St. Jones River Watershed Pollution Control Strategy

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

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Prepared for the St. Jones River Tributary Action Team
By the Watershed Assessment and Management Section
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ST. JONES RIVER WATERSHED POLLUTION CONTROL STRATEGY

INTRODUCTION AND BACKGROUND

The St. Jones watershed is located in Kent County, Delaware, with the Delaware Bay along its eastern border, the Choptank River watershed of the Chesapeake Basin to its west, the Leipsic River and Little Creek watersheds to the north and northeast, respectively, and the St. Jones watershed to its south (DNREC 2005). The watershed is one of sixteen watersheds in the Delaware Bay and Estuary Basin, and one of nine watersheds in Kent County (USGS HUC-10). The watershed is comprised of 57,735 acres of land (DNREC 2005) and contains six municipalities: Dover, Wyoming, Camden, Woodside, Magnolia, and Bowers Beach.

The watershed gets its name from the area's major water system, the St. Jones River, which is 22 miles long and begins in the western portion of Kent County, flowing in a southeasterly direction until it empties into the Delaware Estuary at Bowers Beach. Due to the tidal nature in the lower half of the St. Jones River, the flow decreases and the waters become turbid in these areas. The surrounding soils near the river are considered to have high to very high agricultural productivity.

According to 2007 state land use Geographic Information System (GIS) data, agriculture remains the number one land use in the watershed (37.4%), followed by urban land uses (33.3%), wetlands (17.5%), forests (8.4%), barren land (3.2%). Although only 30% of the watershed is classified as urban/residential, the watershed has the highest population of all watersheds in Kent County (DNREC 2005).

Table 1 lists the water bodies within the St. Jones River watershed listed on the State of Delaware's 1998, 2002, 2004, and 2006 303(d) reports. There are a total of eight listed water segments: 2 tidal segments of the St. Jones River, 3 freshwater stream segments, and 3 freshwater lakes or ponds. These segments contain nutrients, dissolved oxygen (DO), and bacteria, with the most probable source of pollutants identified as nonpoint sources. The total maximum daily load (TMDL) development in the St. Jones River watershed addressed these water quality impairments and presented TMDLs that are aimed at improving water quality in the listed segments.

LANDUSE

Land use information for the year 2007 is presented in Table 2 and Figure 2. The St. Jones River watershed is approximately 57,735 acres (90 mi^2) and is primarily non-urban (66.7%), with approximately 33.3/4% of that land used for agriculture. By 2007 the acreage of urban/residential lands has increased while agricultural and forested land has decreased as presented in Table 3.

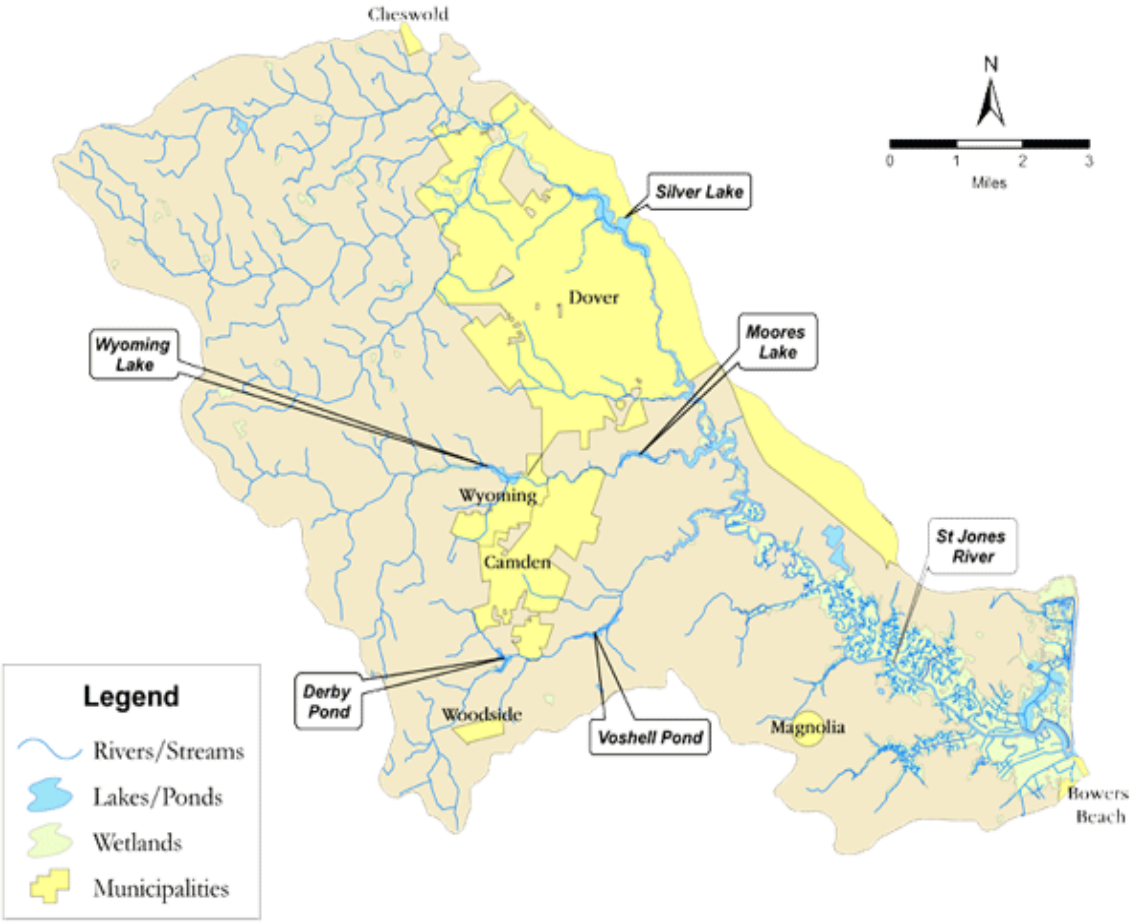

Figure 1 - Map of St. Jones River Watershed as of 2006.

Table 1 - St. Jones River Watershed TMDL Segments				
Water Body ID	**Segment**	**Size Affected**	**Description**	**Parameters**
DE290-001-01	Lower St. Jones	8.3 miles	From Old Lebanon Bridge to the mouth of Delaware Bay	Bacteria, DO, nutrients
DE290-001-02	Upper St. Jones	6.7 miles	From the dam at Silver Lake to Old Lebanon Bridge at Road 357	Bacteria, DO, nutrients
DE290-002	Isaac Branch	9.1 miles	From the headwaters to the confluence with St. Jones River, excluding Moores Lake	Bacteria, DO, nutrients
DE290-003	Fork Branch	7.7 miles	From the headwaters to Silver Lake in Dover	Bacteria, DO, nutrients
DE290-004	Tidbury Branch	3.8 miles	From below Derby Pond to the confluence with the St. Jones River	Bacteria, DO, nutrients
DE290-L01	Moores Lake	27.1 acres	Lake east of Camden	Bacteria, DO, nutrients
DE290-L02	Silver Lake	157.8 acres	Silver Lake at Dover	Bacteria, nutrients
DE290-L03	Derby Pond	23.1 acres	Pond south of Wyoming	Bacteria, nutrients

Table 2 - Summary of 2007 Land Use in the St. Jones River Watershed		
Land Use	**Area (a)**	**% Total Area**
Agriculture	21,596	37.4
Forest	4,858	8.4
Pasture/Rangeland	415	0.7
Urban/Built-up Land	19,206	33.3
Water	1,552	2.7
Wetland	8,689	15.1
Others	1,419	2.4
Total	57,735	100.0

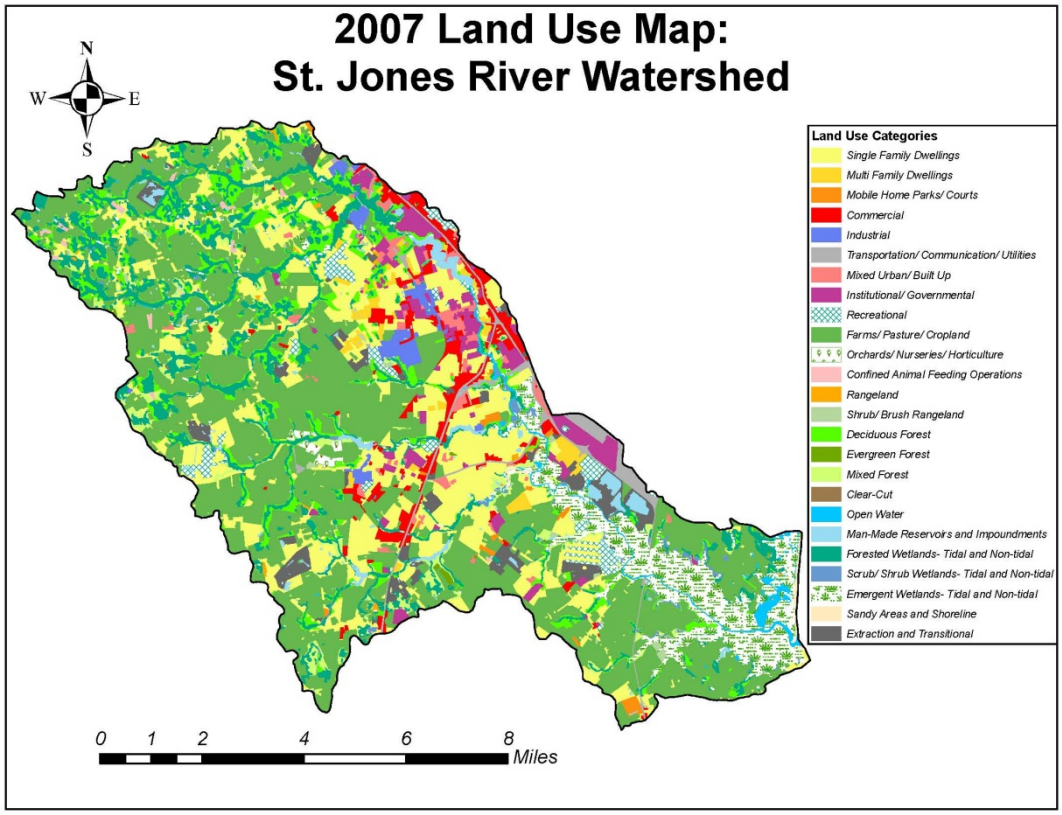

Figure 2 - St. Jones River Watershed Land Use Distribution

Table 3 - Land use change from 1997 to 2007 within the St. Jones Watershed			
Land Use	**1997 % Total Area**	**2007 % Total Area**	**Change**
Agriculture	44.4	37.4	-6.4%
Barren/Open	1.8	3.2	1.4%
Urban	26.9	33.3	6.4%
Forest Land	9.8	8.4	-1.4%
Wetlands/Water	17.1	17.5	0.4

SOURCES OF POLLUTION

Both nonpoint sources and point sources of pollution can be found in the St. Jones watershed. Nonpoint source pollution can be defined as pollution caused by land use practices that occur over large areas. Unlike point source pollution, which deposits pollution into a water body at a specific location, nonpoint sources reach waterbodies at nonspecific locations through groundwater seepage or agricultural runoff along a stream.

The land use distribution in the St. Jones River watershed was generalized into the groups shown in Table 2: agriculture, forest, pasture/rangeland, urban/built-up, wetlands and others. Each of these land uses has a different possible source of pollution that is deposited directly or indirectly into the water system. The "other" land use category includes transitional construction and inland natural sandy areas. Forested areas, made up of deciduous, evergreen, and mixed forests, account for just over 8.4 percent of the watershed. Nutrients and bacteria from the resident wild animals, and organic material from the native plants, are common sources of nonpoint pollution. Wetland areas make up 15.1 percent of the total watershed and are home to many species of plants and wildlife that produce organic, nutrient, and bacterial wastes. Approximately 37.4 percent of the St. Jones River watershed is classified as agricultural, including cropland, farm related buildings, idle fields, orchards, and land used for nurseries. Possible nonpoint sources of pollution from these areas include bacteria and nutrients from animal feed lots, organic material from plants, nutrients from industrial fertilizers, and particulate and dissolved nutrients in runoff. Pasture/rangeland comprises less than 0.7 percent of the watershed, and includes pasture and herbaceous, brush and mixed rangelands. Nutrients and bacteria from animal grazing or production are common sources of nonpoint pollution. Urban land has a higher amount of pollution due to a lower amount of pervious land. Examples of urban land are: roads, salvage yards, mixed urban, professional retail, single family dwellings, utilities and warehouses. Among the causes of pollution from urban land use are nutrients and bacteria in runoff from impervious surfaces, nutrients and bacteria from septic systems, nutrients from residential fertilizers, industrial wastes and domestic pet wastes. In 2007, approximately 33.3 percent of the St. Jones River watershed is urban or built-up. Based on the land use data, the St. Jones River watershed is primarily non-urban (70%); and non-point sources (NPS)_ are an important source of pollution in the watershed. There are two active National Pollutant Discharge Elimination System sites (NPDES) permitted in the watershed but these are non-contact cooling water discharges with low loadings of pollutants: Reichhold Chemicals Dover Plant and Dover McKee Run Power Plant. Therefore, NPSs are the dominant source of pollution in the watershed.

PROGRESS TO DATE

Six years have passed since the TMDL for the St. Jones River was promulgated using pollution levels from 2006. 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. Appendix D documents those calculations and Appendix E estimates the associated costs.

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 2006, 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 - Agricultural Best Management Practice Reductions as of March 2012 in the St. Jones Watershed

		Load Reduction (lb/day)	
	Acres	**TN**	**TP**
Cover crops acreage for 2011	890	10.79	0.38
CRP Practices (data from 2004 and earlier)			
Shallow water areas for wildlife (CP9)	13.8	0.3	0.03
Existing Trees (CP11)	3	0.1	0.00
Grassed waterways (CP8)	0.4	0.0	0.02
Grassed filter strips (CP21)	2.5	0.0	0.23
Wildlife habitat (CP4D)	33.5	0.0	0.23
CREP Practices* (data from 2005 and later)			
Grass buffers (CP21AC)	8.5	0.4	0.16
Wildlife Plantings (CP4D)	42.3	1.7	0.70
Hardwood Plantings (CP3A)	130.3	3.6	1.43
Riparian buffers (CP22)	7	0.2	0.12
Shallow water areas for wildlife (CP9)	10.9	0.4	6.20
Wetland Restoration (CP23)	352	11.5	1.51
Critical area planting	14.3	0.1	0.00
Conservation tillage	1981	1.4	0.00
Manure Relocation (annual tons)	646	3.76	2.79
Phytase	1,007.59		0.44
Nutrient Management Plans	21587.6	63.1	51.10
Total		**95.33**	**64.03**

Total Progress to Date:

Estimated Nutrient Reductions 95.33 lbs/day TN; 64.03 lbs/day TP

Estimated Progress to Date Implementation Cost: $2,503,028 (This cost does not include manure relocation and phytase costs).

Open Space

The Tributary Action Team has made some recommendations for open space, but their recommendations are more voluntary than regulatory. Using GIS mapping tools to determine acreage of open space within the St. Jones indicated there are 8,070.9 acres of public lands in the watershed and approximately 55 % of the public lands are in tidal areas of the watershed.

Total Progress to Date:

Estimated Nutrient Reductions: lbs/day TP unknown; lbs/day TN unknown

Onsite Wastewater

Current septic system pump outs of 100 systems and 18 holding tanks have helped to decrease the nutrient pollution entering the St. Jones watershed.

