled in order to maintain workload and increase work levels to achieve new goals. Two of the three positions will be filled by the end of CY2010, with the final position expected to be filled by FY12. The Section would be better served by increasing the staffing levels by one additional FTE ($50K annually). Additional needs to fill gaps are identified below:

- Additional staff or staff movement will likely be needed to maintain a new aggressive operation and maintenance inspection program in addition to the current operation and maintenance program for the innovative and alternative system requirements, and data collection.
- Improved tracking and reporting of pump-outs and inspections, advanced treatment units, and connections to central sewer

    - Delaware's Environmental Navigator, a data management system, needs improvements. Additional funding for database upgrades and management ($50K annual)

- Staff training in advanced treatment units for permitting, inspection, operation, and maintenance requirements.
- Will need funds to update the database to track waste haulers and verify septic system pump out requirements are being met and expect to have grant funding to update the database.
- There is a need for State and Federal funding resources to include grants to make municipal systems affordable and to help low-income on-site users replace or repair failing systems and/or install nutrient reducing technologies
    - See Community Financing for Septic Management in the Inland Bays Watershed prepared by the Environmental Finance Center January 29, 2008.

Stormwater Management

The State Revolving Loan Fund (SRF) has recently been utilized for "green projects" of which stormwater is a major component. More projects may seek this funding in an effort to improve community drainage, and a strategy should be employed to assure that a water quality benefit is also a part of the project design.

The state has utilized a special fund named the 21rst Century Resource Conservation and Development (RCD) fund to finance major and minor flooding and drainage projects throughout the state for the past 16 years. While these funds are limited, there should be a concerted effort to integrate water quality management in a retro-fit manner into projects funded through this revenue stream.

State cost share funds if enhanced, could be made available for funding more urban projects with a demonstrated water quality benefit in the future. These funds are made available to landowners and could be expanded to include municipalities with a plan for identifying and implementing water quality practices.

The Financial Assistance Branch (FAB) of DNREC through the leadership of the Clean Water Advisory Council (CWAC) is developing a program to deliver funding to municipalities through Stormwater Planning Grants which would require that priority water quality goals be met. In addition, the CWAC and FAB have developed funding through community water quality grants that serve to improve water quality through matching grants.

Other grant funding through Section 319 Grants as well as direct grant funds through the Chesapeake Bay Program and other sources such as National Fish and Wildlife Federation will be used within the watershed, although most of these funds in the past have not been used in the urban corridors. This strategy is changing and more funding in the future will be directed toward the developed portion of the landscape.

The Department will also aggressively seek additional funding and work with the towns, municipalities and the Conservation Districts to identify resources and utilize them to the extent possible to meet the growing demands for funding stormwater source reduction strategies and retro-fits within the Bay watershed.

- GIS data management and system upgrades.
- Revised regulations for industrial storm water management
- New and revised technical standards for management practices.
- Additional training program for staff, permittee, and system owners and operators.
- Outreach to system owners and operators regarding new requirements.
- Additional maintenance inspections on storm water facilities in Kent and Sussex Counties.
- Staff to conduct increased number of compliance inspections and enforcement
- Urban retrofits inventory
- Municipal urban storm water retrofit demonstration projects
- Storm water Retrofits: $140 million

Agriculture

Realizing a significant boost in funding will be warranted for full implementation of BMPs. Delaware will need to pursue increased funding through State programs such as the State of Delaware Conservation Cost Share Program, Delaware CREP Program, Delaware Nutrient Relocation, Delaware CAFO, and Delaware Nutrient Management Programs. Likewise, it is essential Federal Programs, such as EQIP and the Chesapeake Bay Program Grant, be expanded or re-prioritized within the Chesapeake Bay Watershed to account for additional funding needs. Through the Delaware Conservation Partnership, responsible agencies meet quarterly to discuss issues or targeted or prioritized efforts, needs and funding. The Partnership is made up of representatives from NRCS, DDA, DNREC, US Fish and Wildlife, the Conservation Districts, Nutrient Planning Companies, and others. An example of recent NRCS funding change that resulted from the Conservation Partnership is an amendment of the EQIP funding of the cover crop cost share program to an annual contract rather than through a three year contract. This simple amendment made the program more attractive to participants and garnered additional interest in 2010 cover crop planting. Through the Conservation Partnership, additional resources will be pursued to accommodate the increased goal of BMP implementation within the Chesapeake Watershed as highlighted within this document.

As additional funding needs will certainly be warranted, private grants and/or exploratory grants will be additionally pursued. Lastly, to accommodate easier land owner participation by Private Landowners, the State of Delaware, Revolving Loan Fund Program should be review and expanded to allow additional BMP funding as applicable.

Table 11 – Summary of Current Agriculture Funding Sources and Future Need By Gran Program		
Program	**Chesapeake Bay Annual Budget (2009)**	**Funding Needs**
9.1.1.2 Nutrient Planning Program	$172,436	
9.1.1.3 Nutrient Relocation Program	$286,529	Yes
9.1.1.4 Kent County Conservation District Cost Share	$287,856	$425,000
9.1.3 Sussex Conservation District Cost Share Program	$805,411	$3,164,701
9.1.4 New Castle Conservation District Cost Share Program	$150,000	Yes
9.1.5 Agriculture Management Assistance Program	$60,000	
9.1.6 Wetland Reserve Program	$215,000	
9.1.7 Wildlife Habitat Incentives Program	$100,000	
9.1.8 Environmental Quality Incentives Program (EQIP)	$1,787,055	
9.1.9 Chesapeake Bay Watershed Initiative (CBWI)	$1,020,093	$3,880,665
9.1.10 Delaware Conservation Reserve Enhancement Program (CREP)	$93,347	
9.1.11 Conservation Reserve Program (CRP)		
TOTAL	**$4,692,013**	**$7,470,366**

- Implementation and administration of CAFO Program, including staff to conduct compliance inspections and monitoring and permit review. Funding from the 2010 CBRAP has been provide to hire a temporary staff person to assist with this program, however additional funds will be needed for long term implementation.
- Expand Farm Land Preservation Program
- Outreach for the Amish community
- Data on animal counts and animal feeding operations
- Improved data management system

In the Broadkill, like many watersheds, polluted runoff from cropland, manure-disposal sites, and concentrated animal-feeding operations (CAFOs) are some of the important sources of phosphorus to surface waters. As of 2002, there were 29 poultry operations, which produce approximately 2,485,355 birds annually, 2 beef cattle operations, 1 equine and 1 goat operations in the Broadkill Watershed. Potential nutrient inputs are related to manure, runoff, erosion, and atmospheric deposition of nutrients. In 2007, 38.6 % of the Broadkill Watershed was used for agriculture, which equates to approximately 35,426 acres. Therefore, the agricultural activity is the second leading source, after the Sussex County wastewater treatment plant, of phosphorus

entering the waterways. In addition, these sources contribute a significant loading of nonpoint source nitrogen.

There are 35,426 acres of crops in the watershed that require nutrients in order to produce an economic yield. Crops produced in the watershed can include soybeans, potatoes, barley, wheat, corn, and vegetables. Nutrient inputs include fertilizer and manure application, which if applied improperly may contribute to nutrient over-enrichment in streams and tributaries in the Broadkill Watershed.

Other Recommendations for Agriculture

Search for ways to improve real-time assistance to farmers. For example - email digital pictures of pests to farmer to improve efficiency/response time.

- New funding sources should be sought and financial incentives should be increased for wildlife habitat and wetland restoration.
- The State should partner with the Army Corps of Engineers (and other appropriate parties) to pursue restoration of the Broadkill l Watershed.

Summary of Outreach & Education Recommendations

General Urban Outreach & Education

An education program for Home Owners Associations should be developed for stormwater BMP maintenance. Educational resources should be provided and ideally, face to face education that stresses the organizations' responsibility. Topics should include: proper use and application of fertilizer and use of salt and sand during periods of snow.

- Implementation: NA
- Cost: Estimated 0.3 FTE @ $10,000
- Funding: State General Funds through the Watershed Assessment Section and/or Section 319 Grant.
- Load Reduction: NA

The Smartyard Program should be implemented in the watershed to assist homeowners in planting native landscaping to conserve water and reduce fertilizer and pesticide use.

- Implementation: NA
- Cost: Estimated $5,000 annual
- Funding: State General Funds through the Watershed Assessment Section and/or Section 319 Grant.
- Load Reduction: NA

Nutrient Reducing Recommendation Effectiveness Criteria: Effectiveness will be measured by the number of homeowners enrolled in Delaware Livable Lawns or Smartyards programs within the watershed.

Corporate environmental stewardship should be encouraged to provide corporations with the technical expertise to help them better manage and enhance their land through the use of native species and the restoration of natural habitat.

- Implementation: NA
- Cost: Estimated $0
- Funding: NA
- Load Reduction: NA

The Department should coordinate efforts with non-profit watershed organizations (e.g., the Nature Conservancy, Partnership for the Delaware Estuary, etc.).

- Implementation: NA
- Cost: Estimated $0
- Funding: NA
- Load Reduction: NA

A comprehensive education program should be developed for the urban and suburban sector on issues of water quality and urban nutrients. This may include:

- Working with the University of Delaware to revise soil testing so they are more user friendly.
- Educating homeowners on the importance of cleaning up pet waste, water conservation, lawn care (and the use of fertilizers) and proper disposal of grass and yard waste.
- Working with the Delaware Nutrient Management Commission and the Master Gardeners to provide education and programs for homeowners on lawn and garden best management practices.
    - Implementation: NA
    - Cost: Estimated $0
    - Funding: NA
    - Load Reduction: NA

Stormwater Outreach & Education

A comprehensive watershed assessment and protection program should be implemented to provide a framework for coordinating multiple watershed protection efforts. This program should promote the integration of local, state and federal water quality improvement efforts and improve public education and participation in all aspects of watershed protection.