Table 5 - Nutrient Reduction Resulting from Onsite Wastewater Treatment and Disposal System Best Management Practices as of August 2009

		Load Reduction (lbs/day)	
	Number of Tanks	TN	TP
Holding Tanks (12 pump-outs/year)	18	1.36	0.45
Septic System Pump Outs	100	0.24	0.10
Total		**1.60**	**0.55**

Total Progress to Date:

Estimated Nutrient Reductions: 1.60 lbs/day TN; 0.55 lbs/day TP

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 6 - Implemented Stormwater Best Management Practices as of Spring 2012			
Best management Practice (BMP)	**Actual Acreage Treated**	**Daily Load Reduction From Stormwater BMP (lbs/day)**	
		TN	TP
Biofiltration/bioswales	276.1	2.35	0.39
Dry ponds	1271.82	1.08	0.25
Filter Strip	8.17	0.07	0.01
Infiltration systems	245.74	2.09	0.34
Sand Filter	8.7	0.06	0.01
Wet Pond	3231.58	16.48	3.23
Street sweeping, Stream bank restoration and Regenerative step pool system		4.01	3.08

The City of Dover has developed a storm water management program in response to the United States Environmental Protection Agency's (EPA's) regulation referred to as the Stormwater Phase II Rule. Under this rule, storm water discharges to certain municipal separate storm sewer systems (MS4s) are regulated. Specifically, discharges of storm water, to waters of the State of Delaware, from the storm sewer system owned, operated or maintained by the City of Dover are regulated and require a NPDES (National Pollutant Discharge Elimination System) permit.

The City of Dover, through the Department of Public Works, received its NPDES/State permit from the State of Delaware Department of Natural Resources and Environmental Control (DNREC) in 2003. This permit authorizes the discharge of storm water from the City's storm sewer system and requires the implementation of the City's storm water management program. Elements of the City's program include public education and outreach, public involvement and participation, illicit discharge and elimination, construction site runoff control, post construction storm water management, and pollution prevention good housekeeping for municipal operations. When implemented together, it is expected that pollutants discharged into receiving water bodies will be reduced to the maximum extent practicable.

Total Progress to Date:

Estimated Nutrient Reductions: 26.14 lbs/day TN; 7.32 lbs/day TP

Estimated Progress to Date Implementation Cost: $20,855,707 (Street sweeping, stream bank restoration and regenerative step pool system costs not included)

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 of water 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; a few examples of these are proper cleanup of pet waste, managing livestock manure, and 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.

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 of bacteria removal include the use of chemicals, such as chlorine, or the use of ultraviolet lights. These methods can be costly and require considerable oversight. Table 7 illustrates typical bacterial reductions from commonly used BMPs.

Table 7 - 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 %
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	20	45	55-94	44-99
Biofiltration	N/A	N/A	25	34		>99
Bioswales	Low	Medium	25	34	70	
Storm water wetlands	N/A	N/A	30	49	N/A	78-90

*if properly managed

The St Jones bacteria TMDL requires a 90% reduction in bacteria numbers. The State of Delaware Surface Water Quality Standards, as amended July 11, 2004, provides specific numeric

criteria for bacteria for the waters of the Christina Basin. The water quality standard for enterococcus bacteria in the Christina Basin is as follows for primary contact recreation for fresh waters:

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

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

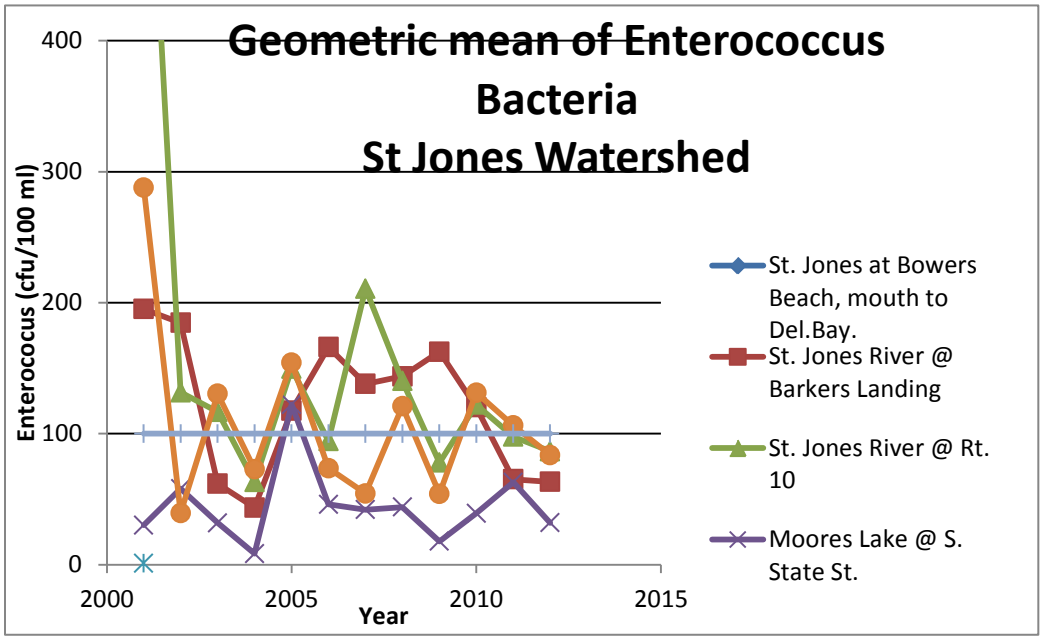

Figure 3 - The year geometric mean of Entrococcus Bacteria in the St Jones River.

The levels of enterococcus bacteria in the St jones River have fluctuating levels with a mostly decreasing trend across stations. Figure 3 shows the geometric mean enterococcus bacteria levels in the 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.

Additional Progress Items

In 1986, the Silver Lake Commission (Commission) was formed following the recommendation of Dover's City Council. On August 27, 1990, by request from then-Mayor Jack Richter, the Commission was officially adopted as an advisory committee to the City Council and City staff.

Since then, the Commission has worked to improve the condition of the Lake and provide a forum for public involvement on issues related to the Lake. Commission members seek ways to

improve the Lake's water quality, wildlife habitat, open space and park opportunities, and water-related activities through participation and coordination with other government bodies and institutions.

The hard work of the Commission and its partners has paid off and can be verified by the amount of progress that has been made within the last year. Some of the major accomplishments of the Commission include:

- **Silver Lake Park -** Two successful planting events took place this past spring and fall of 2011 and one took place in the spring of 2012 that expanded the riparian buffer zone around the St. Jones River in Silver Lake Park. Approximately 120 volunteers helped plant shrubs and trees that will help improve water quality and protect the stream banks. The plantings were a continuation of the Silver Lake Park Revitalization Project that was initiated in 2007.
- **Delaware Agricultural Museum –** The mill pond has been enhanced and the old wind mill is fully functional again. A buffer of native vegetation has been planted around the mill pond to improve water quality and to limit Canada geese access to the pond. The monitoring of bacteria levels in the pond hasdecreased since the buffer has been planted.
- **Mirror Lake –** The Commission is working in conjunction with DNREC and the City of Dover to move forward with the cleanup of Mirror Lake. A stormwater wetland will be constructed in the near future to treat runoff from the DNREC and Treadway Tower parking lots.
- **Eroded channel behind the Ag Museum and Dover pools –** A regenerative step pool system will replace the highly eroded drainage channel that empties directly into Silver Lake. The plunge pools will help collect sediment before it enters the Lake and a newly constructed wetland at the foot of the channel will also help filter the water.
- **Outreach material –** Educational brochures have been developed for City of Dover residents to educate the public about their impact on our local waterways.
- **Rain garden planted at Fairview Elementary –** Over 300 students from kindergarten through fifth grade participated in planting over 200 native plants. The rain garden will collect and filter runoff from the school's roof and will also provide a unique garden for teachers to utilize for outdoor learning activities.

Overall Nutrient Load Reduction Progress

All sectors to date have taken steps to improve water quality through the implementation of laws, regulations, and voluntary BMPs. Analysis using a basic land use loading rate model shows that, to date, nonpoint sources of Total Nitrogen and Total Phosphorus have been reduced by 34% and 151 % respectively from the TMDL baseline levels. While land use modeling based on current practices predicts phosphorus reductions exceeding that required by the TMDL, there is still a need for further reductions in nitrogen and areas that are currently lacking, such as wastewater and stormwater. The total strategy implementation reductions and costs are discussed in more detail in the section entitled, "Analysis for TMDL Achievement and Costs".

ST. JONES RIVER WATERSHED POLLUTION CONTROL STRATEGY RECOMMENDATIONS

BROAD PURPOSE

Remediate the waters of the St. Jones to a condition that meets the standards of the Clean Water Act (CWA). Once the water quality has improved to the necessary extent, the waters can be removed from the 303d list.

SPECIFIC GOALS

Limit pollutants to levels at or below the Total Maximum Daily Load (TMDL) values specified in the regulation; this entails an overall reduction of nitrogen and phosphorus in the waterways by 40%. Nonpoint sources must reduce total nitrogen by 376.51 lbs per day and total phosphorus by 47.62 lbs per day.

Table 8 - Load reduction needed based upon 2007 land use to achieve TMDL reduction of 40% for nitrogen and phosphorus

Load Reduction	Nitrogen N (lbs/day)	Phosphorus (lbs/day)
Stormwater-Current	26.14	7.32
Wastewater-Current	1.60	0.55
Agriculture-Current	95.33	64.03
Riparian Buffers – Current	0.02	0.01
Total – Current Practices	123.09	71.91
Stormwater - Future	13.57	0.66
Wastewater - Future	65.62	7.34
Agriculture - Future	166.22	26.07
Total – Current and Future Practices	368.50	105.98
TMDL Target Reductions	367.51	47.62

Strategy Periodization

The recommendations are organized by major categories (Open Space, Stormwater, Wastewater, Agriculture, and Other) according to pollutant loads and nutrient reduction strategies. The Tributary Action Team first recommendation was that there be a fully funded staff position to coordinate watershed projects. The watershed coordinator responsibilities would be:

1. To develop an implementation strategy from the St Jones Watershed Implementation Plan.
2. Determine what water quality projects are feasible from Implementation Plan based upon water quality benefits, cost of installation and ability to implement project(s).
3. Work with Silver Lake Commission to create partnerships for water quality project(s).
4. Obtain funds for design and construction of water quality projects.
5. Work with City of Dover to plan and create a stormwater utility for watersheds within City of Dover municipal boundaries.
6. To develop watershed educational materials.

The watershed coordinator was initially funded in 2007 through Delaware's 319NPS program and for the last three by a FY 2009 106/604(b) WORKPLAN Subobjective 2.2.1: Protect and Improve Water Quality on a Watershed Basis, awarded to the Department of Natural Resources and Environmental Control in October 2008. As part of that award, the U.S. Environmental Protection Agency (EPA) has directed the Department to carry out planning functions and implement projects which define, assess, and manage pollution entering State waters from "nonpoint sources".

Nutrient Reducing Recommendations

Nutrient Reducing Recommendation 1 – Riparian Buffers

A St. Jones watershed buffer overlay map should be developed to ensure buffers are in place throughout the watershed. This overlay map should be developed in cooperation with local municipalities, used to coordinate efforts among jurisdictions, and must consider urban (developed) and rural (undeveloped) settings.

A 100-foot vegetated or forested riparian buffer zone should be required within the watershed for all water bodies, except for those on agricultural lands. Measurement should be taken from the edge of the bank of the water body landward.

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

Basis of Recommendation: Buffers help to filter nutrients and slow overland stormwater flow. Kent County has issued several ordinances related to development and buffers, including an ordinance requiring 100-foot setbacks from blue line streams and tax ditches, and a 25-foot buffer/setback for wetlands. However, the County setbacks are not required to be vegetated.

The City of Dover has an ordinance that requires all buildings, structures, and impervious surfaces to be set back at least 100 feet from the top of bank from wetlands greater than 0.25 acres in size and from all water bodies. The setback can be reduced provided a riparian buffer is established in the setback. The setback can be further reduced to 30 feet provided the riparian buffer planted in native vegetation and bank stabilization is implemented through the planting of native species. For single family residential use the setback sets may be reduced to 75 feet. The ordinance allows small (less than 200 square feet) stairs, ramps, open decks, patios, or docks to be placed within setback if they are necessary for access to natural features. These ordinances were approved as of November 2010. Figure 4 shows these areas that would be protected under this ordinance and the Kent County's buffer requirements.

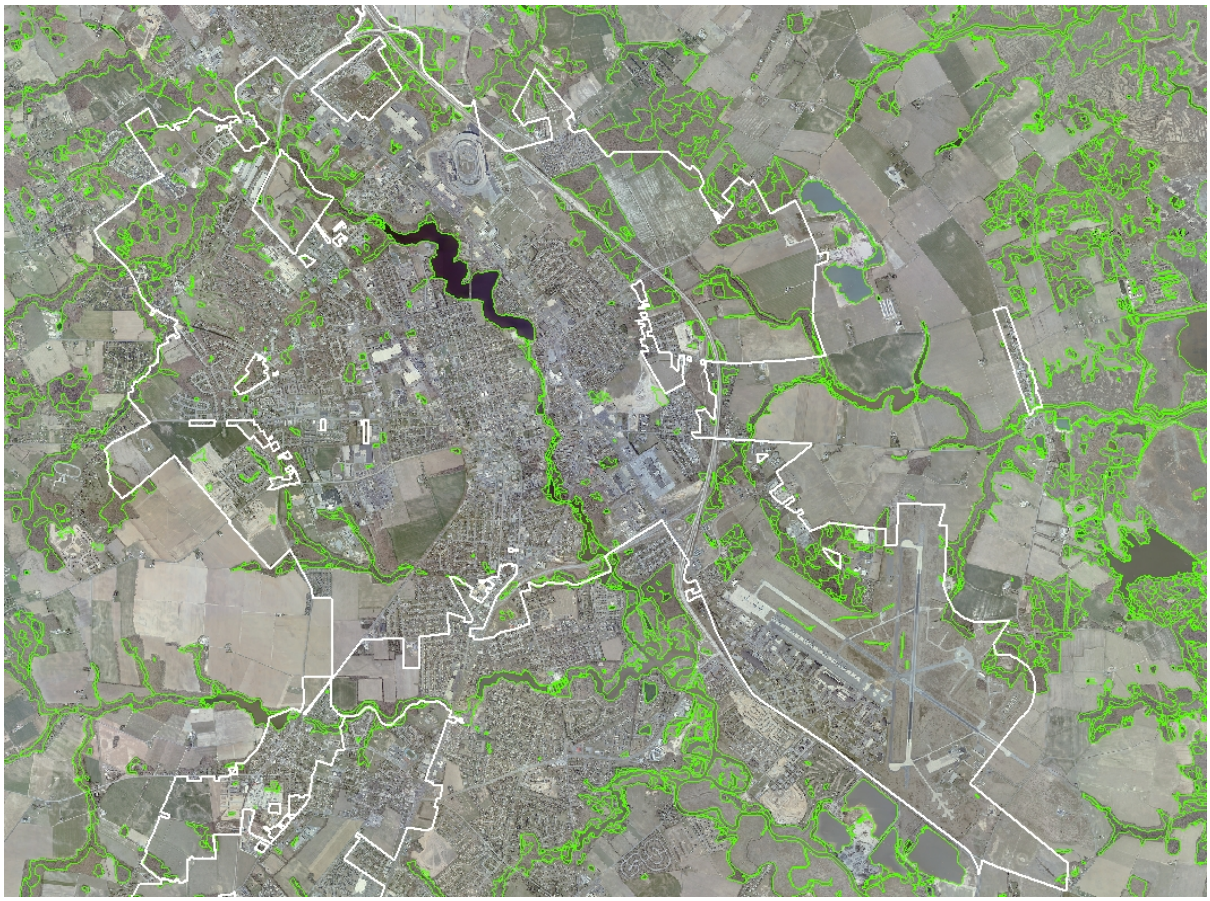

Figure 4 - Streams (outline in green) within Dover that require riparian buffers

The St. Jones Tributary Action Team feels these ordinances (Table 9) may not be strong enough as written to adequately protect the waters of the St. Jones River watershed. Recommendations are being made to strengthen and supplement County and municipal ordinances.