- Implementation: NA
- Cost: Estimated $0
- Funding: NA
- Load Reduction: NA

A comprehensive education plan to teach the public how their actions impact the Murderkill Watershed (and specifically water quality) should be implemented. Some suggestions include:

1. Public service announcements
2. Brochures distributed through real estate agents, retailers, and school children
3. Face to face education with Home Owners Associations and other organizations
4. Coordination with Master Gardeners' education
5. Integration of education into the state and local permitting processes
6. Education on purchasing of water conserving appliances
7. Education for farmers to recommend appropriate use of buffers on lands in production. (Possibly coordinate with Nutrient Management Commission)
    - Implementation: NA
    - Cost: Estimated 0.3 FTE @ $10,000
    - Funding: State General Funds through the Watershed Assessment Section and/or Section 319 Grant.
    - Load Reduction: NA

Summary of Agriculture Outreach & Education Recommendations

- Farmers should be educated on the above mentioned BMPs.
- The public should be educated on practices to discourage resident nuisance waterfowl.
- Farm land and natural resource area preservation should be encouraged and promoted. New funding sources should be sought and financial incentives should be increased. The public should receive education on current programs, including:

- Farmland Preservation Act
- Kent County Transfer Development Rights
- Non-profit environmental groups
- Easements and donations

General Recommendations

Community Water Quality Improvement Grants

The State of Delaware (State) initiated a watershed study of the Broadkill River basin (see Figure 1). This study was initiated to develop a plan to help reduce pollutants in the Broadkill River Watershed (Watershed) to the Total Maximum Daily Loads (TMDL) established by the State Department of Natural Resources and Environmental Control (DNREC) in December 2006. The study, also referred to as The Watershed Plan, is comprised of three (3) steps. This report is the first step - the Baseline Assessment Technical Memorandum, also referred to as the Baseline Assessment. The Baseline Assessment has been prepared to identify and describe the Watershed and sources, types, and locations of water quality degradation. This document serves to consolidate information generated through a variety of available sources, complemented with additional evaluations to characterize the Watershed and assess the nature of impairments. Based on findings of the Baseline Assessment the second step - a pollution control opportunities report - will be completed. The pollution control opportunities report will include a synthesis of pollution control strategies evaluated by the project team [DNREC, Duffield Associates, Inc. (Duffield Associates), and the Center for Watershed Protection (CWP)]. The third and final step is an implementation strategy/plan, which will combine the data in the first two steps, and present prioritization and Watershed management methods to ultimately reduce pollution entering the Watershed.

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 80% and 90%, 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.

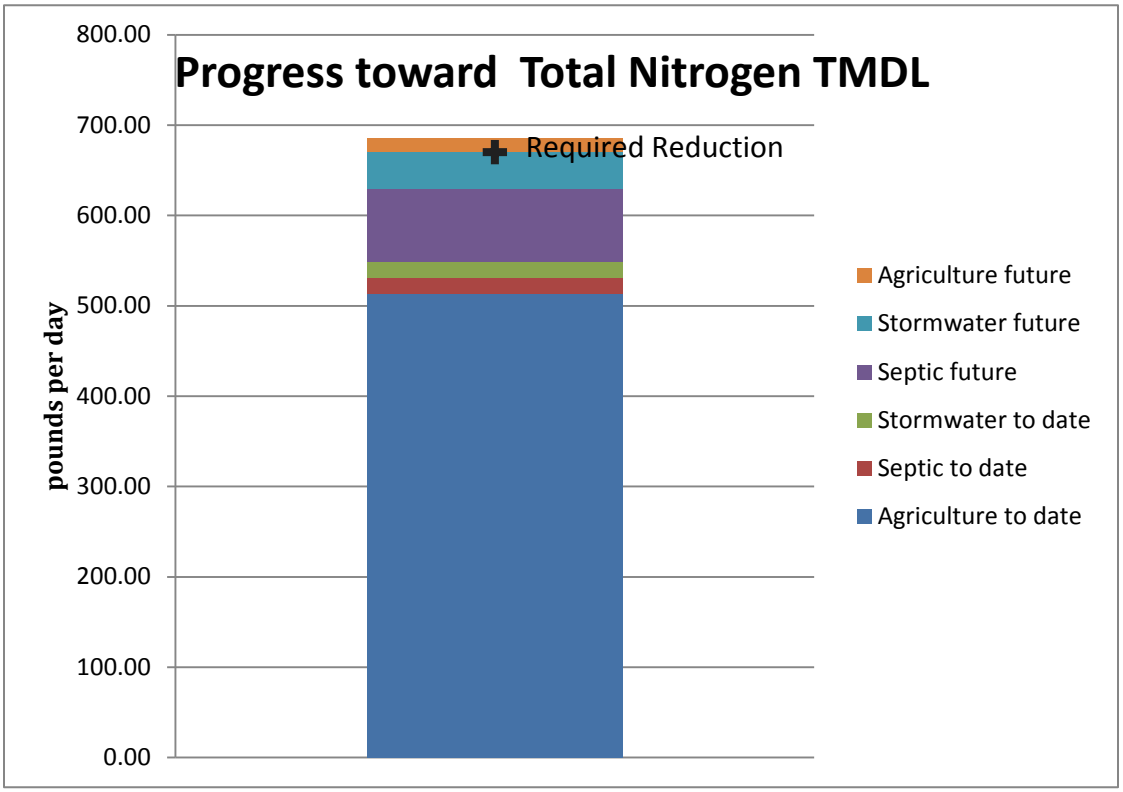

Figure 9 – Nitrogen TMDL Progress

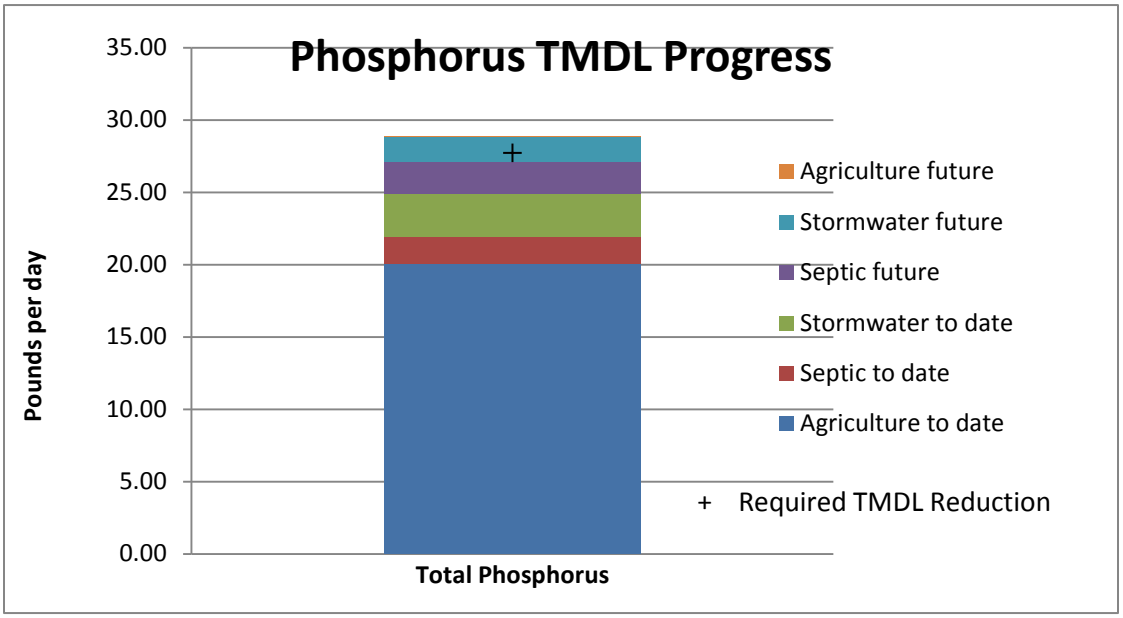

Figure 10 – Phosphorus TMDL Progress

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 (Table 7) 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 Broadkill waters to reach their TMDL reductions as seen in Figures 9 and 10.

Overall, this strategy costs close to $90,000,000 including capital expenditures plus annual operation and maintenance costs of various best management practices. Of this strategy total, about $29,000,000 has already been paid for the installation of current practices Figure 11 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.

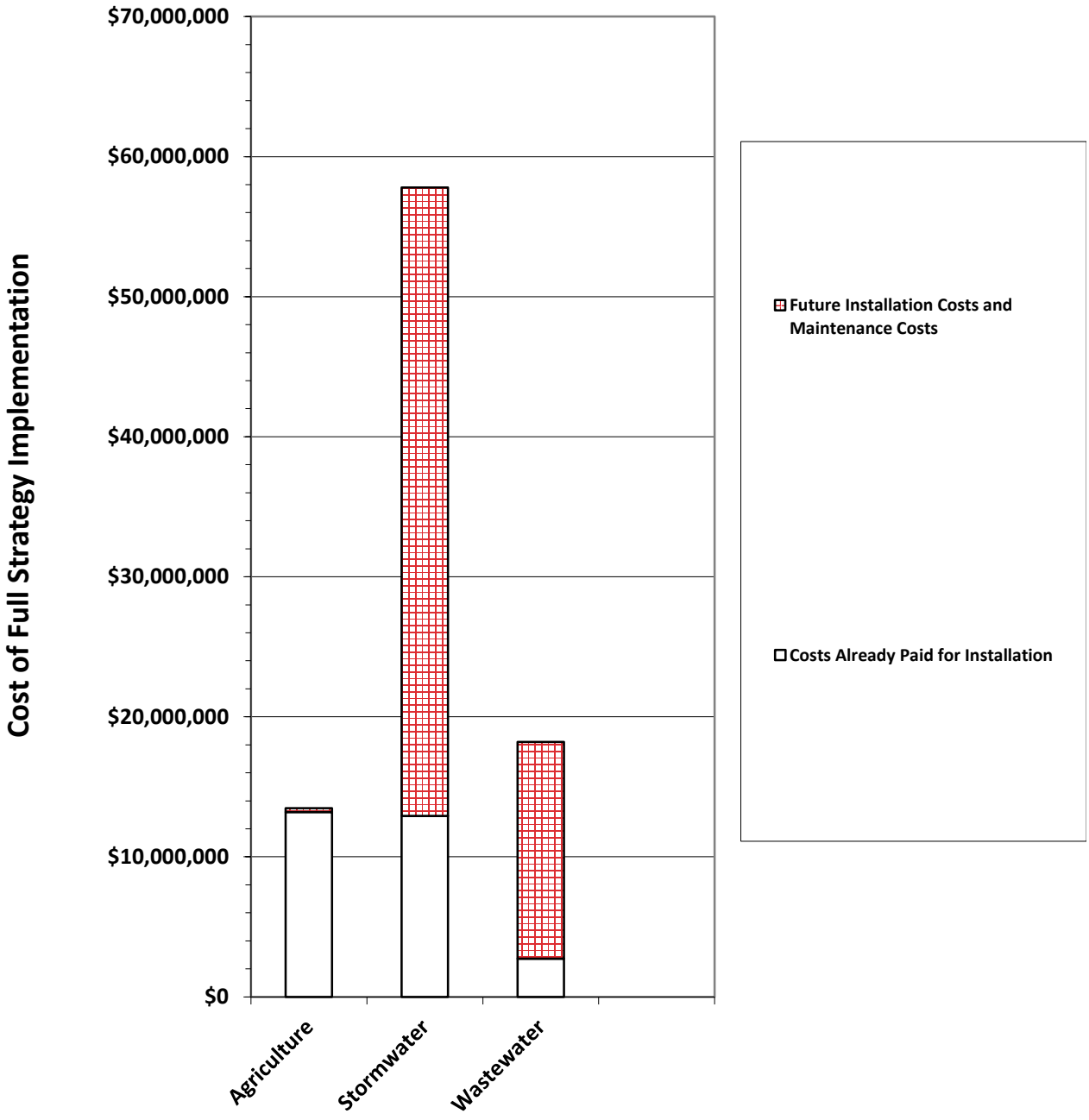

Figure 11 – Total Strategy Implementation Costs

IMPLEMENTATION PROGRAMS

Pollution of the Broadkill did not happen over a short period of time, nor did it only happen due to the actions of a few people. Thus, implementing the Pollution Control Strategy will necessitate participation from a broad variety of programs, agencies, nonprofit, and community organizations. These programs will provide technical, financial, and administrative assistance in the effort to clean up these waters.

Coastal Nonpoint Program – 6217

Congress established the Coastal Nonpoint Program in 1990 under section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) to ensure that coastal states have the tools needed to address polluted runoff. A consistent set of management measures was established for states to use in controlling polluted runoff. Management measures are designed to prevent polluted runoff resulting from a variety of sources. The program includes enforceable policies and mechanisms to ensure implementation of the measures. The Delaware Coastal Nonpoint Program is administered in the State of Delaware by the Delaware Coastal Programs in the Department of Natural Resources and Environmental Control. Delaware's Coastal Nonpoint Program is a networked program with implementation responsibilities distributed throughout the State. The Delaware Coastal Programs receives an annual award used to aid in the implementation of management measures, program initiatives and the funding of grants for projects designed to preserve and protect Delaware's waterways from the degradation of nonpoint source pollution. Through cooperative efforts will both government agencies and local organizations, numerous projects have been designed and funded to help address issues concerning nonpoint source pollution in Delaware.

The Delaware Forest Service

The Delaware Forest Service is a section of the Delaware Department of Agriculture and is charged to improve and enhance the state rural and urban forest resources. Delaware's Forest Service staff, through the Urban and Community Forestry Program, provides technical, educational and financial assistance to cities, towns, communities, developers and local governments to develop a community forestry management plans and resource evaluation studies. Foresters also review new planned subdivisions in order to conserve forest resources. Additionally, the program provides annual grant assistance to a variety of partners to provide both tree planting and tree care activities. Also, the professional foresters help private and public landowners to improve their forest resources through a variety of services. This technical assistance encompasses a wide range of forest management activities including reforestation, timber stand improvements, and timber harvesting and forest management plan development.

DNREC -- Groundwater Discharges Section

Located within the Division of Water, the Groundwater Discharges Section is responsible for overseeing all aspects of the siting, design and installation of on-site wastewater treatment and disposal systems. This is a three step process which includes the site evaluation, the design/permit application and the construction/installation of the system. The Small Systems Permitting Branch reviews and approves site evaluations, permit applications and conducts inspections of system installations. Experimental/alternative technologies and advanced treatment units are approved and permitted for use by the Large Systems Permitting Branch. The Section is also responsible for the permitting of underground injection wells, large spray irrigation wastewater systems, and other means associated with land application wastewater treatment. The Section also issues waste transporter permits and licenses to designers, percolation testers, site evaluators and system installers.

DNREC – Nonpoint Source Program

The Delaware Nonpoint Source Program (NPS) administers a competitive grant made possible through Section 319 of the Clean Water Act. It is housed under the Division of Watershed Stewardship within the Department of Natural Resources and Environmental Control. The grant provides funding for projects designed to reduce nonpoint source pollution in Delaware. NPS pollution may be defined as any pollution that originates from a diffuse source (such as an open field or road) and is transported to surface or ground waters through leaching or runoff. Reduction of NPS pollution, but most frequently involve agriculture, silviculture, construction, marinas and septic systems. Proposals are reviewed and evaluated, and those which are determined to meet specific requirements are eligible for funding. All projects must include matching funding from a non-Federal source totaling at least 40 percent of the overall project cost. In addition to funding projects that achieve reductions in NPS pollution, the Delaware NPS Program is committed to addressing the issue through educational programs, publications and partnerships with other organizations working to reduce NPS pollution in Delaware.

DNREC-Sediment and Stormwater Program

The Sediment and Stormwater Program is managed by the Division of Watershed Stewardship in the Department of Natural Resources and Environmental Control. Delaware's stormwater management program requires sediment control during construction and post-construction, stormwater quantity and water quality control. This program functions from the time construction begins through a project's lifespan. It requires construction and development projects to obtain sediment control and stormwater plan approval, be inspected during construction, and a post-construction inspection of permanent stormwater facilities and education and training. The program's initial emphasis is to prevent existing flooding or water quality from worsening and limit further degradation until more comprehensive, watershed approaches (as detailed in State legislation and regulations) are adopted. Current regulations require stormwater management practices to achieve an 80 percent reduction in total suspended solids load after a site has been developed. This is achievable with present technology. Long-term removal rates over 80 percent may require other measures, such as water re-use, which may be required locally. In Delaware, day-to-day inspection responsibilities are handled by the delegated local agency, but projects where site compliance is not possible are handled by the State with progressive and aggressive enforcement, including civil and criminal penalty provisions.

DNREC - Surface Water Discharges Program

The Surface Water Discharges Program is delegated to the Division of Water in the Department of Natural Resources and Environmental Control. Program administrators are responsible for eliminating pollutant discharges into State surface waters by issuing regulatory permits under the National Pollutant Discharge Elimination System (NPDES). An NPDES permit legally sanctions the discharge of substances that may become pollutants. However, the NPDES permit is designed to limit the discharge of those substances so that there will be no adverse effect on the quality of the receiving waters or interference with the designated uses of those waters. The health of a water body is measured by its attainment of designated uses. If potential pollutants in

a NPDES discharge are reduced to levels that allow receiving waters to meet applicable designated uses, then, in effect, the pollutant discharge has been eliminated.

Municipal sewage treatment or industrial plants that discharge wastewater to surface waters of Delaware are issued permits specifying discharge limitations, monitoring requirements and other terms and conditions that must be met to be allowed to discharge. In addition to wastewater, wastewater facilities often generate a waste sludge solid that is also an NPDES discharge under federal and State regulations. The NPDES General Permit for "stormwater discharges associated with industrial activities," a single permitting regulation with requirements that apply to a group of similar dischargers is also issued to industrial sites that discharge only stormwater.

DNREC – Water Supply Section – Groundwater Protection Branch

This program is responsible for providing technical review of permit applications for non-hazardous waste sites (i.e. large septic, wastewater spray irrigation, sludge application) and for water well permit applications where wells are located near problem sites. Staff hydrologists conduct investigations based on public complaints of groundwater quality, often associated with domestic water wells.

The Source Water Protection Program (SWPP) has been delegated to DNREC and is managed by the Water Supply Section, Groundwater Protection Branch of the Division of Water. This program was created from the 1996 Amendments from the Safe Drinking Water Act. The SWPP is responsible for determining the locations of water supplies used for public drinking water. The program is also responsible for mapping the wellhead protection areas (those areas around a well or group of wells from which a source obtains within those delineated areas, and determining the susceptibility of the drinking water source to contamination. The SWPP is required to make this information available to the public and does so through the program's website: www.wr.udel.edu/swaphome/index.html.