Table 9 - Kent County Ordinance (187-78) and the City of Dover required setbacks from water bodies

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

* Setback be reduced if riparian is planted with native vegetation and bank is stabilized through planting of native vegetation.

Figure 5 shows the area that would be protected by modifying setback by means of Kent County Ordinance §187.

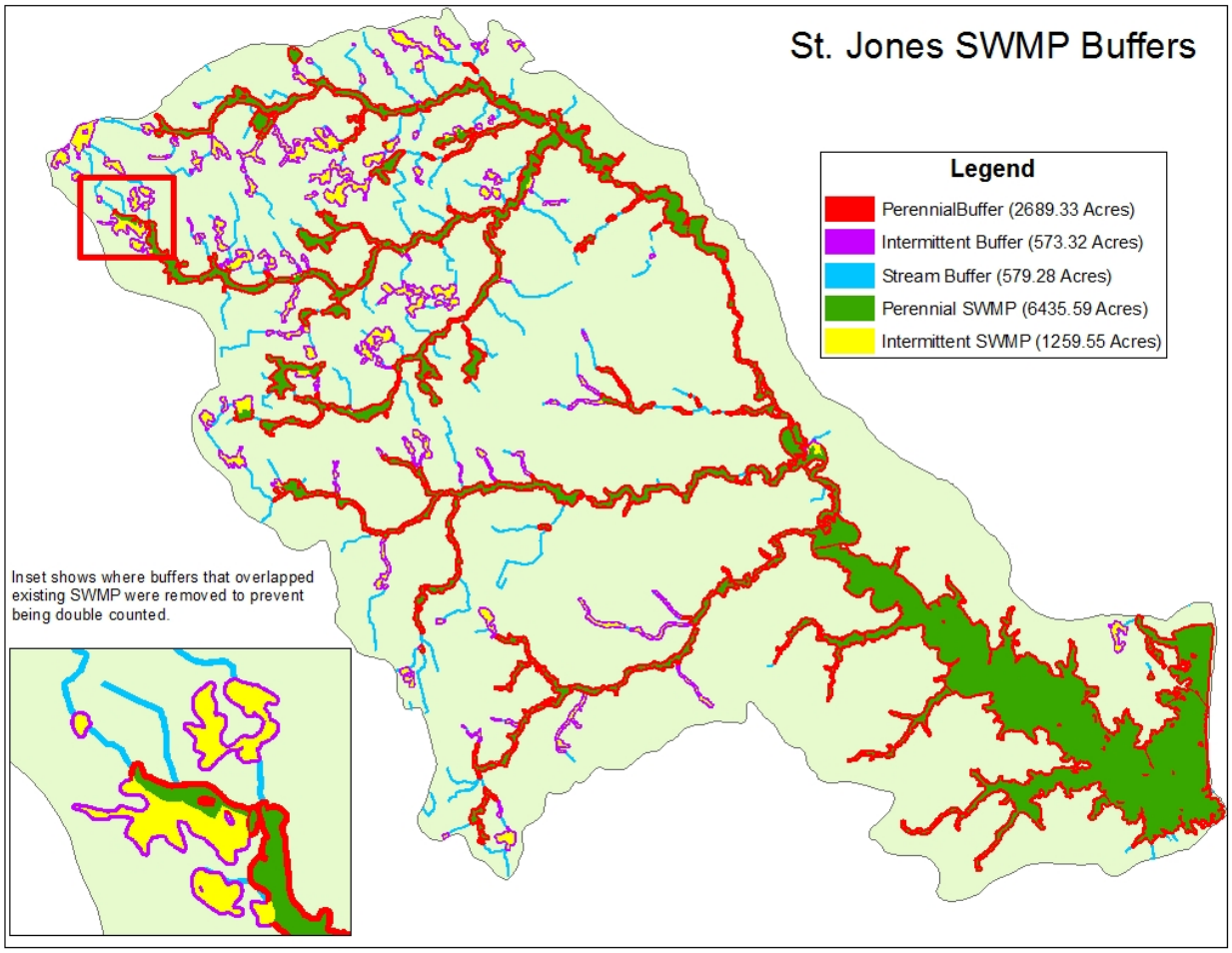

Figure 5 - Riparian Buffers in the St. Jones Watershed

The County setbacks are not required to be vegetated except in some cases for TMDL watersheds. Based upon the Tributary Action Team's recommendations, DNREC is recommending that the County strengthen and supplement County requirements with the expectation that these measures will protect and improve water quality and the quality of life for the residents in the watershed.

From the Team's recommendations, DNREC performed GIS analyses using ESRI's ArcGIS software on the 2007 National Hydrologic Data Set from U.S. Geological Survey (USGS) and Delaware Statewide Wetlands Mapping Project state wetlands maps (SWMP). Using these tools, DNREC was able to compare the current and proposed setback and buffer protection measures for all waterbody types, including TMDL and non-TMDL waters, as well as identify vulnerable areas that require additional protection.

In the first GIS analysis, perennial and intermittent streams were delineated using the Hydrologic Data Set, and 100 and 50 foot buffers were applied respectively either from the center line of the stream for TMDL watersheds, or from the mean high water line, shoreline and/or top of bank for non-TMDL watersheds. To improve consistency, however, the outer limits of delineated tidal or freshwater wetlands served as the starting point to apply the appropriate buffer distances for non-TMDL watersheds. Providing the same buffer starting point for both TMDL and non-TMDL watersheds presents the data in a format conducive for comparisons.

A second GIS analysis was conducted where the buffers were applied from edge of the wetland associated with the perennial and intermittent streams. The City of Dover's ordinance is similar to Kent County's, except the TMDL streams in Dover are not required to have setback as required in Kent County's ordinance; A 100 foot buffer was applied to perennial streams from top of bank (i.e. edge of wetland) and 50 feet from top of bank of the intermittent streams to mimic Kent County setback requirements (ordinance 187-78) for non-TMDL and the City of Dover set back ordinances. Acreage of the buffers from each GIS analysis was determined so that comparison could be made between riparian buffering schemes.

Table 10 - Acreage included in setback by means of Kent County Ordinance §187-78 or protected by §187-77*

Setback	Distance in feet	Type	Acreage included in required County setback 187-78	Additional acres protected by wetlands ordinance 187-77*	Total acres protected resulting from current County ordinances 187-77, 187-78
Any TMDL promulgated watershed	100 from center line of stream	Perennial	3668	6436	10104
Any TMDL promulgated watershed	100 from center line of stream	Intermittent	931	0	931
Non-TMDL watershed	100 from shore line or mean-high line	Perennial fresh and/or tidal waters	2689	6436	9125
Non-TMDL watershed	50 from shore or top of bank	intermittent stream or ditch	1152	1260	2412

* As per ordinance § 187-77, Kent County does not allow subdivision, filling, developing or clearing of vegetation in wetlands unless granted permission by a regulating agency.

The GIS analysis showed that by applying the non-TMDL water setbacks to all perennial and intermittent streams within the St. Jones watershed, an additional 502 acres of buffers would be provided. These acres would protect the streams in the St. Jones watershed and increase the

water quality benefits for the entire watershed. DNREC believes that the current County's TMDL setback ordinance for watersheds does not provide adequate water quality protection to the streams. In most cases, streams are bordered by wetlands without buffers to protect them from adjacent uplands; upland sources are a primary contributor of nutrients and bacteria found in these waters. It must be noted this scenario assumes that all lands adjacent to perennial and intermittent streams were developed, but this would most likely not occur in the St. Jones watershed under current County and municipalities zoning ordinances but some development will occur.

Research has shown that for each acre of grass, shrub, or tree buffer, two upland acres and its excess nutrients and bacteria are removed from the surrounding area. If the County ordinance for non-TMDL waters was applied to TMDL waters in the St. Jones watershed, so that the setback was applied at the mean high tide line for tidal waters and the top of bank for non-tidal waters, an additional 502 acres of buffer would protect the water quality in these waterways.

The proposed recommendation would offer protection for a portion of existing forested riparian buffer that is currently at-risk of being developed under current County and municipal setback requirements. The recommendation would allow inadequate buffers to be reestablished so that they can fully provide water quality treatment benefits. Developers should be required to protect existing, or provide new buffers when necessary, as community open space; however, the responsibility for buffer maintenance will fall to civic and homeowners associations or maintenance corporations rather than individual homeowners. Buffers should be planted and designed to require minimal maintenance. In addition, buffers should be planted with native species in an effort to ease maintenance, reduce erosion, and increase nutrient uptake capabilities. The developer should also guarantee all trees planted in the development remain living for the first year, or offer replacement plants as individuals are lost.

From the GIS analyses and Tributary Action Team recommendations, DNREC proposes that a 100 foot vegetated buffer be applied to all perennial streams from either top of bank or the mean high-tide line based on tidal properties, and 50 feet from top of bank for intermittent streams within the St. Jones watershed. This would mimic Kent County's current ordinance 187-78 for non-TMDL waters, except the setback (buffer) would need to be planted in native vegetation. As applied, the County's TMDL ordinance is less protective than its non-TMDL setback requirements.

Implementation Schedule: City of Dover adopted riparian ordinance in November 2010 and Kent County has proposed a new buffer ordinance in 2012.

Expected Reduction: For each acre of 100 feet wide buffer installed, 0.004 lbs per day of TP and 0.18 lbs per day of TN would be reduced.

Cost: Estimated at $115,000. Developers should be required to protect existing and/or provide new buffers if necessary as community open space; however, the responsibility for buffer maintenance will fall to civic and homeowners associations or maintenance corporations, not individual homeowners. Buffers should be planted and designed to require zero or minimal

maintenance. The developer must also guarantee all trees planted in the development for the first year.

Potential Funding Sources: Funding would come from developers.

Action Needed: The Department will work with Kent County and other municipalities within the watershed to develop buffer regulations that will be consistent with existing ordinances. Also, the Team recommends that Kent County Conservation District (KCD) have the authority to enforce buffer compliance. DNREC will initiate discussions with KCD about this recommendation, and note the possibility of linking the buffer compliance with the recommended implementation of a stormwater utility.

Nutrient Reducing Recommendation 2 – Open Space

Land maintained as passive or active open space under local ordinances or codes should be managed to minimize nutrient loading.

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

Basis of Recommendation: The St. Jones watershed has the highest population of all the watersheds in Kent County, likely due to the high number of economic opportunities in the state capital of Dover. In the past ten years, drastic land changes have taken place in the watershed. Urban and residential land uses have increased by 6.4% in the watershed and agricultural and forested land uses have decreased by 6.4% and 1.40%, respectively. Along with these changes, the amount of impervious surface in the watershed grew as more rural land was converted to urban uses. Currently, the St. Jones watershed has impervious cover well over 13%. As a result of the higher area of impervious cover and increased urbanization, surface water pollution has become an issue throughout the watershed.

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

The City of Dover has drafted environmental protection ordinances to protect public health and safety by ensuring that environmental standards for water, air, and soil in Dover are adequately addressed. The City's intent is to protect environmentally sensitive land as well as the plants and animals that reside on that land. Dover included all land areas that contain one of the following natural features that shall be considered to be an environmentally sensitive area or an area of scarce resources subject to specific requirements for environmental protection and conservation:

flood hazard areas, steep slopes, water bodies and wetlands, wet soils, woodlands, significant wildlife habitats, prime agricultural soils, and designated scenic areas.

Every five years the municipalities in Delaware must review their comprehensive management plans but must be updated every 10 years. Camden, Wyoming and Cheswold are working on their comprehensive management plans. Dover has revised its plan. During 146th legislative session, the General Assembly changed the Act (Senate Bill 138 w. SA 1, An Act to Amend Title 9 Relating to Comprehensive Land Use Plans) that required County governments to review and update their comprehensive plans every five to be updated every 10 years, which is the same presently required for municipalities in the state. DNREC reviews these plans through the State's Preliminary Land Use Service (PLUS) and recommendations are made to improve the protection of the natural resources within their municipal boundaries.

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

Implementation Schedule: Will work with the county and other municipalities to create ordinances.

Expected Reduction: For each acre of open space that is converted from agricultural land, 0.0068lbs/day of TP could be reduced, and.048 lbs/ day of TN could be reduced.

Cost: There is no additional cost for implementing Recommendation 2 because open space is required by existing municipal and county ordinances. There is a cost to enforce the ordinances; however, most of the cost is absorbed by the development community.

Potential Funding Source: Cost is first absorbed by the developer of the project, and then passed on to the new property owner.

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

Nutrient Reducing Recommendation 3 – Open Space Education

Homeowners' association members and homeowners should be educated on caring for open space in their neighborhoods and caring for their backyards to minimize nutrient loading and encourage natural habitat.

Implementation Goal: Develop an education program for caring for open space maintenance and backyard conservation.

Basis of Recommendation: Based on 2007 land use data, a significant portion of the St. Jones watershed is urban (33.3 percent) and much of it is turf. Over 73,000 acres of residential turf exists in Delaware and 58 percent of it is fertilized, usually without having a soil test indicating the need for fertilization.

It is apparent from the data set below that the non-farm fertilizer tonnage has grown significantly since 1995 to 2008. Correspondingly, there has been an eight percent increase in urban acreage over this time period suggesting that fertilizer applications to other land uses, such as residential lawns, is increasing. Sims et al. [1] (2007) reported that from 2000 to 2006, 50%, 30%, and 20% of the non-farm N fertilizer and 44%, 32%, and 24% of the non-farm P fertilizer was used in New Castle, Kent, and Sussex County, respectively.

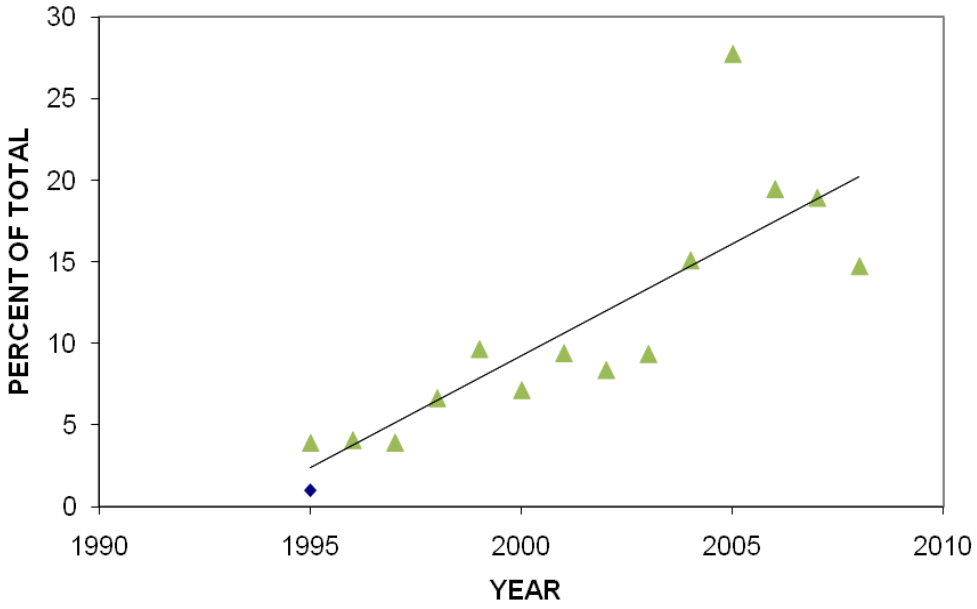

Figure 6 - Percentage of Non-Farm Fertilizer Sold in Delaware by Year

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

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

In response to the needs outlined in the St. Jones Implementation Plan, the St. Jones watershed Coordinator proposes to launch an educational/outreach campaign in the St. Jones watershed in an effort to change watershed residents' lawn care practices. The St. Jones watershed Coordinator, along with project partners, believes that by figuring out the real reasons people over-fertilize, they can cause the necessary behavior changes to reduce nutrient runoff from lawns in the watershed. They are doing this by helping to develop the Delaware Livable Lawns Program. The Livable Lawns Program certifies lawn care companies that follow environmentally-friendly practices in fertilizer application while educating homeowners. While many homeowners may be unaware of where, when, and how much fertilizer to apply, professional lawn care staff have the expertise to fertilize lawns correctly. Certified Livable Lawns companies go a step beyond the current regulations that govern fertilizer use by following environmentally-friendly practices resulting in healthy lawns and healthy water. In addition, the Livable Lawns program is beginning a residential education portion to educate homeowners as to their responsibility when it comes to fertilizer application and how what they do on their lawns can affect us all.