Through the Source Water Protection Law of 2001, the SWPP was charged with the development of a guidance manual for the protection of source water areas. This manual was development to give the counties and those municipalities containing 2000 or more persons) ideas on methods that could be used to protect those areas by 2007.

Local Governments

County and local governments have the authority to enact ordinances to further the goals of this Pollution Control Strategy. They are all required to complete Comprehensive Plans and address how they intend on assisting in the implementation of the TMDLs. Many of these entities have ordinances that require buffers, open space and maximum impervious coverage – ordinances that work towards achieving water quality standards. Local governments within the TMDL watershed include: Sussex County, Cities of Georgetown and Lewes and the Town of Milton.

Nutrient Management Commission

The Delaware Nutrient Management Program was established as a result of the Delaware Nutrient Management Law. The Delaware Nutrient Management Commission (DNMC) was established to direct the program and develop regulations pertaining to nutrient management, waste management for Animal Feeding Operations (AFOs) and National Pollutant Discharge Elimination System (NPDES) permits for concentrated animal feeding operations (CAFOs). The DNMC manages activities involving the generation and application of nutrients in order to help maintain and improve the quality of Delaware's ground and surface waters to help meet or exceed federally mandated water quality standards in the interest of the overall public welfare. All persons who operate an animal feeding operation in excess of 8 animal units (1 AU = 1,000 pounds) and/or control/manage property in excess of 10 acres where nutrients are applied must develop and implement a nutrient management or animal waste plan. The DNMC provides cost assistance programs, certifications and investigation of complaints.

Office of State Planning Coordination

The mission of the Office of State Planning Coordination (OSPC) is "the continuous improvement of the coordination and effectiveness of land use decisions made by state, county and municipal governments while building and maintaining a high quality of life in the State of Delaware." Under the new PLUS (preliminary land use service) process, the OSPC will bring together State agencies and developers early in the development process in order to try to identify and mitigate potential impacts. The OSPC also supports the Governor's "Livable Delaware" initiative and has published *Better Models for Development in Delaware* that includes many best management practices which will be needed in order to achieve the TMDL.

Soil and Water Conservation Districts

County Conservation Districts were created by State law and are administer through Delaware Natural Resources and Environmental Control. They operate the State Conservation Cost Share Program which provides funds for installation of agricultural management practices, promote the State Revolving Loan Fund Program for poultry producers (low-interest loans to implement best management practices) and are the delegated agencies for the Sediment and Stormwater Management Program carrying out plan review and field inspections in their respective counties. Watersheds prioritized by Delaware's Nonpoint Source (Section 319) Pollution Program can be targeted by these activities.

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

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 its 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.

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 decision-making. 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 B—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 Broadkill calls for a 75% reduction in bacteria and for 40% reduction in total nitrogen (TN) and total phosphorus (TP) (EPA, 2006). The baseline period for this TMDL was established from 2006 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 results are tabulated below (Table 1).

Table 1 – 2002 Broadkill Watershed Land-use Acreages

Urban	Agricultural	Forest	Wetland	Water	Range	Total acreage
8,687	28,004	14,562	12,734	1,677	2679	68, 624

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 Broadkill Watershed to produce daily nutrient loads according to land use, as displayed in Table 3.

Table 2 – Land-use Loading Rates*

	TN (lbs/acre/yr)	TP (lbs/acre/yr)
Developed	12.0	1.3
Agriculture	15.5	0.40
Range	7.5	0.02
Forests	3.5	0.01
Wetlands	0.0	0.0
Water	0	0.0

*Average values for Delaware Bay/River Watersheds from TMDL models with extreme values removed (see 2/27/07 email from Hassan Mirsajadi).

Table 3 – 2002 Murderkill Watershed Land-use Based Loads							
	Urban	**Agricultural**	**Forest**	**Wetland**	**Water**	**Range**	**Total**
TN (lbs/day)	334.9	1,124.3	136.4	0.00	0	4.6	**1668.5**
TP (lbs/day)	37.26	29.01	1.57	0.00	0	0.98	**73.50**

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 "Range" 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/day) (Table 2)

EX: TN load for urban land use:

TN load	=	2679 acres	X	0.03 lbs TN/acre/yr	=	**24.6 lbs TN/day**

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 Broadkill Watershed, the TN load needs to be reduced by 670.17 lbs/day and the TP load by 27.7 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:

Required TMDL reduction (lbs/day)	=	1668.47 lbs TN/day	X	40%	=	**667.39 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 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 Broadkill Watershed are:
0.052 lbs TN/system/day and 0.004 lbs TP/system/day for individual small systems less than 2,500 gpd

Connecting OWTDS to Sewer Districts

Since 1992, 11 OWTDS (septic) systems are reported to have been removed from the Broadkill watershed by connecting homes and businesses to sewer districts. These systems have been connected to sewer districts that dispose of their waste at spray irrigation facilities. Reductions for systems that are connected to plants that use spray irrigation receive a 90% efficiency since nutrients remain in the ecosystem (DNREC Groundwater Discharges Section, personal communication, 2003). The nutrient load reductions are calculated using the following equation.

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

EX: TN reduction due to OWTDS connection:

TN load reduction (lbs/day)	=	0.052 lbs TN/system/day	X	350 eliminated OWTDS	X	90%	=	**16.54 lbs TN/day**

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 is 12 holding tank currently in the Broadkill Watershed. Each time a holding tank is pumped, 2.71 lbs TN and 01.02 lbs of TP do not enter the Broadkill.

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-outs per 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-outs per year	X	1 tank	=	**32.52 lbs TN/yr or 0.09 lbs TN/day**

OWTDS Pump-outs

Using a GIS, an analysis was conducted that determined as of June 2012, there were 8,328.00 OWTDS in the Broadkill Watershed. Using a GIS, an analysis was conducted that determined as of December 31, 2005, there were 18,212 OWTDS in the Inland Bays Watershed. Plans are in place to convert 2,359 systems to sewer by 2010 (Sussex County Engineering Department, written communication, 2006). Once this projection is taken into account, the total number of OWTDS in the Inland Bays Watershed will be 15,853. I f all individual/small system owners complied with the maintenance requirement to pump their systems once every three years, approximately 5,284 small systems should be pumped out each year.

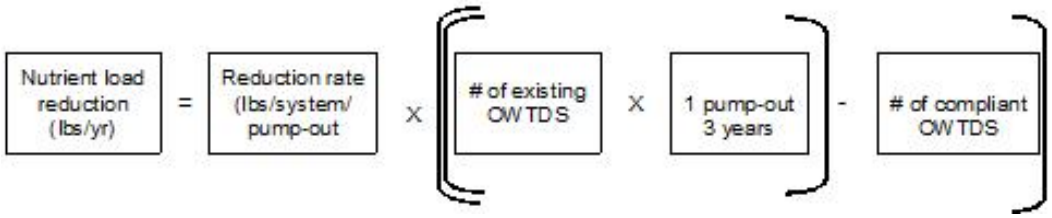
Waste haulers usually deliver waste to the nearest wastewater treatment plant. The two wastewater treatment facilities in the watershed (South Coastal and Wolf Neck) keep records on the amount of waste they accept from OWTDS pump-outs. These records indicate that close to five million gallons of effluent and septage were pumped out in 2002 and earlier years (Sussex County Engineering Department, South Coastal Wastewater Treatment Plant, personal communication, 2000 & 2002). Since OWTDS tanks in Delaware have a 1,000 gallon capacity on average, then it can be assumed that approximately 4,698 septic tanks were pumped out for compliance purposes in 2002, which is a compliance rate of 77%. Then it will be assumed that the 2002 compliance rate continues into the future, which indicates that there will likely be 1,507 systems pumped-out per year in the future, on average.

By assuming that after three years, a septic tank will contain 750 gallons of effluent and this equals 100 tanks being pumped out a year in the Broadkill Watershed based on a 1,000 gallon tank capacity. By assuming that after three years, a septic tank will contain 750 gallons of

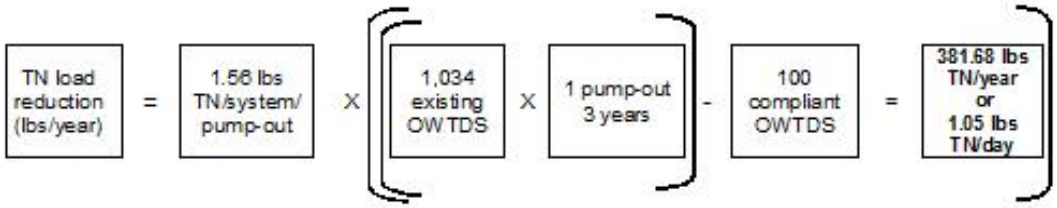
effluent and 250 gallons of septage (volumes based on local inspector-hauler observations), and using the concentrations of effluent and septage given above, the effluent load reductions per system achieved by a pump-out program are shown below in Table 6.

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:



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 Broadkill 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 alternative systems:

TN load reduction (lbs/day)	=	0.052 lbs TN/system/ day	X	1,034 OWTDS	X	50%	=	**27.1 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 (open channel)*	50	70
Filtering Practice (bioretention)	50	70

Stormwater BMP Calculations

Several types of structures that treat stormwater runoff are used throughout the Broadkill Watershed. 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 12 lbs/acre/yr, while the phosphorus loading rate is 0.03b/acre/yr (Averages values for the Delaware bay/River Watersheds from TMDL models with extreme values removed. Mirsajadi, 2007)

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)	=	1503 acres treated with wet ponds	X	0.03 lbs TN/acre/day	X	30%	=	**14.83 lbs TN/day**

Potential Future Stormwater Retrofit Projects:

It is anticipated that an additional 3,156 acres of urban area in the Broadkill watershed 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, "Ponds" and "Other." These values were divided by the total area treated in each category to calculate nutrient reduction rates. For "Ponds," the reduction rates are 1.84 lbs TN/acre/yr and 0.25 lbs TP acre/yr, while the reduction rates for "Other" are 5.69 lbs TN/acre/yr and 0.20 lbs TP acre/yr.

The potential future loading reduction to the stream as a result of retrofitting 3,156 acres of urban lands can thus be determined using the equation below.

Nutrient load reduction (lbs/day)	=	Reduction rate (lbs/acre/day)	X	Acres of retrofit	X	Future percent use of practice

EX: TN reduction from future stormwater ponds:

TN load reduction (lbs/day)	=	0.0086 lbs TN/acre/day	X	603 acres	X	50%	=	**6.1 lbs TN/day**

Open Space Calculations

Grassed Open Space

Grassed open space is treated as a land use change from agricultural cropland to grassed open space. Thus, the acres that undergo change will receive a lower loading rate. The loading reduction is calculated as follows.

$$\text{Nutrient load reduction (lbs/day)} = \left[\text{Agricultural loading rate (lbs/acre/day)} - \text{Grass loading Rate (lbs/acre/day)}\right] \times \text{Acres of open space practices}$$

EX: TN reduction due to open space provisions existing ordinances:

$$\text{TN load reduction (lbs/day)} = \left[\text{0.04 lbs TN/acre/day} - \text{0.02 lbs TN/acre/day}\right] \times \text{400 Acres} = \textbf{34.2 lbs TN/day}$$

Riparian Buffer

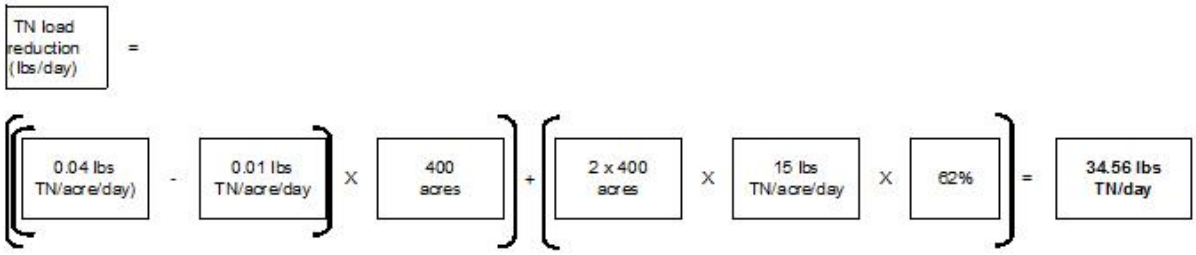
It is assumed that for every one acre of land where riparian buffers are employed, that two upland urban acres are treated. This approach is similar to the practice employed by the Chesapeake Bay Program (CBP, 1998). The efficiencies for nutrient load reductions are an average of the range presented 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.

$$\text{Nutrient load reduction (lbs/day)} = \left[\left[\text{Agricultural loading rate lbs/acre/day} - \text{Forest loading rate (lbs/acre/day)}\right] \times \text{Acres of buffers}\right] + \left[\text{2 x acres of buffers} \times \text{Urban loading rate (lbs/acre/day)} \times \text{Reduction efficiency (\%)}\right]$$

EX: TN reduction due to riparian buffer requirements in existing ordinances:



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 cannot currently be estimated since all nutrient fate and transport processes are not well understood at this time.

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).

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

The United States Department of Agriculture, National Resource Conservation Service provided information on each cover crop planted in the 2008-2009 season in the Broadkill 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.

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

EX: TN reduction due to 3,144.80 acres of cover crops:

TN load reduction (lbs/day)	=	0.04 lbs TN/acre/day	X	4563.1 acres	X	55%	=	**105.95 lbs TN/day**

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/day)	=	(	Agricultural loading rate (lbs/acre/day)	-	Grass loading Rate (lbs/acre/day)	)	X	Acres of CRP practices

EX: TN reduction due to 118.25 acres of wildlife habitat:

TN load reduction (lbs/day)	=	(	0.04 lbs TN/acre/day	-	0.02 lbs TN/acre/day	)	X	118.25 Acres	=	**4.73 lbs TN/day**

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.

$$\text{Nutrient load reduction (lbs/day)} = \left[\left[\text{Agricultural loading rate lbs/acre/day} - \text{Grass/Forest loading rate (lbs/acre/day)}\right] \times \text{Acres of CREP practices}\right] + \left[\text{2 x acres of CREP practices} \times \text{Agricultural loading rate (lbs/acre/day)} \times \text{Reduction efficiency (\%)}\right]$$

EX: TN reduction due to 14.4 acres of CREP filter strips:

$$\text{TN load reduction (lbs/day)} =$$

$$\left[\left[\text{0.04 lbs TN/acre/day)} - \text{0.02 lbs TN/acre/day}\right] \times \text{14.4 acres}\right] + \left[\text{2 x 14.4 acres} \times \text{0.04 lbs TN/acre/day} \times \text{46\%}\right] = \textbf{1.23 lbs TN/day}$$

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		16.7	1.4	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 12,583.65 acres of nutrient management planning in the Broadkill Watershed in 2008. Using the TN and TP efficiencies and the agricultural loading rate reported earlier, the daily load reductions due to these acres can be calculated as follows.

TN load reduction (lbs/day)	=	24,476 acres under NMPs	X	Agricultural loading rate 0.04 lbs (TN/acre/day)	X	Reduction efficiency (30%)	=	**337.3 lbs TN/day**

Overall Nutrient Load Reductions

The total nutrient reductions achieved by practices currently on the ground in the wastewater, stormwater, open space and agricultural sectors have been determined. In addition, the nutrient reductions possible from several potential future wastewater management policies and stormwater projects have also been estimated. These values are shown in Table 10 along with the nutrient reductions required to meet the TMDL goals. Current practices have contributed 80 percent of the required TN reduction and 90% percent of the required TP reduction. Potential reductions from the wastewater and stormwater sectors increase the progress for TN to 100% and 104.0 for TP. For bacteria reductions surface water monitoring will indicate the effectiveness of the current and future BMPs.

Table 10 – Nutrient Reductions Achieved from Current and Potential Future BMPs		
	TN Reduced (lbs/day)	**TP Reduced (lbs/day)**
Wastewater	18.54	1.89
Stormwater	16.60	2.97
Agriculture	498.27	20.02
Sub-total	**533.41**	**24.89**
Future Wastewater	81.902	2.16
Future Stormwater	40.10	1.79
Future Agriculture	14.80	0.03
Total	**138.8**	**3.98**
Required Reduction	**670.17**	**27.70**

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Appendix C – Pollution Control Recommendation to the Department

Broadkill Watershed Tributary Action Team
Pollution Control Strategies
Draft January 14, 2008

Overview

The Broadkill River and its tributaries and ponds are impaired by high levels of bacteria and elevated levels of the nutrients nitrogen and phosphorus. Because of this, Delaware has committed to develop pollution control strategies for the Broadkill River Watershed. Enhancements in wastewater treatment, agricultural practices, and erosion and sediment controls have contributed to improving the Broadkill's health. However, levels of nutrients and bacteria in the waterways remain high. There has been a significant decrease in wetlands and forests over time as these natural filters have been converted for other uses. The land use continues to change from what was recently a watershed dominated by cropland to a more urban/suburban watershed. The impact of these land use changes is uncertain.

As residents and stakeholders of the Broadkill Watershed, we need to make decisions about its future. The multitude of activities that take place on land (69,000 acres in the drainage area), such as farming, lawn fertilizing, and septic use, even miles from the river, produce nutrients that enter the river through surface water runoff and groundwater recharge. Because of its diffuse nature, this nonpoint source pollution has proven difficult to tackle. Point source pollution, which is discharged from a specific site like a pipe, also occurs in the Broadkill and is regulated through permits. Since sources of pollution come from a variety of areas, any water quality goals will require everyone to do their part.

Total Maximum Daily Loads (TMDLs) were established for the Broadkill River Watershed in December 2006. The TMDL requires:

- A 40 percent reduction in non-point source nitrogen load (from the 2002-2003 baseline),
- A 40 percent reduction in non-point source phosphorus load (2002-2003 baseline),
- A 75 percent reduction in non-point source enterococcus bacteria (2002-2003 baseline), and
- 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.

In terms of daily non-point nutrient loads, a 40% reduction in nitrogen (baseline 1,675 lbs/day) would require a reduction of 670 lbs/day to reach the target load. A 40% reduction in phosphorus (baseline 69.3 lbs/day) would require a 27.7 lbs/day reduction to reach the target

load. Although it is difficult to quantify bacteria sources, the Team believes that measures taken to reduce nutrients will have a beneficial effect on the bacteria pollution levels.

Guiding Principles

The Team worked to improve the water quality of the Broadkill River watershed using sound science as a basis for decisions, developing solutions that are integrative, creative and innovative, with due consideration given for the private property rights of individuals in the community and for the welfare of present and future generations who live and work in the watershed.