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

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

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

At no cost to participants, the Smartyards Program provides official certification for properties where owners meet the four criteria necessary for wildlife habitat: food, cover, water, and places

for wildlife to raise young. Certified habitats may range from those meeting the minimum requirements, such as a small urban balcony or rooftop, to extensive naturalized areas that meet a variety of wildlife needs. By adopting practices beneficial to wildlife such as planting native species, limiting use of chemical fertilizers and pesticides, reducing the size of lawn areas, and better maintaining small areas of forest or wetlands if located in backyards, participants help to improve local water quality. Smartyards provide habitat for a greater diversity of wildlife species, prevent the pollution of runoff from urban and suburban yards, and reduce the quantity of runoff more than traditional turf grass landscapes. Participants begin to make the connection that the wildlife in their yards is a part of the natural environment of their community, which includes the St. Jones River and its tributaries. The Watershed Coordinator has received some interest in this program in Dover and wants to implement it in the St. Jones in 2012.

In late 2005, the Delaware Coastal Program produced Community Spaces, Natural Places which is a guide to restoration, management and maintenance of community open spaces. The guide provides communities and landowners with a basic understanding of low cost natural habitat options for community open space and was designed to provide practical approaches for open space management, challenges, and opportunities of mobilizing a community open space as well as low cost natural habitat options for open space.

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

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

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

Implementation Schedule: Liveable Lawns program started in January 2011.

Expected Reduction: For Smartyards 0.11 of N and 0.04 lbs per acre lot of P for Smartyard landscaping and but EPA considers urban stormwater runoff from yards, streets, parking lots and other areas to be one of the most significant of contamination in our county's waters.

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

Action Needed: The Department will work with the Delaware Nursery and Landscape Association and the Delaware Nutrient Management Commission to accomplish this

recommendation and will work with other partners including the County and local governments to accomplish this recommendation.

Nutrient Reducing Recommendation 4 – Sewer Repair

Sewer transmission systems should be repaired to reduce infiltration and inflow during wet periods.

Implementation Goal: Reduce inflow and infiltration into Kent County Sewer system.

Basis of Recommendation: Based upon information provided to the Team from Kent County's wastewater treatment facility, flow to the county wastewater treatment plant may double during rain events and nutrient loads may increase from more runoff. It is estimated that Dover residents are paying at least $100,000 a year just to treat rainwater that has infiltrated into Dover's collection system. In the fall of 2006, Dover contracted with Video Pipe Services of Beltsville, Maryland to determine areas where the sewer collection system needs repairs in order to eliminate infiltration. From the information collected from this action, the City of Dover estimated that over 700,000 gallons of rain water was eliminated from infiltrating and inflowing during wet periods into their collection system. This estimated inflow resulted from 27 homes in old Dover. The video of the collection system and subsequent smoke testing showed that most of the infiltration came from roof downspouts being connected to the wastewater collection system in old Dover area of the City. The City requested that each of the 27 home owners have their downspouts disconnected from their below grade drain pipes which connected to sewer system and requested the downspouts be allowed to flow on to the ground. The City re-checked each home to see if the disconnection was completed. As of November 2012 over 60 homes have had their down spouts disconnected from the sewer and the City is in the process of relining sewer mains to reduce inflow and infiltration of rainwater.

Implementation Schedule: On going process.

Expected Reduction: Reduction of 2.9 lbs/day of P and 35 lbs/day of N from rain water inflowing from 27 homes.

Cost: The City of Harrington estimated $400,000 to fix leaky sewer pipes that are letting rainwater into the town's sewer system.

Potential Funding Source: Sewer fees from customers of Kent County Wastewater Treatment Facility and from City of Harrington**.**

Action Needed: None.

Nutrient Reducing Recommendation 5– Septic Pump Out and Inspection

Onsite Wastewater Treatment and Disposal Systems (OWTDSs) should be inspected and pumped out regularly to reduce nutrient loading of the groundwater. Compliance with current regulations should be promoted.

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

Basis of Recommendation: Currently septic permits require that the systems be pumped out every three years or when the system contains 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 homeowners 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 inspections and pump outs. Following the inspection, the inspector should provide the homeowner/resident with educational materials and receipt of pump out.

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

With the promulgation of 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 inspected and pumped out on-site wastewater treatment and disposal systems will occur more regularly. The proposed regulations require that a septic system to be inspected when the parcel is sold. If the new regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

The watershed currently has 6,244 OSWD systems within its boundaries. If all systems are pumped once every three years, as required by state regulations,[14] then 2,081systems would be 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 0.6 lbs/system/year and1.6 lbs/system/year, respectively.

Implementation Schedule: New regulations will be promulgated by 2012.

Expected Reduction: 5.69 lbs/day of TP and 14.2 lbs/day of TN for pumping out 2,081 septic tanks

Cost: The costs of the inspection will be covered through an agreement between the buyer and the seller. The cost of pumping out OWTDS ranges from $185-200 per system, with an average

[14] Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems, adopted March 11, 2002.

cost of $192.50 per system (DNREC Small Systems Branch, personal communication, 2007). Permit conditions require that septic systems be pumped once every three years, which capitalizes this figure to $68.60/system/year. The proposed inspection will be performed at an estimated cost that range from $200 to $400 with an average cost of $300 at the time of pump-out (DNREC Small Systems Branch, personal communication, 2007). Thus, the inspection fee will only be incurred once every three years, so that annually it equates to $100. The total cost of the OWTDS inspection and compliance program will cost the system owner $169/system/year.

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

Action Needed: With the promulgation of the new proposed Regulations Governing the Design, Installation, and Operation of On-site Wastewater Treatment and Disposal System by the end of 2012, the Department believes that Nutrient Reducing Recommendation 5 for inspections of individual onsite wastewater treatment and disposal systems (OSWDS) will occur at the time of sale and at least once every three years. If the new on-site wastewater treatment and disposal system regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

Nutrient Reducing Recommendation 6 – Cesspools and Seepage Pits

> Cesspools and seepage pits should be eliminated systematically as these wastewater systems discharge nutrients and bacteria directly into the groundwater. The septic inspection and maintenance program should help locate and eliminate them.

Implementation Goal: Eliminate all cesspools and seepage pits in the watershed.

Basis for Recommendation: The DNREC Watershed Assessment Section estimates that there are at least 30 cesspools[15] and/or seepage pits in the St. Jones watershed, however that estimation may be low. Any existing cesspools would likely be with old farmsteads and very old mobile home parks.

Implementation Schedule: New regulations will be promulgated by 2012.

Expected Reduction: 0.6 lbs/day of TP and 0.16 lbs/day of TN for 30 cesspools

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

[15] This number was determined by using a GIS and old aerial photographs to assess large parcels over 10 acres within the Murderkill Watershed with the assumption that large parcels were farmsteads and had a dwelling unit and cesspool.

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

Action Needed: With the promulgation of the new proposed Regulations Governing the Design, Installation, and Operation of On-site Wastewater Treatment and Disposal Systems in 2012, the Department believes that Nutrient Reducing Recommendation 6, which details the systematic elimination of cesspools and seepage pits as the properties are transferred from one owner to another. If the new on-site wastewater treatment and disposal system regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

Nutrient Reducing Recommendation 7 – Septic Removal

> If it is physically and legally available (as defined by the Regulations Governing the Design, Installation and Operation of OWTDSs), OWTDSs should be removed in growth zones and connected to the Kent County Wastewater Treatment Facility. The inspection and maintenance program will identify the connection of failed systems to sewer systems, if available, or replacement systems, if not.

Implementation Goal: Eliminate failing septic systems by connecting them to Kent County Wastewater Treatment Plant.

Basis for Recommendation: In Delaware, surface and ground water are directly connected. Consequently, impacts on groundwater will impact the quality of the surface water. In the summer, surface water flow is primarily groundwater seepage into the stream. Nutrients from onsite wastewater treatment and disposal systems will reach the surface water through the groundwater.

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, DNREC believes that Nutrient Reducing Recommendation 7 will be met. If the new regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

St. Jones watershed is estimated to have 918 residents that with be connected to Kent County Treatment Facility over the next 15 years. Many of these systems are old and are malfunctioning.

Implementation Schedule: To be completed by 2027.

Expected Reduction: 0.11 lbs/day of TP, and 3.44 lbs/day of TN for 61 system per year

Cost: Kent County charges a capital impact fee of $1,679 and a sewer district impact fee of $1,491 for each home or equivalent dwelling unit. There is also an $85 permit fee required by

the County. Total cost to connect to county sewer is $3,255 but this does not include the actual cost to run the sewer pipe into the county sewer line.

Potential Funding Source: As areas are being developed by private entities, the developers will absorb some of the septic elimination cost.

Action Needed: Assist the county by identifying areas that have a large number of failing old wastewater treatment and disposal systems due to system age and undersized disposal areas.

Nutrient Reducing Recommendation 8 – Performance Standards

> All new and replacement onsite wastewater disposal systems must be designed to achieve performance standards using the best available "new technology" to achieve required nutrient reduction targets for the watershed.

Implementation Goal: Require all new onsite wastewater treatment and disposal systems to meet TMDL nitrogen reductions.

Basis for Recommendation: In response to the TMDL, Kent County requires that new individual residential, large, or community onsite sewage treatment and disposal systems sited in a watershed with an established Total Maximum Daily Load (TMDL) shall be designed and installed in accordance with the nutrient load reductions prescribed by the TMDL or they shall use the best available technologies in order to achieve the required nutrient reduction targets set for the particular watershed (See Chapter 187, Subdivision and Land Development (Adopted June 24, 2003)).

The DNREC Ground Water Discharges Section and the Watershed Assessment Section contracted with Dr. Mike Hoover with the University of North Carolina to develop and recommend performance standards for all sizes of onsite systems. Technologies are available to reduce the nutrients in OWTDS effluent and are defined by the following performance standards: Performance Standard Nitrogen level 1 (PSN1) to achieve 5 mg/l at the end-of-pipe of the pretreatment unit; PSN2 10 mg/l at the end-of-pipe of the pretreatment unit; PSN3 20 mg/l at the end-of-pipe of the pretreatment unit; PSP1 4 mg/l at the end-of-pipe of the pretreatment unit; PSP2 8 mg/l at the end-of-pipe of the pretreatment unit.

Because of this work, the permit applicant can select an approved technology from a list maintained by the Ground Water Discharges Section. Since alternative systems are more expensive than standard systems, the Department wants to ensure that they are functioning in order to ensure the nutrient reductions and protect the investment, and therefore will require a service contract with a certified service provider.

In addition, new homebuyers may not understand the functioning of their system or the impacts a failing system could have on the environment. Therefore, by providing education materials, the homeowner may prevent long-term problems and save money.

Implementation Schedule: Will be implemented with adoption of new regulations in 2012.

Expected Reduction: A total of 210 septic systems were pumped out and inspected in Sussex County, and seventy percent were in satisfactory condition. So, there was a 30% failure rate. If this rate was applied to the St. Jones watershed, there would be a potential of 1,809 failed septic systems within the watershed, and of these 1,809 failing system, 61 would be connected to county sewer. Because Kent County 's Chapter 187, Subdivision and Land Development (Adopted June 24, 2003) only requires new systems to meet TMDL reductions, no reductions in nutrients would occur with this part of the recommendation unless the system was to connect to county sewer.

As existing systems less than 2,500 gpd fail and require replacement, PSN3 will be required by the revised state Regulations Governing the Design, Installation, and Operation of Onsite Wastewater Disposal Systems and will result in a reduction up to 10.6 pounds of nitrogen per year per system.

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

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

Potential Funding Source: The cost of these systems will be paid by the land owner. Cost-share funds may be found to assist those of middle income and below. At present, State Revolving Fund (SRF) money and the Septic Rehabilitation Loan Program provide low interest financing for replacing failing septic systems and cesspools with on-site wastewater disposal systems that will function in an environmentally sound and cost effective manner. The loan is secured by a mortgage lien on the rehabilitated property. This program is managed by the Financial Assistance Branch with technical assistance from the Ground Water Discharges Branch. The Financial Assistance Branch shares a partnership with First State Community Action Agency (FSCAA), who has program specialists in Georgetown and Dover to assist with the application process.

Action Needed: 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 this recommendation on performance standards will be met.

If the new regulations are not promulgated as anticipated, the Department will promulgate the necessary regulations for this recommendation.

Nutrient Reducing Recommendation 9 – Stormwater Utility

A stormwater utility should be implemented to generate a stable source of funding for stormwater management within the watershed.

Implementation Goal: Institute a stormwater utility in Kent County and within Dover.

Basis of Recommendation: Governor Minner's Task Force on Surface Water Management quantified the statewide financial need for stormwater management. The Finance Subcommittee identified stormwater capital requirements of $207.3 million over the next five years and projected annual maintenance requirements of $13.73 million (DNREC, 2005). The Task Force recommended that a stormwater utility operating at the county or local level should be formed as a funding vehicle for the purpose of providing a simplified and comprehensive approach to drainage and flooding problems. A stormwater utility is an approach that can generate a stable source of funding for stormwater management within the region. The funds are made available by collecting user fees. Stormwater utility fees are generally set by the amount of impervious cover on each resident's property; the higher the impervious cover the higher the fee. GIS mapping will be utilized to measure impervious surface generated by residential and commercial development, and the utility fee will be charged based on the property's Equivalent Runoff Unit (ERU).

Level of Service analysis began in May of 2008 and was funded equally by the Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Soil and Water Conservation, the Kent Conservation District, and Kent County. Representatives from these agencies oversaw its preparation as the Joint Coordinating Committee (JCC). The purposes of the project were to determine the current level and costs of surface water management offered in Kent County and to identify the levels and costs needed to adequately meet the needs of current residents and the expanding population. This analysis built upon previous efforts such as Governor Minner's Task Force on Surface Water Management (2005) and the Delaware Public Policy Institute Dialogue on Financing Wastewater and Stormwater Infrastructure (2006). In addition to the sponsoring agencies, meetings were also held with numerous other government entities and stakeholders including DelDOT, tax ditch managers, municipal representatives, the Home Builders Association of Delaware, and the Kent County Conservancy.

This Level of Service analysis offered several recommendations on stormwater management through creating a stormwater management district and developing mechanisms governing the maintenance of privately-owned stormwater management structures. Level of Service Analysis provided a framework for budgetary conversations and guidance for moving forward. It is not an end point but rather a blueprint for future actions.

One challenge for the City of Dover to establish a storm water utility within its borders is that the City is not a delegated agency for stormwater management. Thus, the City would need to

become a delegated agency, which would include developing a fee schedule and staffing plan to accomplish this. Additionally, any proposal that includes additional fees will likely not gain any traction until the economy turns around.

Implementation Schedule: No date has been set.

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

Cost: DNREC, Kent County, and KCD requested a level of service analysis and investigation of the stormwater service district. URS, Inc. received the contract for the analysis, which costs $75,000.

Potential Funding Source: Kent County and City of Dover

Action Needed: The Department will assist the County and/or Dover to implement a stormwater utility in their jurisdictions.