The Team operated by consensus, and effort was made to meet the interests of all the participating stakeholder groups. We defined "consensus" to mean that there is no dissent by any member. Members were advised by facilitators not to block or withhold consensus unless they had serious reservations with the recommendation or approach. If members disagreed with the recommendation or approach selected by the rest of the group, they were asked to offer an alternative. If there was still disagreement after discussion and consideration of alternative approaches, we have noted that member(s) withheld consent. Within the PCS recommendations we note where Team members dissented with majority as a "veto"

I. Agriculture

Agriculture is by far the largest land use in the watershed representing approximately 40% of the land area. In 1999, the Delaware Nutrient Management Act was established to improve water quality while maintaining agricultural profitability. It established a certification program that encourages the implementation of best management practices (BMPs). Currently, all agricultural operations in the Broadkill watershed have developed nutrient management plans. BMPs installed through 2006 include: Nutrient Management Plans; cover crops; Conservation Reserve Program practices; Conservation Reserve Enhancement Program (CREP) practices; manure relocation/alternative use; and the use of Phytase in poultry feed. These BMPs have produced reductions of approximately 481.96 lbs/day of Nitrogen (70% of total target reduction) and 19.58 lbs/day of Phosphorus (70% of total target reduction). Annually, these BMPs cost approximately $282,000, making them a very cost effective means of reducing nutrients to local ground and surface waters, however these reductions are estimates based on assumptions for each BMP efficiency.

These reductions in N and P are impressive. These voluntary cost share programs seem to be accomplishing the intended purpose. In comparison to other pollution control strategies in urban sectors, these approaches are relatively inexpensive to implement. Even more could be done if all citizens were willing to share in the cost; the issue is one of fairness and who pays.

The team notes that some agricultural operations in the watershed are in environmentally sensitive areas and if further reductions are recommended, then the following criteria should be considered:

1. Target BMP types and target locations based on farm (***site***) specific criteria (proximity to impaired waterbodies, soil types, BMPs in place, BMPs in compliance and BMPs needed). (NOTE: Points to consider include: profit margin-don't throw another cost

burden on farmer; inspections-lose cost share support if not following rules; evaluation component-how many inspectors/frequency of inspections/compliance rate).

2. Because these BMPs may be cost prohibitive for the individual farmer to bear, increase cost share program funds for best management practice strategies that produce significant results in the most sensitive areas. These BMPs may include: cover crops, conservation tillage, riparian buffers, manure storage sheds, etc. Continue to refine Nutrient Management Plans for all agricultural operations in the watershed, such as providing more assistance with implementation for Pre-Sidedress Nitrogen Tests (PSNTs), NMP soil sampling, education, outreach, and measurable outcomes. (NOTE: who will do this- U of D, Conservation District, and/or crop consultants? Will there be an evaluation system?)

3. Search for ways to improve real-time assistance to farmers. For example - email digital pictures of pests to farmer to improve efficiency/response time. The team notes that the conversion of agricultural land for non agricultural purposes will change nutrient runoff in ways that should be closely monitored.

II. Non Agriculture Stormwater

In 2002, there were more than 8,800 acres of developed lands in the watershed. Any development that occurred prior to 1990 was not subject to the State's Sediment and Stormwater Law, which requires any land disturbing activities of a certain size to address water quantity and water quality issues specifically related to sediment. Many stormwater BMPs address both water quantity and quality, however, some BMPs are more effective at reducing nutrients than others. The Sussex Conservation District, who oversees the planning, construction, and maintenance of stormwater facilities in the county, is in the process of updating a database that will track BMPs by type and location. Until that data is available, a visual reconnaissance of subdivisions in the Broadkill Watershed in Spring 2007 revealed that approximately 190 acres are treated by dry ponds and that approximately 1,500 acres are treated by wet ponds. These BMPs produce reductions of 17.23 lbs/day of Nitrogen and 2.90 lbs/day of Phosphorus. Annually, these BMPs cost approximately $455,000.

As noted in the Agriculture recommendations, the Team notes that conversion of Agriculture to non-agricultural land uses can impact the nutrient reductions made by the Agriculture sector. There are currently 15,000 (approx.) new residential units approved by municipal and county government in the watershed. The types of development and use of stormwater best management practices can have either positive or negative effects on nutrient reductions.

The Team recommends:

- Development activities that are subject to Delaware's Sediment and Stormwater Law shall provide stormwater management that includes nutrient reductions consistent with TMDL load reductions, or shall utilize 'best available technologies' (BATs) in the project design where TMDL load reductions are not feasible.

- Enforce sediment control measures during construction phase. We recommend enforcement provisions that are adequate and appropriate. This may include larger

penalties, such as fines and stop work orders, and require remediation in addition to mitigation. We recommend the review and approval of sediment control measures during the pre-construction phase, and enforcement responsibilities.

- Encourage site specific, streamside vegetated buffers throughout the watershed through open space designations and incentives, as well as through targeted outreach/education programs. (2 vetoes)
- Provide incentives for the use of pervious materials and strategies (to take the place of traditional impervious ones) for sidewalks, parking lots, and roadways should be provided to developers by all governmental entities.
- Encourage the use of conservation design principles that reduce surface water runoff of nutrients, such as those that promote infiltration, narrower roads and sidewalks, swales and grassed waterways, water conservation and recycling, natural resource protection, open space preservation, and park creation, among other practices.
- The County, State and local governments should create codes and regulations that provide for incentives that allow and promote "conservation design" principles with a goal of reducing nutrient loads. Require stormwater maintenance plans for new development.
- Develop manuals on residential stormwater system maintenance to address new and older developments. Existing documents should be disseminated to homeowners.
- Develop a program or means to provide outreach/education to homeowners served by a stormwater management system. This program should address maintenance plans, funding obligations, legal obligations, resource agencies, etc.
- Require Realtors to provide disclosure information regarding stormwater management requirements to the buyer in writing at time of contract (1 veto).
- Establish stormwater retrofit requirements for direct discharge to the Broadkill River, ponds, and tributaries.
- Require DNREC to develop a stormwater retrofit strategy for communities built before 1991 so they can reduce the quantity of nutrients, bacteria, and sediment that they deliver to ponds and streams (e.g. rain gardens, vegetative buffers).
- As part of DelDOT highway maintenance program, plant trees ***(vegetated buffers)*** along all roads and highways to absorb water and reduce run–off, consistent with highway safety standards (2 vetoes).
- Encourage county and municipal authorities to reduce the number of required parking spaces at shopping malls, break up the parking areas with planted islands, and use of porous surface.
- Encourage municipal and county authorities to mail stormwater pollution prevention information.

- Encourage municipal and state authorities to prevent or remediate the silting in of public pond systems to assure their ongoing existence.
- Investigate the possibility of converting ditches to shallow ponds that could remove nutrients from the runoff stream by holding up low flow rates to permit time for nutrient reduction (1 veto).
- Investigate and propose modalities for financing future stormwater needs.
- Use cost-benefit analysis to help set priorities for stormwater management projects.
- Require stormwater maintenance plans for new commercial properties. (1 veto)
- Develop manuals on stormwater system maintenance to address commercial properties. Existing documents should be disseminated to commercial property owners.
- Develop a program or means to provide outreach/education to commercial property owners served by a stormwater management system. This program should address maintenance plans, funding obligations, legal obligations, resource agencies, etc.

III. Wastewater

Within the Broadkill Watershed, several initiatives have led to nutrient reductions to date. A state-wide Holding Tank Compliance Program assists the 21 holding tanks in the watershed with monthly pump-outs, which reduces the nutrients entering groundwaters. In addition, approximately 350 individual onsite wastewater treatment and disposal systems (OWTDS) in the Red Mill Pond area were eliminated when they were connected to a central sewer district. These actions have resulted in estimated reductions of 18.54 lbs/day of Nitrogen and 1.89 lbs/day of Phosphorus and annually, had a cost of approximately $333,000. (Note that this cost is annualized over the life of the loan and/or BMP).

- Require new and replacement onsite wastewater treatment and disposal systems (OWTDS) larger than 2,500 gpd to use technologies that achieve specific performance standards for TN and TP. Typically, phosphorus reducing technologies are only recommended where site specific conditions warrant.
- Investigate and report state-of-the-art best available technologies for the non-water management of waste, including pilot demonstration projects.
- Require enforcement of existing individual OWTDS regulations. (1 veto)
- Provide incentives and financial assistance when needed for repair and upgrade of individual OWTDS, (particularly for low income households).
- Develop a program or means to provide outreach/education to homeowners served by an OWTDS. This will require a dissemination strategy.

Broadkill Steering Committee

Member	Affiliation/interest
Gary Stabley	– President, City of Lewes Board of Public Works
Rich Collins	– Positive Growth Alliance
Annabella Larsen	– Prime Hook National Wildlife Refuge
George O'Shea	– Prime Hook National Wildlife Refuge
Marilyn O'Neal	– Perdue, Georgetown
Judy Denver	– U S Geological Survey and watershed resident
Joan Martin Brown	– Milton resident and Milton Town Council
Bob Stenger	– Watershed resident and golf course owner/operator in upper watershed
Nick DiPasquale	– Duffield Associates, Inc. and Audubon Society
Charles Jones	– Milton resident with boat livery on Broadkill River
Ernie Sheppe	– Morris & Ritchie Associates and professional engineer
Bob Howard	– watershed resident
Bev and Ron Stoner	– watershed residents and Broadkill River Monitoring Program
Sandra DeeHenning	– watershed resident and Broadkill River Monitoring Program
Kip Foskey	– Sussex Conservation District

Facilitators

Joe Farrell – University of Delaware Sea Grant Program

Bill McGowan – University of Delaware Cooperative Extension

DNREC, Division of Water Resource, Watershed Assessment

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May 14, 2008

Honorable John Hughes, Secretary
DNREC
Office of the Secretary
89 Kings Highway
Dover, DE 19901

Dear Secretary Hughes:

On behalf of the Broadkill Watershed Tributary Action Team enclosed are the Team recommendations for Pollution Control Strategies for the watershed.

In January 2006, the Department of Natural Resources and Environmental Control (DNREC) initiated a public process to address water quality in the Broadkill River watershed. The University of Delaware Sea Grant Program served as a neutral host and provided facilitation, education and logistic support. A steering committee, comprised of watershed residents, local business, local government, and government agencies determined the direction of the team by learning about the water quality problems and potential solutions specific to this watershed and determined the best way to share these issues with the public and invite their involvement.

The product of their deliberation were two public forums, held in December 2006, where we shared water quality concerns with the community, encouraged discussion and sought common ground on which to develop formal recommendations for DNREC. As a result of these forums, we gained new stakeholders as team members who assisted in creating these recommendations. At this point the steering committee became the Broadkill Watershed Tributary Action Team.

The Team deliberated over the course of a year – from January 22, 2007 to January 14, 2008 – to build agreement among stakeholders on a plan of action for the watershed to reduce nonpoint source nutrient enrichment and bacteria inputs, as prescribed by Total Maximum Daily Loads (TMDL) for the Broadkill River Watershed. The TMDL Regulation (December 2006) calls for non-point source reductions of 40% for nitrogen and phosphorous and 75% reduction for bacteria.

The Team was advised by DNREC Watershed staff that the Department would strongly consider the guidance of this multi-stakeholder team in the development of watershed Pollution Control Strategies.

While these recommendations are a “first cut”, based on data available, the Team stands ready to further refine recommendations based on DNREC evaluation of effectiveness.

Thank you for the opportunity to participate in this process. We hope that these recommendations contribute to development of effective and long lasting strategy to reduce nutrient enrichment the watershed.

Sincerely

Joe Farrell	Bill McGowan
Team Facilitator	Team Facilitator
Delaware Sea Grant Program	Delaware Cooperative Extension

Cc: Broadkill Tributary Action Team
L. Jones
J. Schneider
K. Bunting Howarth

Appendix D - BMP COST CALCULATIONS

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

Appendix E – Broadkill Public Process – summary (prepared Oct 2012 J Farrell)

In January 2006, the Department of Natural Resources and Environmental Control (DNREC) initiated a public process to address water quality in the Broadkill River watershed. The University of Delaware Sea Grant Program served as a neutral host and provided facilitation, education and logistic support.

Representatives of stakeholder groups were invited to serve on the Broadkill Watershed Steering Committee. The goal of the steering committee was to guide a strategy for improving water quality that Broadkill watershed residents and other stakeholder groups could accept in order to achieve stated water quality goals. It was further hoped that the Steering Committee would serve as the nucleus of a Broadkill Tributary Action Team. Broadkill Steering Committee members included:

Gene Dvornick – Pintail Development LLC, Milton Town Council, Milton VFD

Gary Stabley - Chair, Lewes Board of Public Works

Rich Collins - Positive Growth Alliance

Jonathan Schafler, Refuge Manager - Prime Hook Wildlife Refuge

Marilyn O'Neal – Perdue, Georgetown

Ann Buck - Mariner Middle School teacher (retired)

Sarah Cooksey - watershed resident and DNREC/Del Coastal Program

Judy Denver - USGS and watershed resident

Joan Martin Brown – Milton resident and retired EPA and World Bank

Bob Stenger – Wastewater expertise and golf course operator in upper watershed

Marianne Walch - DelDOT Stormwater Quality Program and watershed resident

Joy Sikora – Georgetown Planning Commission and real estate

Nick DiPasquale – Duffield and Associates and Audubon Society

Wayne Baker – Agriculture and watershed resident

Facilitators – Bill McGowan, Delaware Cooperative Extension and Joe Farrell, Delaware Sea Grant

The Steering Committee met every 4-6 weeks for approximately 8 months (eight meetings from 2/9/06 to 10/23/06). They learned about the water quality problems and potential solutions specific to the Broadkill watershed and determined the best way to share these issues with the public and invite their involvement. They helped develop a watershed issues paper to serve as basis of public forums *Broadkill River Watershed: Your Challenge, Your Choice* which was distributed by mail to all residents in watershed

Public forums were held on Wednesday, December 6, 2006, and Saturday, December 9, 2006, to gather public opinion on three approaches to pollution control strategy. The approaches were outlined in detail in a document and handed out at the forum. This document was used to educate the group, facilitate discussion, and help identify what is most important to the participants. The participants were asked which approach most closely represented their interests or was the most feasible approach to clean up the Watershed.

In Jan 2007, DNREC, with Delaware Sea Grant support, convened the Broadkill Tributary Action Team (TAT) comprised of many of Steering Committee members and new members from interested public.

The TAT deliberated watershed concerns and held 12 meetings from 1/22/06 to 1/14/08. In January 2008, they agreed on Draft Recommendations for a Broadkill Pollution Control Strategy. The Draft Recommendations were submitted to DNREC Secretary Hughes in May 2008. Those Tributary Action Team members serving at conclusion of process included:

Gary Stabley - President, City of Lewes Board of Public Works

Rich Collins - Positive Growth Alliance

Annabella Larsen - Prime Hook National Wildlife Refuge

George O'Shea – Prime Hook National Wildlife Refuge

Marilyn O'Neal – Perdue, Georgetown

Judy Denver – U S Geological Survey and watershed resident

Joan Martin Brown – Milton resident and Milton Town Council

Bob Stenger – Watershed resident and golf course owner/operator in upper watershed

Nick DiPasquale – Duffield Associates, Inc. and Audubon Society

Charles Jones – Milton resident with boat livery on Broadkill River

Ernie Sheppe – Morris & Ritchie Associates and professional engineer

Bob Howard – watershed resident

Bev and Ron Stoner – watershed residents and Broadkill River Monitoring Program

Sandra Dee Henning – watershed resident and Broadkill River Monitoring Program

Kip Foskey – Sussex Conservation District

Facilitators Joe Farrell - University of Delaware Sea Grant Program and Bill McGowan - University of Delaware Cooperative Extension

Lyle Jones, Jennifer Volk, John Schneider – DNREC, Division of Water Resource, Watershed Assessment

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For more information contact Jennifer Volk, Division of Water Resources, 302-739-9939, jennifer.volk@state.de.us or Melanie Rapp, Public Affairs, 302-739-9902.

Public Forums Set for Dec. 6 and 9 on Water Quality of the Broadkill River Watershed

Two public forums on water quality of the Broadkill River Watershed will be held in December.

- Wednesday, Dec. 6 at 6:30 p.m. – Cannon Laboratory, Room 104, University of Delaware College of Marine and Earth Studies, 700 Pilottown Road, Lewes, DE 19958
- Saturday, Dec. 9 at 10 a.m. – Mariner Middle School Cafeteria, 16391 Harbeson Road, Milton, DE 19968

Residents living in the Broadkill River Watershed are encouraged to attend one of the forums, hosted by the Broadkill Tributary Action Team Steering Committee, DNREC's Division of Water Resources, and the University of Delaware Sea Grant Program.

The Broadkill River and its tributaries are considered impaired by the state and the Environmental Protection Agency. The watershed is located in eastern Sussex County and includes the town of Milton and parts of Lewes and Georgetown. The major pollution sources have been identified as non-point sources, including failing septic systems, lawn fertilization, farming practices, and runoff from driveways, roads, and ditches.

Prior to the first forum, approximately 15,500 households living in the Broadkill Watershed will receive booklets, developed by the Broadkill Tributary Action Team Steering Committee, which describe the water quality problems and proposed approaches to address the issues. The following three approaches are included in the booklet and will be discussed at the forum.

- *The Broadkill River Watershed depends on you and me*: This approach suggests that if people know the issues and solutions they will do what is best for the river.
- *The Broadkill River Watershed belongs to all of us:* This approach suggests that if we collectively act as stewards of the river, we will ensure its quality.
- *Science and rules will protect the Broadkill River Watershed:* This approach suggests that vigilance, monitoring, and corrective action are necessary.

Residents of the watershed can help their Tributary Action Team develop the best package of pollution controls by attending a public forum and providing recommendations. Participant will

be entered into a drawing to win a rain barrel and one of two compost bins, which will be awarded at the close of each forum. Light refreshments will be served.

For more information, contact Jennifer Volk, Division of Water Resources, at 302-739-9939 or Joe Farrell, U. of D. Sea Grant Program and Broadkill Tributary Action Team Facilitator, at 302-645-4250, jfarrell@udel.edu.

DNREC's Division of Water Resources monitors, manages and protects Delaware's ground and surface waters, tidal wetlands, and underwater lands. It also provides public education and outreach programs and coordinates citizen volunteer monitoring and action teams. For more information, visit DNREC's web site at www.dnrec.delaware.gov.

The Broadkill River Watershed
Public Forums Summary

I. Background Information

A 1997 federal court case required Delaware to set pollution limits for our waterways because existing pollution control strategies were not sufficient to meet Delaware state standards for water usage and recreation. A series of public forums were scheduled to help decide what strategies are necessary to reduce these pollutants and how they will impact those who live, work and recreate in the Broadkill Watershed. The University of Delaware Sea Grant Program and the Delaware Department of Natural Resources and Environmental Control (DNREC) asked a group of stakeholders to be in charge of these forums and aid in the ultimate decision making process. This committee was also responsible for designing a booklet that outlines three approaches to addressing water pollution in the Broadkill River Watershed which were used in the forums. The Broadkill Steering Committee consists of citizens with diverse interests from the watershed.