Nutrient Reducing Recommendation 10 – Stormwater Best Management Practices

Stormwater Best Management Practices (BMPs) should be designed to reduce nutrients according to TMDLs.

Implementation Goal: Implement the new proposed Delaware Sediment and Stormwater Regulations.

Basis of Recommendation: The Delaware Sediment and Stormwater Regulations govern the development of plans and design the criteria implemented in the State. Current regulations minimize water quality and quantity impacts due to land disturbing activities by preferring the use of "Green Technology BMPs." "Green Technology BMPs" are practices that achieve stormwater management objectives by applying the principles of filtration, infiltration, and storage associated with natural vegetation and undisturbed soils, while minimizing a reliance on structural components. These BMPs are effective in nutrient reduction.

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

Implementation Schedule: Promulgate regulations by end of 2012.

Expected Reduction:

Table 11: Effectiveness of various Stormwater BMPs to reduce nutrient (TN & TP) Loads		
Stormwater BMP	**Reduction Efficiency for TN**	**Reduction Efficiency for TP**
Wet Ponds[1]	0.30	0.50
Dry Ponds[1]	0.05	0.10
Sand Filters[1]	0.40	0.60
Infiltration Systems[1]	0.50	0.70
Biofiltration/bioswales[1]	0.50	0.70
Stormwater wetlands[1]	0.3	0.50
Rain Gardens[1]	0.40	0.60

[1]: Chesapeake Bay Non- Point Source Best Management Practices Table 1, 2006.

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

Potential Funding Source: Funded through State general funds.

Action Needed: With the promulgation of the new proposed Sediment and Stormwater Regulations by the end of 2012, the Department believes that this recommendation will be met. If the new regulations are not promulgated as anticipated, the Department will promulgate stormwater regulations for the St. Jones watershed that meet this recommendation and the required TMDL reduction.

Nutrient Reducing Recommendation 11 – Impervious Cover

Local municipalities, Kent County Conservation District and Kent County, should meet to determine how to limit the addition of new effective impervious cover and encourage the use of pervious surfaces.

Implementation Goal: Implementation of new proposed Sediment and Stormwater Regulations to limit effective impervious cover.

Basis for Recommendation: Limiting impervious cover reduces the amount of runoff that can enter the river and its tributaries. Research has consistently shown that once a threshold of imperviousness is crossed in a given watershed, water quality and stream habitat cannot be maintained at the predevelopment level. The consensus among many independent researchers is that watershed imperviousness should not exceed 10 percent in environmentally sensitive watersheds. As research has uncovered the link between increasing impervious cover and deteriorating water quality, businesses have developed pervious paving products that can replace impervious products (Center for Watershed Protection, March 2003).

The Department recommends that the effective impervious cover be reduced on redeveloped properties. Effective impervious cover is the portion of the total amount impervious cover that is directly connected to the storm drain system. Impervious cover that drains to vegetated areas where stormwater can infiltrate, or be filtered and stored, is not considered part of the effective impervious cover.

Kent County Code (Chapter 187, Article 5, §205-51) presently allows 20 percent of each lot to be covered by impervious surfaces; however, this allotment does not include streets or other impervious areas outside the lot boundary. Consequently, subdivisions have over 20 percent impervious cover, while commercial lots could have 100 percent impervious cover. In 1992 impervious cover within the St. Jones watershed was estimated to be around 11 percent, and in 2007 is estimated to have increased to 12.5 percent. With the present rate of growth in the St. Jones watershed in the past five years, impervious cover could be nearer 15%.

The State of Delaware Source Water Protection Law of 2001 requires local governments with year-round populations of 2,000 or greater to implement measures to protect the quality and quantity of public water supplied within delineated surface water, wellhead, and groundwater recharge areas by 2007. This law required Dover, Camden, and Wyoming to develop measures to protect source water.

In the Source Water Protection Guidance Manual for the Local Governments of Delaware, local governments are encouraged to adopt ordinances that protect ground and surface waters in Water Resources Protection Areas (WRPAs) through a source water protection hierarchy (ranked in descending order of preference):

1. Preserve WRPAs as open space and parks by acquisition or conservation easement.
2. Limit impervious cover of new development to 20% within WRPAs.
3. Allow impervious cover of new development to exceed 20% within WRPAs (but no more than 50% impervious) provided the applicant develops recharge facilities that directly infiltrate rooftop runoff.
4. Allow impervious cover of new development to exceed 20% within WRPAs (but no more than 50% impervious) provided the applicant develops recharge facilities that infiltrate stormwater runoff from forested and/or grassed surfaces with pretreatment.

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

Implementation Schedule: The new regulations will be promulgated by December of 2012.

Expected Reduction: Although there have been links between percent impervious cover and watershed health, nutrient loading rates for phosphorus and nitrogen have not been established for percent imperviousness. Reducing runoff will reduce nutrient loads in the river, ponds, and tributaries, although we do not have the ability to connect a numeric reduction with coverage limits.

Cost: This recommendation would only apply for new proposed development so it is not possible to calculate implementation costs at this time.

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

Action Needed: With the promulgation of the new proposed Sediment and Stormwater Regulations by the end of 2012, the Department believes that this recommendation to establish watershed-wide limit for effective impervious coverage will be met. The Department will work with Kent County or any municipality to develop effective impervious cover reduction controls through ordinances on redeveloped properties.

Nutrient Reducing Recommendation 12 – Stormwater Retrofits

A stormwater inventory should be conducted to identify areas where stormwater retrofits would effectively reduce sediment and nutrients.

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

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

DNREC hired Duffield Associates, Inc. to develop a Watershed Implementation Plan (2008) for the St. Jones River. The purpose of the plan is to characterize the watershed quality, identify potential sources/types/locations of impairment, and to identify potential restoration opportunities. The focus of this watershed plan is to improve water quality and associated natural resources. A focus of the study is to identify potential restoration opportunities in the watershed.

Restoration/enhancement/preservation opportunities were identified in the following major categories:

- Stream/Riparian Buffers/Floodplains;
- Wetlands;
- Agricultural Best Management Practices;
- Urban Stormwater Retrofits;

- Urban Sub-Watershed Site Reconnaissance; and
- Conservation Easements or Acquisitions.

Implementation Schedule: Inventory was completed October 2008.

Expected Reduction: Nutrient reductions will depend on the specific systems selected for upgrade and the acreages involved.

Cost: Cost of the St. Jones River Watershed Implementation Plan was $175,000. Cost will of implementation depends on the specific systems selected for upgrades.

Potential Funding Source: State and federal grants

Action Needed: Implement the existing St. Jones River Watershed Implementation Plan.

Nutrient Reducing Recommendation 13 – Stormwater Education

Since Homeowners Associations are critical for successful stormwater BMP maintenance, there should be a governmental agency charged with making sure the Associations are functional. In the Association by-laws, there should be a requirement for stormwater education. An education program for Homeowners Associations should be developed for stormwater BMP maintenance.

Implementation Goal: Develop an education program for stormwater management and maintenance.

Basis of Recommendation: Educational resources should be provided to homeowners associations, especially face to face education, which stresses the organizations' responsibilities. Topics should include: proper use and application of fertilizer and use of salt and sand during periods of snow. 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.

The plan should consist of the following parts:

1. Identify values which are affecting residential activities and target those that will affect behavior change.
2. Encourage educational facilities with turf athletic facilities where nutrients are applied to develop a nutrient management plan for their facility.
3. Develop an advertising strategy that promotes the use of soil tests to the urban/suburban homeowner.
4. Work with the University of Delaware to revise their soil test results sheet for homeowners to make it easier to be understood and provide specific fertilizer application recommendations based upon existing fertilizer blends found within the State.
5. Education of fertilizer retailers such that retailers will pass out educational materials with purchase of fertilizer and will have available soil testing materials at their location.

6. Educate homeowners and homeowner associations on stormwater BMPs that can be used around the home to reduce impact on water quality.
7. Integrate education into various (State and local) permitting processes.
8. Create public information campaigns based upon goal of behavior change.
9. Support a demonstration project/workshop for homeowners on application of fertilizers and composting methods.
10. Support and encourage the use of water conservation measures like those below by individuals to help reduce the amount of nutrients leaving individual properties.
    - Gray water recycling (use of gray water around the home on plants and gardens, etc).
    - Rain collection systems such as rain barrels and rain gardens.
    - Directing stormwater runoff from roofs and impervious surfaces onto grassy areas.
    - The use of water saving devices in and around the home.
    - The overall reduction of water usage in households and on lawns.
11. Work with the Delaware Nutrient Management Commission and the Master Gardeners to provide education and programs for homeowner's on lawn and garden best management practices such as:
    - Proper mowing practices.
    - Leaving lawn clippings on the lawn.
    - Leaving a buffer along stream edge.
    - Reducing lawn size.
    - Water conservation measures and stormwater BMPs for the lawn and garden.
    - Encouraging use of native species and noninvasive species.
    - Discouraging ideas that lawns need chemicals to be green.
    - Proper use of lawn and garden chemicals (including natural fertilizers and compost).
    - Use of compost rather than chemicals as a means of reducing synthetic chemical fertilizers.

Implementation Schedule: The Delaware Liveable Lawns program was initated in early 2010. The Delaware Livable Lawns Program certifies lawn care companies that follow environmentally-friendly practices in fertilizer application while educating homeowners. While many homeowners may be unaware of where, when, and how much fertilizer to apply, professional lawn care staff have the expertise to fertilize lawns correctly (See Nutrient Reducing Recommendation 3). The Delaware Liveable Lawns website helps homeowners and commercial applicators to learn about proper fertilization (www.delawarelivablelawns.org).

On September 15, 2010, "Rain Gardens for the Bays" – a regional campaign for greening our neighborhoods and improving water quality in the Delaware Bay, Maryland Coastal Bays, and Delaware's Inland Bays was launched at the Delaware Agricultural Museum and Village in Dover. At the event, Governor Jack Markell signed a Proclamation declaring Sept. 15 – 21, 2010 as "Rain Gardens for the Bays Week" in Delaware and encouraged the public to create rain gardens where they work, live and play.

A rain garden is a garden located in a shallow depression near a runoff source – a downspout, driveway or paved surface – with soil that drains quickly and deep-rooted native plants and grasses that naturally absorb water and filter pollutants. When rainwater from storms comes in contact with buildings, roads, parking lots and other impervious surfaces, the runoff collects pollutants – oil and grease, nutrients, bacteria, harmful metals, and other substances – and deposits these pollutants in our waterways.

Rain gardens are sustainable, affordable and particularly effective in capturing rain water, mitigating flooding, creating habitat for local species and reducing up to 80 percent of the pollutants in stormwater runoff. The campaign includes a new one-stop website, www.raingardensforthebays.org, with easy-to-use information and diagrams on how to design and build a rain garden. Photos of rain gardens planted throughout the region are posted, and the site encourages the registration of new rain gardens as a way to measure the progress of the campaign. All new rain gardens registered on the website will receive a "Registered Rain Garden" sign to post at their garden.

Funding for 10 demonstration rain gardens was awarded to the campaign through the federal Clean Water Act Nonpoint Source Program via a grant to DNREC's "319" program. Demonstration rain gardens are being located throughout the region at public buildings, schools, museums and other sites with public access, as a way to educate and encourage people to plant rain gardens.

Expected Reduction: Nutrient reductions cannot be assigned to this recommendation as it is a mechanism for education,though rain gardens can reduce nitrogen and phosphorus in stormwater by as much 40% for nitrogen and 60% for phosphorus.

Cost: Unknown at this time and is a function of program developed. Liveable Lawns program was begun with funds from DELDOT. The program cost $ 40,000 for the first year and will cost $ 25,000 each year thereafter. The Rain Gardens for the Bays was initiated with $50,000 from EPA and the program received and additional $50,000 in 2011 from EPA.

Potential Funding Source: State and/or Federal grants.

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

Nutrient Reducing Recommendation 14 – Agricultural BMPs

Best Management Practices (BMPs) for agriculture should be encouraged and supported. New funding sources should be sought and financial incentives should be increased.

Implementation Goal: Train Kent Conservation District staff to use existing targeting tool.

Basis for Recommendation: The establishment of best management practices on agricultural land will address nutrient inputs from all facets of agriculture operations, including the use of manure from animal operations and fertilizers for crops. The environmental and quality of life

benefits of agriculture should be recognized as a way to encourage and enforce BMP implementation. Encourage the use of buffers on agricultural lands where best nitrogen and phosphorous uptake is likely. By targeting areas for BMP implementation geographically, more effective and efficient nutrient reductions can likely be expected.

Specific BMPs that are used in the St. Jones watershed have many beneficial nutrient reducing capabilities as follows:

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

The Kent Conservation District developed a Geographic Information System database of farm fields to improve their ability to coordinate and effectively manage agricultural NPS pollutant reductions. The spatial database will facilitate a more efficient:

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

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

Implementation Schedule: Have District staff trained by December 2012.

Expected Reduction: As of December 2010, agricultural best management practices on the ground in the St. Jones River Watershed have reduced phosphorus loads by 58.30 lbs per day or 90 percent of the way towards the P load goal, and 88.61 lbs per day of nitrogen or 10 percent of the way towards the nitrogen load goal.

Cost: The costs of implementing BMPs have been estimated using data gathered by United States Department of Agriculture (USDA), Natural Resource and Conservation Service (NRCS) at the county and state level. Recently, changes in the state cost share program have required a Pollution Control Strategy for watershed residents to receive funding. Thus, the state cost share information found in Table 11 is based on a PCS approved for the St. Jones watershed. These are estimates, as costs for specific project may vary.

Table 12: Agricultural BMP Costs

	Installation Cost / Acre	*Lifespan (years)*	*Total Maintenance Costs over Lifespan*	*Total Cost/ Acre*
Cover Crops	$49.33	1	$5	$54.33
Ponds	$3,758.50	10	$5	$3,808.50
Grassed Waterways	$16,404.24	10	$5	$16,454.24
Filter Strips/Wildlife Habitat	$495.24	10	$5	$545.24
Forest Buffers	$495.24	15	$5	$570.24
Riparian Buffers	$502.00	15	$5	$577.00
Wetland Restoration	$4,374.50	15	$5	$4,449.50
Field Border	$495.24	10	$5	$545.24
Critical Area Planting	$7,229.24	10	$5	$7,279.24
Conservation Tillage	$17.33	4	$5	$37.33

Potential Funding Sources: United States Department of Agriculture Natural Resource Conservation Service, Farm Service Agency, Kent Conservation District, DNREC Watershed Assessment, DNREC NPS Program 319 Funding, United States Fish and Wildlife Service, DNREC Ecological Restoration Program, Delaware Department of Agriculture Nutrient Management Commission

Nutrient Reducing Recommendation 15 – Nutrient Management Act

Because nutrient management plans reduce excess cropland nutrients, it is recommended that the Nutrient Management Commission ensure full compliance of the Nutrient Management Act.

Implementation Goal: This has been completed as of December 2007. However, the Delaware Nutrient Management Commission is checking continuing to check compliance of Nutrient Management Act.

Basis for Recommendation: As of 2007, all lands (over 10 acres) that have nutrients applied must be in compliance with the 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 quantify the efficiency and reduction of nitrogen and phosphorus.

Since the baseline period (1997), the agricultural community has reduced a significant amount of nonpoint source nutrient loading, leading the efforts to curtail nonpoint source nutrient loading. From 1997 to 2008, multiple best management practices (BMPs) have been implemented, and the Delaware Nutrient Management Act was passed. 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. In 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 2009, there were 18 poultry operations, which produce approximately 696,004 birds annually, 18 Amish dairies, 13 beef cattle operations, 31 equine and 5 goat operations in the St. Jones watershed[8]. There are 49 Amish farms within the watershed. Potential nutrient inputs are related to manure, runoff, erosion, and atmospheric deposition of nutrients. In 2007, 37.4% of the St. Jones watershed was used for agriculture, which equates to approximately 21,588[9] acres. In 1997, agricultural land use accounted for 44.7%[10] of the total land area in the watershed; therefore, the agricultural activity is the second leading source. There are 21,588 acres of crops in the watershed.[11] Crops require nutrients in order to produce an economic yield. Crops produced in the watershed may include soybeans, potatoes, barley, wheat, corn, and vegetables. Nutrient inputs include fertilizer and manure application, which when applied improperly can contribute to nutrient over-enrichment in streams and tributaries in the St. Jones watershed.

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 shows the breakdown of responses among different sizes of farms:

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[8]Mark Hogan, Nonpoint Source 319 Program, DNREC. 02010. Personal Communication.
[9] 2007 Landuse data
[10] 1997 Landuse data
[11] Glenn Gladders, Nonpoint Source 319 Program, DNREC. 2004. Personal Communication.

1-10 Acres- 9% 100-499 Acres- 25%
11-99 Acres- 29% 500+ Acres- 20%
Animals Only- 10%

The survey indicated that fertilizer application rates have most severely decreased among farmers who till at least 500 acres, while manure applications have most dramatically decreased among farmers who till between 11 and 99 acres. The County determined that Sussex farmers had the highest reduction rate of N and P fertilizer applications, Kent farmers had the lowest rate of N applications, and New Castle farmers had the lowest rate of P applications.

An Agricultural Workgroup was established to gather the best available science on nonpoint source pollution prevention and compare efficiencies based on the DCP survey to other estimates of nutrient management planning effectiveness. 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 as seen in Table 12.

Table 13. Percent changes in fertilizer and manure application rates by county as a result of the 2002 Nutrient Management Law (data from 2007 DCP Survey)

County	Acres in farms	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
Statewide weighted average	510,253	16.7	31.0	19.9

Initially, the Workgroup looked at 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 removed the reductions and acreage associated with manure allowance and cover crops from further calculations; the 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%.

In the Appoquinimink 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 was 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.

The 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 proposed to use the DCP efficiencies to estimate the reduction in nutrient application rates resulting from the promulgation of the Nutrient Management Law.

Implementation Schedule: Check for compliance of Nutrient Management Act December of each year.

Expected Reduction: Total Phosphorus 51.10 lbs/day and 61.18 lbs/day of Total Nitrogen

Cost: Estimated up to $93,900. Because nutrient management plans reduce excess cropland nutrients, it is strongly recommended that the Nutrient Management Commission ensure full compliance of the Nutrient Management Act. The cost to develop a nutrient management plan decreases as the acreage in the plan increases. A three year plan for an operation with less than 500 acres costs $5.70, with 501-1,000 acres cost $4.50, with 1,001-2,000 acres cost $3.90, and with more than 2,000 acres cost $3.30 (DNMC, 2004). The average of these values is $4.35/acre every three years, which when annualized is $1.45/acre/year. Farmers can be reimbursed the entire cost for developing a nutrient management plan from the Delaware Nutrient Management

Commission. The cost can also be expressed as $0.34/lb TN reduction. At this time, phosphorus reductions are not being calculated for NMPs.

Potential Funding Sources: Delaware Nutrient Management Commission, State of Delaware Cost Share, DNREC Watershed Assessment, and/or NPS Program 319 Funding

Action Needed: The Department and Delaware Department of Agriculture should assess the impact of nutrient management planning as required by the Nutrient Management Law. Both Departments as well as the Delaware Nutrient Management Commission are actively quantifying the effect of nutrient management on water quality.

Nutrient Reducing Recommendation 16 – Stream Monitoring

Ongoing in-stream monitoring must be done in order to quantify the amount of nutrients in the waterways of the St. Jones watershed.

Implementation Goal: On a routine basis, monitor surface water quality of St. Jones River through DNREC's GAMN stations.

Basis for Recommendation: Monitoring plans help determine the effectiveness of watershed projects that aim to improve TMDLs and overall water quality. As a result, it is important to institute tracking and monitoring systems to measure improvements in subwatershed indicators over time. These systems include the internal tracking of restoration projects in each sub-watershed, as well as monitoring of stream indicators at sentinel monitoring stations. Performance monitoring of individual restoration projects can be tracked to improve the design of future restoration practices. Information gathered from a tracking system is then used to revise or improve the restoration plan over a multi-year cycle.

Undoubtedly, over time, the St. Jones watershed will experience significant changes in land use. Monitoring plans for water quality improvement should take in to account the possibility of build out and the associated impacts. As a result, the following monitoring approaches are recommended:

Project Monitoring (Milestone Monitoring): As warranted, small scale (reach or smaller) project monitoring should be conducted to illustrate benefits of individual restoration efforts. Project managers will want to invest in both in-stream and non-stream monitoring of individual restoration projects to assist in measuring project success. Such monitoring can be relatively simple (observing the success of a reforestation project or measuring public awareness through surveys) or extremely complex and expensive (measuring the pollutant reduction of a storm water retrofit or the biological response to a comprehensive stream restoration project). On an annual basis, information derived from the baseline and project monitoring should be compiled into a report.

The annual report should summarize current biological and physical conditions in the watershed; the number, type, and extent of projects taken; and the St. Jones success to date of the plan in

improving watershed conditions. Reporting on an annual basis will allow for mid-course corrections and adjustments to be made based on the monitoring data.

Sentinel Station Monitoring: Sentinel monitoring stations are fixed, long-term monitoring stations which are established to measure trends in key indicators over many years. DNRECs Water Quality Monitoring stations (GAMN) contain the history of data necessary to detect trends in water quality that would be beneficial to determine project success in removing targeted pollutants. These are the stations which TMDL data was calibrated.

If future funding allows, it is recommended to expand the GAMN station locations to include routine sampling of those station currently only monitored on an as needed basis. This would allow for data continuity and ease of collection. In addition, if additional point sources are discovered or added, downstream sampling sites should be added. Additionally, as warranted on a project specific basis, increase sampling will occur to measure and document BMP efficiency.

Illicit Discharge Monitoring: Illicit discharge detection and investigation are critical elements of watershed restoration and planning especially when there are obvious indicators of illicit discharges. Illicit discharges are often a significant source of pollution in a watershed that occurs repeatedly in association with specific polluting behaviors. The NPDES stations are areas where illicit discharges can be detected. Additionally, volunteer stream assessments which could be conducted yearly could identify potential illicit discharges.

Implementation Schedule: DNREC evaluates its monitoring plan yearly to maximize monitoring dollars with sampling needs.

Expected Reduction: An efficiency and reduction value cannot be assigned to this recommendation. Monitoring does not have a direct reduction.

Cost: Each year the State spends $71,000,000 on sampling and monitoring.

Potential Funding Sources: DNREC receives state funding and EPA funds for its surface water monitoring program.

Action Needed: The Department has calculated nitrogen and phosphorus loads from existing water quality and flow data to determine if TMDL reductions are being met on a yearly basis. These calculations have been completed for the years 2002 through 2010. From 2002 data, TMDL have not been met. For phosphorus in the St Jones River, during years of lower stream flow, the phosphorus TMDL was met but during wet years with higher flows the phosphorus TMDL was not met.

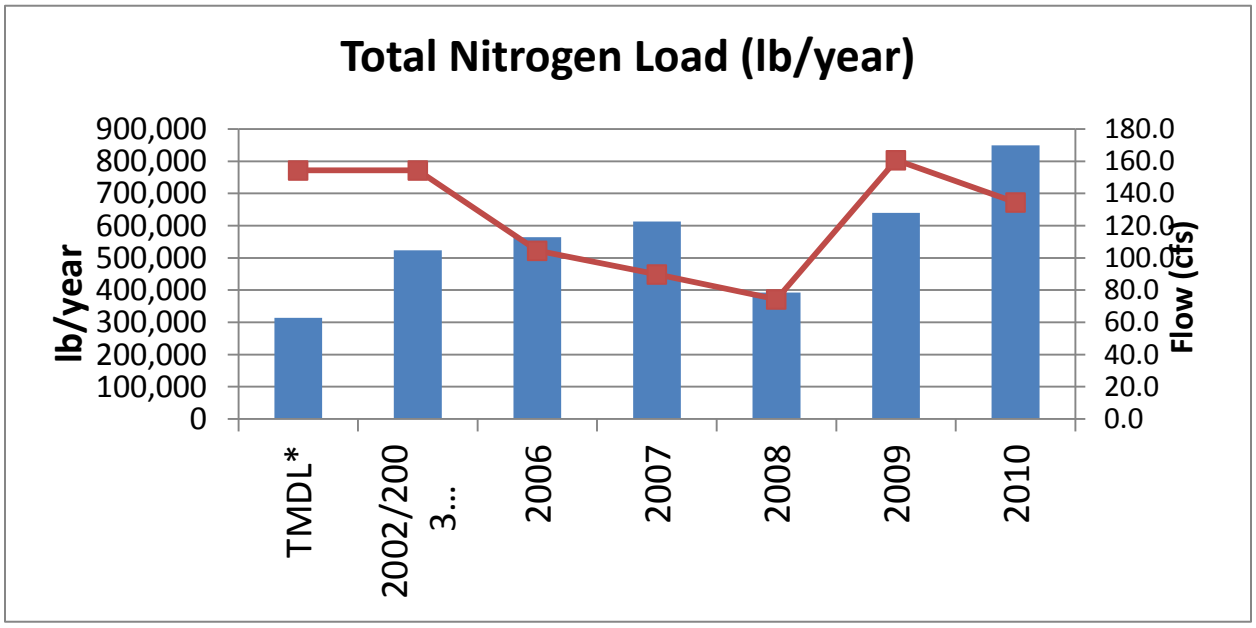

Figure 7 - Total Nitrogen loads in the St Jones watershed from 2003 to 2010

Figure 8 - Total Phosphorus loads in the St Jones watershed from 2003 to 2010

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 TP and TN have been reduced by 151% and 34%, respectively. 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.

The Total Phosphorus reduction is easily achieved in the St Jones Watershed, but the required Total Nitrogen reduction is much more difficult to achieve. The existing best management practices only reduced the total nitrogen load to the St Jones by 123 pounds and an additional 245 pounds of total nitrogen is still needed in order to meet required TMDL of 368 pounds per day reduction. Those additional 245 pounds will come from converting dry pond into bioretention facility, by completing existing and proposed projects along the St Jones near Silver Lake Park (Silver lake Commission, 2011), by increasing cover crop acreage and by wetland restoration and riparian buffer creation on both public and private lands. Connecting septic systems to the Kent County wastewater treatment facility will also reduce the nitrogen load to the St. Jones. Table 13 lists the acreage needed from the various best management practices in order to achieve the required TMDL reduction.

While current implemented practices have been shown to help reach the required reductions, it is important to note that there are practices that are still necessary to keep the watershed healthy and meeting its TMDL required reductions. The most important area for future implementation is wastewater. This includes requiring existing septic tanks to be pumped out at time of property transfer and preferably once every three years, continuing to connect existing septic tanks to sewer systems and implementing technologies that will allow systems to meet performance standards to remove nutrients. In addition, realizing that development is still occurring throughout the watershed and stormwater best management practices are required, future BMP implementation must move away from practices that only deal with water quantity, but also provide significant water quality benefits. Also, the strategy is based on the maintenance of agricultural practices currently in place as well as the continued push towards open space and riparian buffer preservation. Thus, future practices are critical towards meeting the TMDL required reductions as you can see in Figures 6 and 7 which show that future practices put TP to be reduced by 223% and TN by 100% towards the goal, as depicted by the green target lines.

Table 14: Best Management Practices Goals for Achieving the St Jones Watershed TMDL Reductions			
Best Management Practice	Acres	Total Nitrogen Reduced (lbs/day)	Total Phosphorus reduced (lbs/day)
Urban			
Dry Pond conversion to Bioretention practice	1272	9.73	1.53
Silver Mills Regenerative step pool	200	0.68	0.18
Silver Lake Mill Race Wetland enhancement	20	0.17	0.03
Central Middle School Regenerative steep Pool	50	0.03	0.05
St Jones stream bank restoration at Central Middle School	1200 feet of shore line	0.66	0.1
Total proposed reduction		11.27	1.89
Agriculture			
Cover Crops	12,063	174.27	6.12
Riparian buffer on public and private lands	1589.71	42.66	4.77
Wetland Restoration	352	11.51	6.20
Total proposed reduction		228.44	17.09