The following approaches have been developed based on the committee's efforts to characterize what is important to all stakeholders in the watershed. These approaches will be used to assist the team in the development of the Pollution Control Strategy. The approaches are:

> Approach 1- The Broadkill River Watershed depends on you and me. With proper education people will be able to make wise choices that protect the watershed.
>
> Approach 2- The Broadkill River Watershed belongs to all of us. Good stewardship is the only way to guarantee that this river will be a part of future generations.
>
> Approach 3- Science and rules will protect the Broadkill River Watershed. We must "mind the store" taking action to protect natural buffers, wetlands and marshes.

Public forums were held on Wednesday, December 6, 2006, and Saturday, December 9, 2006, to gather public opinion on the three approaches. The approaches were outlined in detail in a document and handed out at the forum. This document was used to educate the group, facilitate discussion, and help identify what is most important to the participants. The participants were asked which approach most closely represented their interests or was the most feasible approach to clean up the Watershed.

The forums consisted of stakeholders as well as residents with personal interest in the health of the Watershed. These forums served as and educational tool as well as a way to get feedback on the committee's three approaches. Once the results from these forums are compiled, a Tributary Action Team will develop pollution control strategies.

II. Issue Description

The Broadkill River and several of its tributaries and ponds are impaired by high levels of bacteria (75% reduction required) and elevated levels of the nutrients nitrogen (40% reduction required) and phosphorous (40% reduction required). Because of this, Delaware will develop pollution control strategies for the Broadkill River Watershed. Enhancements in waste treatment, agricultural practices, and erosion and sediment controls have contributed to the Broadkill's health. However, levels of nutrients and bacteria in the waterways remain high. There has been a significant decrease in wetlands and forests over time as these natural filters have been converted for other uses. The land use continues to change from what was recently a watershed dominated by cropland to a more urban/suburban watershed. The impact of these land use changes is uncertain.

As residents of the Broadkill Watershed, we need to make decisions about its future. The multitude of activities that take place on land (69,000 acres in the drainage area), such as farming, lawn fertilizing, and septic use, even miles from the river, produce nutrients that enter the river through surface water runoff and groundwater recharge. This nonpoint source pollution, because of its diffuse nature, has proven difficult to tackle. Point source pollution, which is discharged from a specific site like pipe, also occurs in the Broadkill and is regulated through permits. Since sources of pollution come from a variety of points, any water quality goals will require everyone to do their part.

III. Roles

Forum Moderator: Bill McGowan
Scribes: Jen Volk
Observers: Laura Boyer/ Maria Willin
Sponsoring Organization: University of Delaware Sea Grant Program and Delaware Department of Natural Resources and Environmental Control (DENREC)

IV. Forums Conducted

Forum 1: Wednesday, December 6, 2006 from 6:30 – 9:00 pm at the University of Delaware College of Marine and Earth Sciences
Forum 2: Saturday, December 9, 2006 from 10:00 – 12:30 pm at the Mariner Middle School Cafeteria

V. Demographics of Forum Participants

Survey Results Include:

Milton: 23 responses

Lewes: 29 responses

News Ad: 2 responses

Sex: 67% Male 33% Female	**Race:** 2% African American 2% Asian American 2% Native American 91% Caucasian 2% Other
Age: 2% 17 or younger 6% ages 18 - 29 16% ages 30 – 49 59% ages 50 – 64 16% ages 65 - older	**Education Level:** 2% some high school 10% high school graduate 20% some college 39% undergraduate degree 29% graduate degree

VI. Survey Results

Here is a list of principles on which pollution control strategies might be based. How important do you think each one is?	**Very Important**	**Somewhat Important**	**Not at all Important**	**Not Sure**
a. Use community participation programs to instill a collective sense of stewardship and legacy for the Broadkill watershed.	**74%**	**20%**	**2%**	**4%**
b. The health of the Broadkill watershed is best left to individuals taking responsibility for their actions	**24%**	**41%**	**30%**	**6%**
c. Fix, improve and use existing government programs including enforcement.	**83%**	**15%**	**2%**	**0%**
d. Create partnerships with organizations and individuals concerned about the Broadkill watershed.	**75%**	**21%**	**0%**	**4%**
e. Offer incentives that encourage entrepreneurial market forces to focus on the Broadkill River.	**71%**	**25%**	**2%**	**2%**
f. Strict laws should protect the Broadkill watershed.	**56%**	**38%**	**6%**	**0%**

Look at the list in question # 1 again. How strongly is each principle actually reflected in our current policies?	**Strongly**	**Somewhat Strongly**	**Not at all**	**Not Sure**
a. Use community participation programs to instill a collective sense of stewardship and legacy for the Broadkill watershed.	**22%**	**44%**	**26%**	**8%**
b. The health of the Broadkill watershed is best left to individuals taking responsibility for their actions.	**16%**	**40%**	**28%**	**16%**
c. Fix, improve and use existing government programs including enforcement.	**30%**	**30%**	**32%**	**8%**
d. Create partnerships with organizations and individuals concerned about the Broadkill watershed.	**22%**	**44%**	**24%**	**10%**
e. Offer incentives that encourage entrepreneurial market forces to focus on the Broadkill River.	**30%**	**18%**	**38%**	**14%**
f. Strict laws should protect the Broadkill watershed.	**28%**	**26%**	**36%**	**10%**

How concerned are you about the issues below?	Very Concerned	Somewhat Concerned	Not at all Concerned	Not Sure
a. Strong environmental regulations may financially burden residents of the watershed.	**42%**	**40%**	**15%**	**2%**
b. Lack of scientific data prohibits sound pollution control strategies.	**46%**	**33%**	**17%**	**4%**
c. People do not know or may not care about the health of the watershed.	**63%**	**26%**	**6%**	**6%**
d. Current regulatory programs do not ensure adequate protection for the watershed.	**65%**	**20%**	**6%**	**9%**
e. Addressing water quality issues through land use planning will not work in the current environment.	**37%**	**38%**	**12%**	**12%**
f. A strong "voice" that speaks out for the health of the Broadkill does not exist.	**57%**	**28%**	**6%**	**9%**

How do you feel about these approaches to pollution control strategies?	Favor	Oppose	Not Sure
a. Use incentives such as density bonus to promote "green development".	**79%**	**11%**	**9%**
b. Create "Streamwatch" groups to monitor the Broadkill.	**81%**	**4%**	**15%**
c. Review water and wastewater regulations for efficacy.	**94%**	**6%**	**0%**
d. Ensure water quality components are included in the land use plan.	**92%**	**0%**	**8%**
e. Increase funding for agriculture conservation practices.	**81%**	**11%**	**8%**
f. Develop water quality education programs.	**96%**	**2%**	**2%**
g. Monitor and regulate activities with health and safety foremost.	**83%**	**6%**	**11%**
h. Support the purchase of critical habitat areas.	**89%**	**11%**	**0%**
i. Revise storm water regulations to include nutrient reduction.	**83%**	**8%**	**9%**

Which statement best describes how you feel?	%
a. I am not at all certain what approach to use for pollution control strategies.	**8%**
b. I have a general sense of what approach to use for pollution control strategies.	**46%**
c. I have a definite opinion as to what approach to use for pollution control strategies.	**46%**

VII. Themes Summarized By Approach

Approach 1: The Broadkill River Watershed depends on you and me.

Participants liked that this approach encouraged the education of communities surrounding the watershed. They felt that this would provide additional knowledge and increased awareness. Participants felt that capitalizing on the idea that without action we will lose the Broadkill will catch the attention of the citizens. They felt that regular inspection and regulations must be initiated. They showed interest in the idea of offering incentives may help generate interest in the health of the Broadkill. Along with the incentives, there must be a source of authority that

can uphold the regulations that the tributary team designs. Participants suggested the idea of fines of varying degrees depending on the violation.

There were concerns about where the monetary support will come from and whether or not the average citizen will care enough to get involved. Participants also voiced concerns about the other aspects of pollution. They do not want to down play the point source pollution, emitted by other contributors in their growing community. Several pollution prevention methods were suggested such as requiring buffers for both agriculture and developing communities.

Approach 2: The Broadkill River Watershed belongs to all of us.

Participants were in agreement that for this approach to be a success it would require the efforts of everyone: developers, farmers, citizens, etc. Even large point source organizations must be included in the process. Again participants encouraged the idea of "trade" or financial incentives to promote healthy action.

On the other hand participants showed concern regarding those who are responsible for making the final call on the new rules and regulations that will govern the Broadkill. The concern for an increase in tax dollars was raised as well as concern among landowners regarding the effects these new regulations may have on their equity and retirement. Participants also struggled to see major differences between approaches one and two; perhaps these could be combined in the future.

Approach 3: Science and rules will protect the Broadkill River Watershed.

Participants felt that this approach would most likely result in success if we use the "right rules, based on research". They felt that using scientific research to attain a factual basis for new laws will enable people to see the true need for action. Participants felt that evidence was a key factor in encouraging the communities to make a change. Again the idea of community involvement was seen as very important. Several ideas for change were offered by participants such as alternative lawn care options, using and building upon existing regulations.

Most of the concerns in this approach were related to cost. Many fear that people will be unable to handle the financial burden of the changes that will be enforced. If that is the case where will we find a sufficient source of funding?