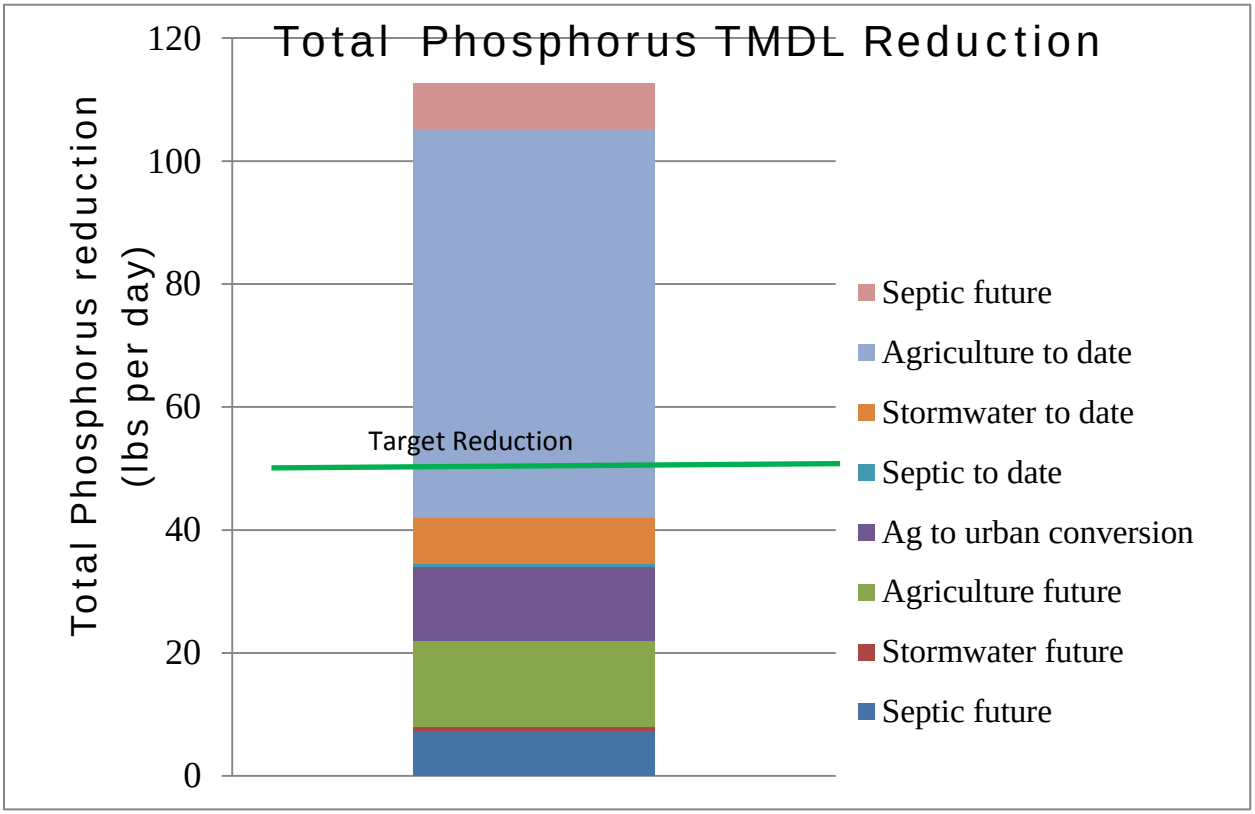

Figure 9 - Total Phosphorus Reduced in the St. Jones Watershed

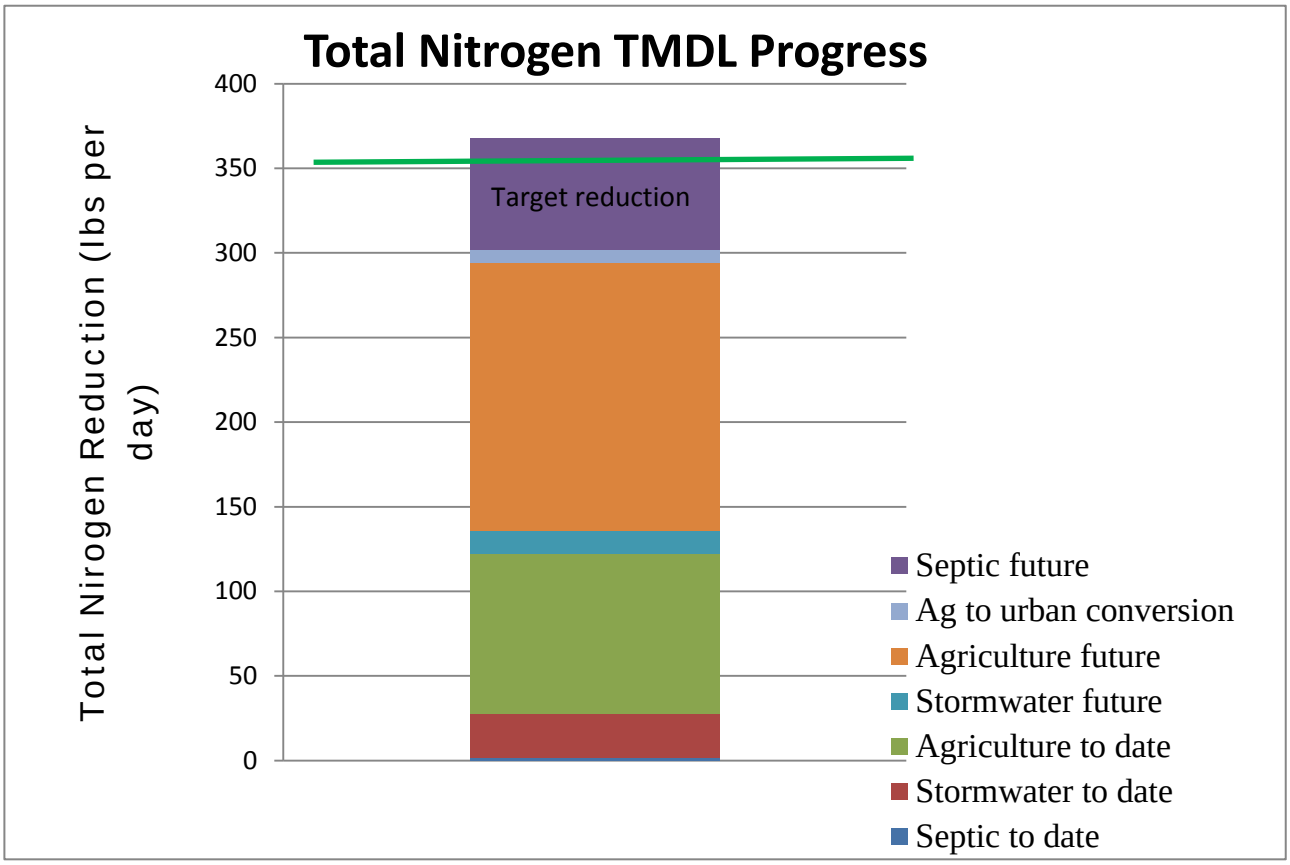

Figure 10 - Total Nitrogen Reduced in the St. Jones Watershed

Overall, this strategy costs over $103,000,000 including capital expenditures plus annual operation and maintenance costs of various best management practices. Of this strategy total, about $23,000,000 (about 23%) 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.

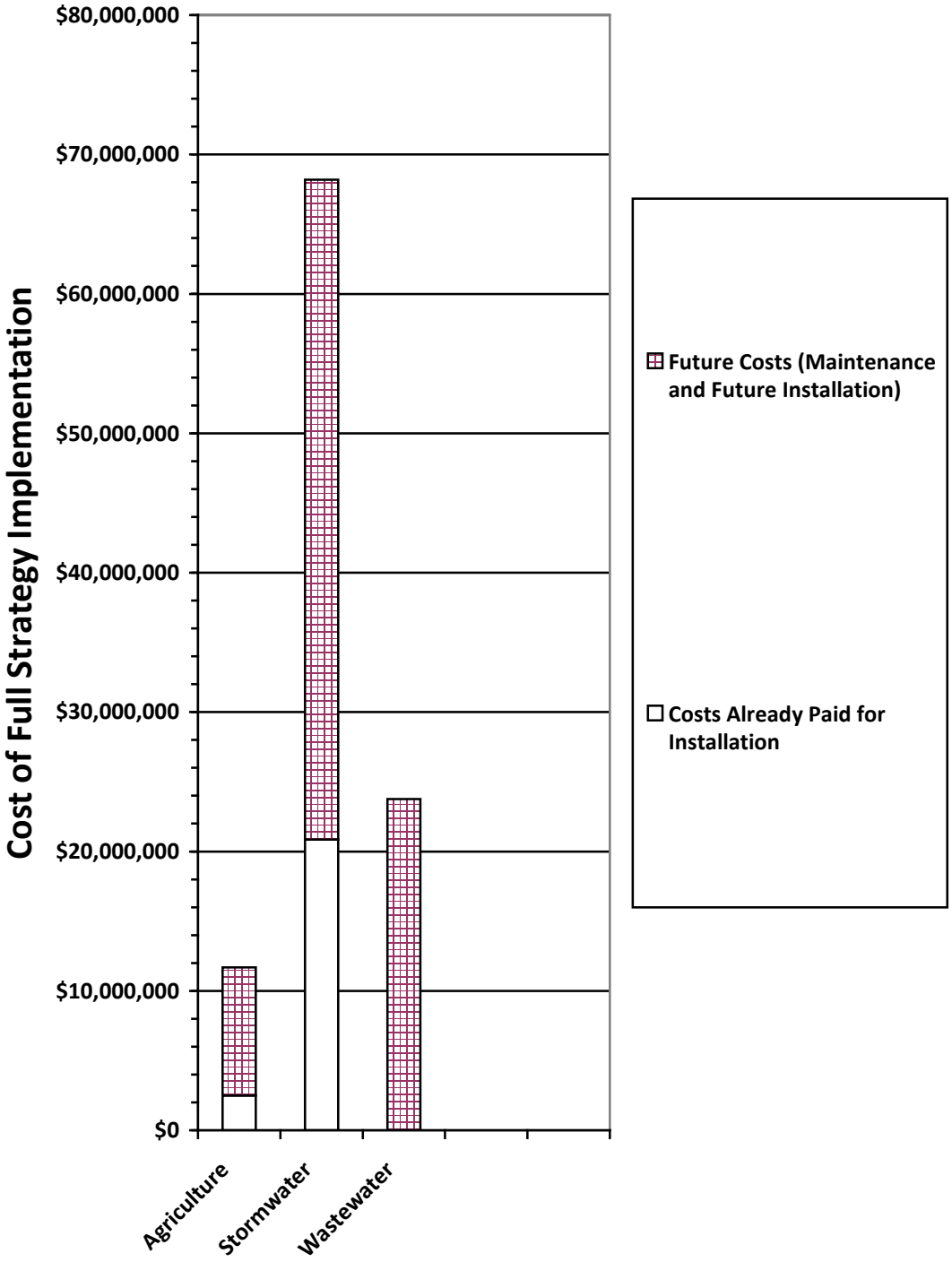

Figure 11 - Total Strategy Implementation Costs

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.

IMPLEMENTATION PROGRAMS

Pollution of the St. Jones has been an ongoing occurrence over a long span of time by many people. Implementing its 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

The Coastal Nonpoint Program was established by Congress 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, 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, silvilculture, 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: Kent County, City of Dover, Town of Cheswold, Town of Camden, Town of Wyoming, Town of Woodside, Town of Magnolia, and Town of Bowers Beach.

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.

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Appendix A - 7426 TMDLs for the St. Jones River Watershed, Delaware

1.0 Introduction and Background

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

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

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

2.0 Total Maximum Daily Loads (TMDLs) Regulation for St. Jones River

Article 1 - The total nitrogen load from the two point source facilities in the watershed (Dover McKee Run and Reichhold Chemicals) shall be limited to 9.2 pounds per day. The nitrogen waste load allocation for Dover McKee Run will be 7.7 pounds per day and for Reichhold Chemicals will be 1.5 pounds per day.

Article 2 - The total phosphorous load from the two point source facilities in the watershed (Dover McKee Run and Reichhold Chemicals) shall be limited to 0.37 pounds per day. The phosphorous waste load allocation for Dover McKee Run will be 0.24 pounds per day and for Reichhold Chemicals will be 0.13 pounds per day.

Article 3 - The *enterococcus* bacteria load from the two point source facilities in the watershed (Dover McKee Run and Reichhold Chemicals) shall be limited to 1.67E+09 colony forming units (CFU) per day. The *enterococcus* bacteria waste load allocation for Dover McKee Run will be 1.1E+09 CFU per day and for Reichhold Chemicals will be 5.7E+08 CFU per day.

Article 4 - The nonpoint source nitrogen load in the entire St. Jones River watershed shall be reduced by 40 percent from the 2002-2003 baseline level. This shall result in a yearly-average total nitrogen load of 860.3 pounds per day.

Article 5 - The nonpoint source phosphorous load in the entire St. Jones River watershed shall be reduced by 40 percent from the 2002-2003 baseline level. This shall result in a yearly-average total phosphorus load of 63.01 pounds per day.

Article 6 - The nonpoint source *enterococcus* load in the entire St. Jones River watershed shall be reduced by 90 percent from the 2002-2003 baseline level. This shall result in a yearly-average *enterococcus* load of 1.63E+11 CFU per day.

Article 7 - Based upon water quality model runs and assuming implementation of reductions identified by Article 1 through Article 6 above, DNREC has determined that, with an adequate margin of safety, water quality standards will be met in the St. Jones River.

Article 8 - Implementation of this TMDLs Regulation shall be achieved through the development and implementation of a Pollution Control Strategy. The Strategy will be developed by DNREC in concert with the Tributary Action Teams, other stakeholders, and the public.

10 DE Reg. 1037 (12/01/06)

Appendix B - Tributary Action Team Letter to Secretary Hughes

January 18, 2007

The Honorable John A. Hughes
Delaware Department of Natural Resources and Environmental Control
89 Kings Highway
Dover, DE 19901

Dear Secretary Hughes:

The St. Jones Tributary Action Team respectfully submits the attached document as the recommended Pollution Control Strategy for achieving the 2006 Total Maximum Daily Load required nonpoint source nutrient load reductions and bacteria reductions for the St. Jones Watershed.

In June 2005, a steering committee was convened by the Delaware State University Cooperative Extension and the Delaware Department of Natural Resources and Environmental Control. The committee of about twenty people included local farmers, homeowners, master gardeners, business owners, city, state and municipal planners and homebuilders. Initially the committee was charged with creating an issue booklet that outlined three approaches for how to address water pollution in the St. Jones. In February and March 2006, the Team held public forums to gather opinions from local citizens regarding these approaches and which ones best represented their interests. The forums also served as a way to educate the public about water quality concerns and encourage their involvement in the team.

Following the forums, guiding principles were written to summarize the input from the public forums and provide the foundation on which the Team would develop its recommendations. In April 2006, St. Jones Tributary Action Team was formed including members of the original steering committee and new members from the community. After extensive education, both in the classroom and in the field, the Team wrote its recommendations during meetings from September 2006 to January 2007. The attached document is the outcome of these efforts.

We hope you find our recommendations for the Pollution Control Strategy to be effective in reducing nutrient loads and bacteria in the St. Jones Watershed. Please keep us informed as the process continues.

Sincerely,

Cynthia C. McAllister
Facilitator for The St. Jones Tributary Action Team

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St. Jones Tributary Action Team
Pollution Control Strategy

Overall Recommendation

The Team recommends that there be a fully funded staff position to coordinate watershed projects.

Open Space Recommendations

I. Buffers

A. The Department should develop a St. Jones Watershed buffer overlay map to ensure buffers are in place throughout the watershed to improve water quality. This overlay map should be developed in cooperation with local municipalities and used to coordinate efforts among jurisdictions and must consider urban (developed) and rural (undeveloped) settings.

B. A 100 foot vegetated or forested riparian buffer zone should be required within the watershed for all water bodies. However, this requirement should not apply to agricultural lands. Measurement should be from the edge of the bank of the water body landward.

C. If a buffer cannot be placed within a project or an existing buffer area is reduced during development, the lack of the buffer should be mitigated. The Department should develop the criteria for compensation and a selection of alternatives which can be used as compensation. The criteria should consider both urban and rural settings and provide equivalent nutrient reductions (1:1 ratio).

D. Vegetation within the buffer should be made up of "recommended plantings" of native species. However, the type of plantings should not be mandated. A minimum density of plantings is required to ensure water quality benefits.

E. Buffers should be maintained in perpetuity and should be managed to maintain water quality benefits. Use of easements in this regard is encouraged.

F. In all common areas, boundary signs should be installed to identify the buffer and its boundary. However, signs are not required on private property.

G. The Team recommends that buffer compliance should be the responsibility of the Kent County Conservation District during its planning and review process. The Department should initiate discussions with the District about this recommendation. (However if a stormwater utility is implemented, as the Team recommends, buffer compliance could be linked into this effort.)

Open Space Recommendations (continued)

II. Open Space

A. Land maintained as passive or active open space under local ordinances or codes should be managed to minimize nutrient loading.

B. Home Owners' Association members should be educated on caring for open space in their neighborhoods to minimize nutrient loading and encourage natural habitat.

III. Education

A. A comprehensive watershed assessment and protection program should be implemented state-wide 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.

B. A comprehensive education plan to teach the public how their actions impact the St. Jones 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 of school children on water quality
8. Education for farmers to recommend appropriate use of buffers on lands in production. (Possibly coordinate with Nutrient Management Commission)

Wastewater Recommendations

I. Sewer Transmission Systems should be repaired to reduce infiltration and inflow during wet periods.

II. Onsite Wastewater Treatment and Disposal Systems (OWTDSs) should be inspected and pumped out regularly to reduce nutrient loading of the groundwater. Compliance with current regulations should be promoted.

III. Cesspools and seepage pits should be eliminated systematically as these wastewater systems discharge nutrients and bacteria directly into the groundwater. The septic inspection and maintenance program should help locate and eliminate them.

IV. If it is physically and legally available (as defined by the regulations governing the design, installation and operation of OWTDSs), OWTDSs should be removed in growth zones and connected to Kent County Wastewater Treatment Facility. Through the inspection and maintenance program, failed systems should be identified for connection to sewer, if available, or replacement, if not.

V. If an OWTDS fails, it will be identified through the inspection and maintenance program. To obtain a new permit, the system will be required to use the best available "new technology" to achieve required nutrient reduction targets for the watershed.

Stormwater Recommendations

I. General

A. A stormwater utility should be implemented to generate a stable source of funding for stormwater management within the watershed.

B. Stormwater Best Management Practices (BMPs) should be designed to reduce nutrients according to TMDLs.

C. Local municipalities, Kent County Conservation District and Kent County should meet to determine how to limit the addition of new impervious cover to less than 20% of the watershed to conserve water quality. During the review process, the use of pervious surfaces should be encouraged.

D. Local municipalities and Kent County should adopt regulations to promote Low Impact Development (LID) in new construction and redevelopment. The team recommends the use of tax incentives where possible.

E. A stormwater inventory should be conducted to identify areas where stormwater retrofits would effectively reduce sediment and nutrients.

F. Since Home Owners Associations are critical for successful stormwater BMP maintenance, there should be a governmental agency charged with making sure the Associations are functional. In the Association by-laws, there should be a requirement for stormwater education.

II. Education

A. 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.

B. 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.

C. 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.

D. The Department should coordinate efforts with non profit watershed organizations (e.g., St. Jones Greenway Commission, Silver Lake Commission, etc)

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

1. Working with the University of Delaware to revise soil testing so they are more user friendly.

2. 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.

3. 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.

Agriculture Recommendations

I. Recommended agriculture best management practices

The Team recommends that Best Management Practices (BMPs) for agriculture be encouraged and supported. New funding sources should be sought and financial incentives should be increased. The following BMPs, in particular, should be considered for additional funding:

A. **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.

B. **Grassed filter strips and grassed buffers** to trap sediments in surface runoff and take up excess nutrients.

C. **Grassed waterways** to transport surface runoff away from cropland without causing erosion or flooding and protect and improve water quality.

D. **Riparian forested buffers** to reduce nutrient losses from upland acres and to reduce sediment bound phosphorous from entering waterways.

E. **Water control structures** to increase the water level in the field which allows for denitrification and reduces dependency on irrigation.

F. **Pasture stream fencing** to reduce the bacterial and nutrient loads to a water body.

G. **Nutrient Management Planning:** The Team is aware that as of 2007 all lands (over 10 acres) that have nutrients applied must be in compliance with the 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. Because Nutrient Management Plans reduce excess cropland nutrients, the Team strongly recommends that the Nutrient Management Commission ensure full compliance of the Nutrient Management Act.

H. **Manure relocation** has removed significant amounts of excess manure from the Inland Bays and Nanticoke watersheds, consequently removing excess nutrients from those watersheds. Thus, the Team recommends that all excess manure (per the Nutrient Management Plan) be removed from the St Jones Watershed. If funds are lacking, the Team recommends that additional state and federal funds be applied to the manure relocation program.

Agriculture Recommendations (continued)

I. Although it is difficult to quantify the nutrient reductions associated with **Structural BMPs (**such as manure structures, pads, sheds and composters) the Team recommends that these BMPSs 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.

II. Education

A. Farmers should be educated on the above mentioned BMPs.

B. The public should be educated on practices to discourage resident nuisance waterfowl.

C. 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:

1. Farmland Preservation Act
2. Kent County Transfer Development Rights
3. Non-profit environmental groups
4. Easements and donations

III. Other

A. New funding sources should be sought and financial incentives should be increased for wildlife habitat and wetland restoration.

B. The State should partner with the Army Corps of Engineers (and other appropriate parties) to pursue restoration of the St. Jones Watershed.

Appendix C - Public Talk –Real Choices

Introduction

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

A Common Model for Public Engagement

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

A Preliminary Approach

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

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 D - BMP Nutrient Reduction calculations

BMP NUTRIENT REDUCTION CALCULATIONS

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

The Total Maximum Daily Load (TMDL) for receiving waters in the St JonesSt Jones calls for a 40% reduction in total nitrogen (TN) and a 40% reduction in total phosphorus (TP) (EPA, 2005). The baseline period for this TMDL was established from 2002 land use data used to determine the acreages of each of the following land uses: Urban, Agricultural, Forest, Wetland, Water, and Other, which includes land uses like rangeland and barren land. The results are tabulated below (Table 1).

Table 1. 2002 St Jones St Jones Watershed Land-use Acreages

Urban	Agricultural	Forest	Wetland	Water	Other	Total acreage
17,410	24023	5082	8643	1354	1824	58, 346

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 St Jones 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)	Source
Developed	6.2	0.73	St Jones TMDL, 2006
Agriculture	8.0	3.21	St Jones TMDL, 2006
Grasslands	8.0	0.73	St Jones TMDL, 2006
Forests	6.3	2.56	St Jones TMDL, 2006
Wetlands	0.0	0.00	St Jones TMDL, 2006

Table 3. 1997 St Jones Watershed Land-use Based Loads								
	Urban	**Agricultural**	**Forest**	**Wetland**	**Water**	***Range***	**Other**	**Total**
TN (lbs/day)	296	523.7	87.41	0	0	*9.13*	31.2	**947.43**
TP (lbs/day)	34.82	48.05	35.57	0	0	0.83	2.84	**122.11**

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

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

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

EX: TN load for urban land use:

TN load	=	1,000 acres	X	6.2 lbs TN/acre/yr	=	6,200 lbs TN/yr or 16.99 lbs TN/day

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

The annual and daily nutrient load reductions needed from non-point sources to achieve the reductions outlined in the TMDL are calculated using the following equation. For the St Jones Watershed, the TN load needs to be reduced by 934.8 lbs/day and the TP load by 40.29 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 (lb/day)	=	Baseline load (lb/day)	X	Percent reduction

EX: TN TMDL required load reduction:

Required TMDL reduction (lb/day)	=	947.43 lbs TN/day	X	40%	=	37.9 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 St Jones Watershed are:

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

I. Connecting OWTDS to Sewer Districts

Since 1992, 11 OWTDS (septic) systems are reported to have been removed from the St Jones watershed by connecting homes and businesses to sewer districts ((New Castle County Special Services, written communication, 2009) and (Town of Middletown, written communication, 2009)). 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	11 eliminated OWTDS	X	90%	=	**0.52 lbs TN/day**

II. Holding Tank Inspection and Compliance Program

On average, holding tanks have a 2,800 gallon capacity. Metcalf and Eddy (1991) reported that holding tanks typically hold 2,596 gallons of effluent and 204 gallons of septage (solids). Recent observations from the compliance program indicate volumes of 2,464 gallons of effluent and 336 gallons of septage volume. The average effluent concentrations previously discussed (50.0 mg TN/L and 15.7 mg TP/L) have been used to determine the effluent loads from holding tanks. The nutrient load contribution from septage in holding tanks will be determined using the nutrient concentrations in septage from holding tanks (600 mg TN/L and 250 mg TP/L), as reported in Wastewater Engineering, Third Edition (Metcalf and Eddy, 1991). The nutrients removed per holding tank pump-out are shown in Table 5, calculated using the above concentrations.

Table 5. Nutrient Reductions from a Holding Tank Pump-Out

	Total N (lbs/tank/pump-out)	**Total P (lbs/tank/pump-out)**
Holding Tank Effluent	1.03	0.32
Holding Tank Septage	1.68	0.70
Total	2.71	1.02

Effluent:
Nutrients Removed (lbs/tank/pump-out) =
Conc. (mglL) x (lb/453,592 mg) x (2,464 gal/tank) x (3.7854 l/gal)
Septage:
Nutrients Removed (lbs/tank/pump-out) =
Conc. (mglL) x (lb/453,592 mg) x (336 gal/tank) x (3.7854 l/gal)

There is 1 holding tank currently in the St Jones Watershed. Each time a holding tank is pumped, 2.71 lbs TN and 1.02 lbs of TP do not enter the St Jones.

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 year	X	# of tanks

EX: TN reduction due to Holding Tank Pump Out:

TN load reduction (lbs/day)	=	2.71 lbs TN/tank/pump-out	X	12 pump-outs year	X	1 tank	=	**32.52 lbs TN/yr or 0.09 lbs TN/day**

III. OWTDS Pump-outs

Using a GIS, an analysis was conducted that determined as of March 2009, there were 6244 OWTDS in the St Jones Watershed.

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

Nutrient load reduction (lbs/yr)	=	Reduction rate (lbs/system/ pump-out	X	# of existing OWTDS	X	1 pump-out 3 years	-	# of compliant OWTDS

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

TN load reduction (lbs/year)	=	1.56 lbs TN/system/ pump-out	X	1,034 existing OWTDS	X	1 pump-out 3 years	-	100 compliant OWTDS	=	381.68 lbs TN/year or 1.05 lbs TN/day

IV. OWTDS Performance Standards

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

A recommendation in the St Jones 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)	=	0.052lbs TN/system/ day	X	1,034 OWTDS	X	50%	=	**27.1 lbs TN/day**

Stormwater BMP Calculations

I. Stormwater BMPs

Several types of structures that treat stormwater runoff are used throughout the St Jones 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 15 lbs/acre/yr, while the phosphorus loading rate is 0.5 lb/acre/yr (Ritter and Levan, 1992).

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

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

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

EX: TN reduction due to wet ponds:

TN load reduction (lbs/day) = 5,861.43 acres treated on average X 15 lbs TN/acre/yr X 30% = **26,376 lbs TN/yr or 72 lbs TN/day**

II. Potential Future Stormwater Retrofit Projects:

It is anticipated that an additional 1272 acres of urban area in the St Jones 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, “Dry Ponds” and “Infiltration Practices.” These values were divided by the total area treated in each category to calculate nutrient reduction rates. For “Dry

Ponds," the reduction rates are 0.31 lbs TN/acre/yr and 0.0.7 lbs TP acre/yr, while the reduction rates for "Infiltration Practices" are 3.10 lbs TN/acre/yr and 0.51bs TP acre/yr.

The potential future loading reduction to the stream as a result of retrofitting 1,722 acres of urban lands can thus be determined using the equation below.

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

EX: TN reduction from future stormwater infiltration Practices:

TN load reduction (lbs/day)	=	(	3.10 lbs TN/acre/yr for infiltration practices	-	0.31.10 lbs TN/acre/yr for dry ponds	)	X	1722 acres	=	350.3 lbs TN/yr or 9.73 lbs TN/day

Open Space Calculations

I. 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.

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

EX: TN reduction due to open space provisions:

$$\text{TN load reduction (lbs/yr)} = \left[\text{8.0 lbs TN/acre/yr} - \text{6.3 lbs TN/acre/yr}\right] \times \text{665 acres} = \text{1130.5 lbs TN/yr or 3.1 lbs TN/day}$$

II. 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.

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

EX: TN reduction due to UDC riparian buffer requirements:

$$\text{TN load reduction (lbs/yr)} = \left[\left[\text{8.0 lbs TN/acre/yr} - \text{6.3 lbs TN/acre/yr}\right] \times \text{1,972 acres}\right] + \left[\text{2 x 1,972 acres} \times \text{6.3 lbs TN/acre/yr} \times \text{62 \%}\right] = \text{18,758 lbs TN/yr or 51.4 lbs TN/day}$$

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.

I. Cover Crops

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

Table 8. Cover Crop Efficiencies for TN

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

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

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

TN load reduction (lbs/day)	=	8 lbs TN/acre/yr	X	3,144.80 acres	X	54.9%	=	**13,812 lbs TN/yr or 37.8 lbs TN/day**

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

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

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

EX: TN reduction due to 1,413.80 acres of wildlife habitat:

TN load reduction (lbs/yr)	=	(8 lbs TN/acre/yr	-	6.3 lbs TN/acre/yr)	X	1,413.80 acres	=	344.5 lbs TN/yr or 0.94 lbs TN/day

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

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

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

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

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

EX: TN reduction due to 30.8 acres of CREP filter strips:

$$\text{TN load reduction (lbs/yr)} = \left[\left[\text{8 lbs TN/acre/yr} - \text{6.3 lbs TN/acre/yr}\right] \times \text{30.8 acres}\right] + \left[\text{2 x 30.8 acres} \times \text{25 lbs TN/acre/yr} \times \text{46 \%}\right] = \text{284.0 lbs TN/yr or 0.77 lbs TN/day}$$

IV. Field Border

Nutrient reductions from field borders are treated as Conservation Reserve Program (CRP) practices. These practices are treated as a land use change from agricultural cropland to grassland habitat. Thus, the acres that undergo change will receive a lower loading rate. It is important to note that field borders are measured in feet and must be converted to acres.

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

EX: TN reduction due to 18,299 ft of wildlife habitat:

$$\text{TN load reduction (lbs/yr)} = \left[\text{8 lbs TN/acre/yr} - \text{6.3 lbs TN/acre/yr}\right] \times \text{8.38 acres} = \text{14.25 lbs TN/yr or 0.04 lbs TN/day}$$

V. Critical Area Planting

Critical area planting is a BMP that controls soil erosion and results in phosphorus reductions since phosphorus adsorbs to soils. The critical area planting practice is considered a hot spot BMP and is applied to areas in fields where soils are severely eroding. Soil loss is based upon NRCS values. The critical area planting practice decreases soil erosion from these highly erodible areas from 10 tons per acre per year to 0.5 tons per acre per year, or a soil loss reduction of 9.5 tons per acre per year. To calculate the reduction from this practice, the acreage of the practice is multiplied by the soil loss reduction value, the amount of readily desorbed phosphorus (0.23 mg P/kg soil) (Sims et al. 1994), and conversion factors.

TP load reduction (lbs/yr)	=	Acres	X	Reduction in soil loss (9.5 tons/ac/yr)	X	Readily desorbed phosphorus (0.23 mg P/kg soil)	X	Conversion factors

EX: TP reduction due to 35.80 acres of critical area planting:

TP load reduction (lbs/yr)	=	35.8 acres	X	9.5 tons/ ac/yr	X	0.23 mg P/kg soil	X	2000 lbs/ ton	X	kg 10^6/mg	=	**0.16 lb TP/yr or 0.004 lb TP/day**

VI. Conservation Tillage

Conservation tillage is a BMP that controls soil erosion by modifying tillage practices on a farm field which reduces sediment and hence phosphorus losses from the tilled field. Soil loss is again based upon NRCS values. Conservation tillage practice can lower soil erosion to 1.5 tons per acre per year from approximately 4.1 tons per acre per year for conventional tillage, or a soil loss reduction of 2.6 tons per acre per year. To calculate the reduction from this practice, the acreage of the practice is multiplied by the soil loss reduction value, the amount of readily desorbed phosphorus (0.23 mg P/kg soil) (Sims et al. 1994), and conversion factors.

TP load reduction (lbs/yr)	=	Acres	X	Reduction in soil loss (2.6 tons/ac/yr)	X	Readily desorbed phosphorus (0.23 mg P/kg soil)	X	Conversion factors

EX: TP reduction due to 4,182.20 acres of conservation tillage:

TP load reduction (lbs/yr)	=	4,182.20 acres	X	2.6 tons ac/yr	X	0.23 mg P/kg soil	X	2000 lbs/ ton	X	kg 10^6/mg	=	**5 lb TP/yr or 0.01 lb TP/day**

VII. Nutrient Management Plans

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

The Delaware Conservation Partnership (DCP) conducted a survey in July 2007, after the deadline requiring all eligible farm operations to have a plan, to evaluate nutrient management planning in the state. The DCP consists of the Delaware Conservation Districts, the Natural Resources Conservation Service, and the Delaware Department of Natural Resources and Environmental Control, and strives to work together to meet the needs of Delaware Farmers by providing cost-share programs, educational opportunities, and nutrient management planning services. The survey was designed to inform those programs by identifying gaps in information and education and opportunities to spend cost-share dollars more effectively. In short, the purpose of the project was to make nutrient management work better for farmers in Delaware.

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

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

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

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

Table 5. Change in Fertilizer and Manure Application Rates Due to 2002 Nutrient Management Law				
County	*Farm Acres*	*% Change in nitrogen fertilizer applications*	*% Change in phosphorus fertilizer applications*	*% Change in manure application*
Kent	173,808	13.4	26.9	5.4
New Castle	66,981	16.0	20.1	13.6
Sussex	269,464	18.5	37.1	24.2
Weighted Average		16.4	31.4	19.9

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

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

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

TN load reduction (lbs/yr)	=	21,587 acres under NMPs	X	Agriculture loading rate (8 lbs TN/acre/yr)	X	Reduction efficiency (13%)	=	**22450.5 lbs TN/yr or 61.5 lbs TN/day**

Appendix E - 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