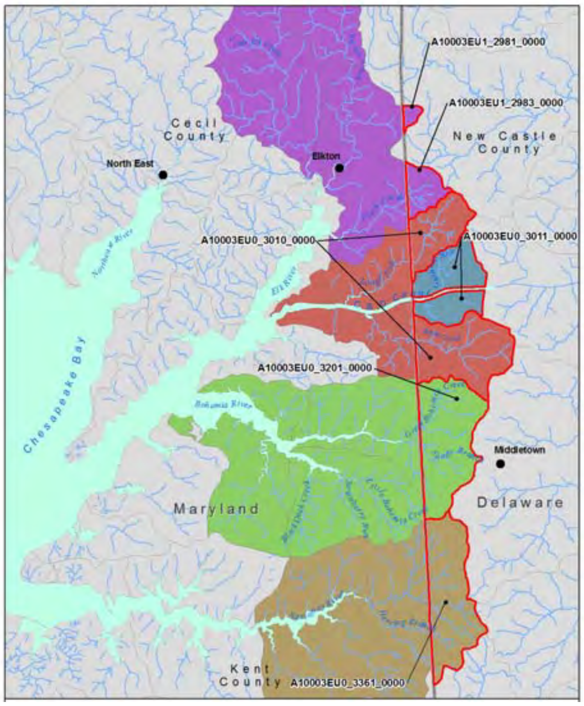
Upper Chesapeake Watershed Management Plan

Final Plan

December 2013



Prepared for:

Department of Natural Resources and Environmental Control (DNREC)

Prepared by:

KCI Technologies, Inc.
1352 Marrows Road
Suite 100
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KCI Job Order No. 17133560

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List of Acronyms

BMP	Best Management Practices
CAFO	Concentrated Animal Feeding Operations
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
DNREC	Department of Natural Resources and Environmental Control
USEPA	United States Environmental Protection Agency
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
SWM	Stormwater Management
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WIP	Watershed Implementation Plan
WSM	Chesapeake Bay Watershed Model
WWTP	Wastewater Treatment Plant

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Appendix A: WIP communications updates as of March 1, 2012.
Appendix B: State of Delaware Ambient Surface Water Quality Monitoring Program – FY 2012

1 Introduction

The Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Watershed Stewardship is developing Watershed Plans to describe the conditions of major watersheds across the State and to present restoration measures aimed at meeting DNREC's watershed management goals. In 2010 and 2012, the State of Delaware completed Phase I and Phase II Watershed Implementation Plans (WIP) for the Chesapeake Bay in response to requirements for meeting the Chesapeake Bay Total Maximum Daily Load (TMDL) for nitrogen, phosphorus, and sediment. This current planning effort is designed to forward the recommendations provided in the WIPs, with greater specificity for smaller planning units, while incorporating existing data and planning efforts. As the effort is focused on the Chesapeake Bay, the plans include Delaware's Bay watersheds which have been grouped into the following four planning units.

- Upper Chesapeake, which includes the Elk River, C&D Canal, Bohemia Creek, and the Sassafras River;
- Chester River and Choptank River;
- Nanticoke River, which includes three major tributaries, Gum Branch, Gravelly Branch, and Deep Creek; and
- Pocomoke River and Wicomico River.

Additionally, DNREC is preparing a Watershed Plan for the Broadkill River. Although outside of the Chesapeake Bay drainage, the Broadkill River has several local 303(d) impaired waters listings and a TMDL was approved in 2006 for total nitrogen, total phosphorus, and enterococcus bacteria; therefore it is a high priority watershed and has been included in the current planning effort.

Information synthesized and incorporated into this plan for the Upper Chesapeake Watershed is pulled from several resources. The primary sources are:

- Delaware's Phase I Chesapeake Bay Watershed Implementation Plan – November 29, 2010, prepared by Delaware's Chesapeake Interagency Workgroup (DCIW, 2010)
- Delaware's Phase II Chesapeake Bay Watershed Implementation Plan – March 30, 2012, prepared by Delaware's Chesapeake Interagency Workgroup (DCIW, 2012)

1.1 Goals and Objectives

The primary goal is to prepare the Upper Chesapeake Plan in accordance with the United States Environmental Protection Agency's (EPA) nine essential elements for watershed planning. These elements, commonly called the 'a through i criteria' are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements is of particular importance when seeking implementation funding. The EPA has clearly stated that to ensure that Section 319 (the EPA Nonpoint Source Management Program) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements.

The Upper Chesapeake Plan is organized based on these elements, which include:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in item (b) immediately below.

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

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

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

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

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised.

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

The outcomes of the planning effort are to provide guidance for the strategic implementation of watershed protection and restoration efforts that will advance progress toward meeting Delaware's Bay TMDL pollutant loading allocations, and ultimately meeting water quality standards. Successful implementation of the plan will lead to improvements in local and Bay-wide watershed conditions and aquatic health.

1.2 Regulatory and Programmatic Environment

While many varied regulatory and volunteer programs exist to enforce environmental protection, the primary programs and regulations addressed by this plan are the Chesapeake Bay TMDL and the National Pollutant Discharge Elimination System (NPDES) permit. The *Chesapeake Bay Total Maximum Daily Loads for Nitrogen, Phosphorus, and Sediment* (USEPA, 2010a), is a result of requirements under the Clean Water Act to meet water quality standards and executive order 13508 sign by President Barack Obama in 2009 that put a renewed emphasis and focus on the Chesapeake Bay.

As a result of the renewed effort, and to ensure that progress is achieved, an accountability framework was implemented with actions that the EPA could take if Bay states did not show satisfactory progress. The first two elements of the framework included the development of Watershed Implementation Plans and two-year milestones that would identify specific targets and schedules. A third element linked the

Bay TMDL to the NPDES program by calling for inclusion of meeting wasteload allocations within the NPDES permit.

2 Watershed Characteristics

2.1 Watershed Delineation and Planning Segments

Delaware lies on the Eastern shore of the Chesapeake Bay, with Bay drainage originating from each of Delaware's three Counties and including land located entirely within the Atlantic Coastal Plain Physiographic Province. The Elk River, C & D Canal, Bohemia River, and Sassafras River make up five of Delaware's 11 303(d) modeled segments and six of the 26 land river segments, which is the primary planning unit for modeling and accounting being used by the EPA (Figure 1 and Figure 2). These three rivers, with the inclusion of the C&D Canal and the Upper Chester River, make up the Upper Eastern Shore Basin.

Major Basin	Minor Basin	303(d) Segment	Land River Segment	County
Eastern Shore of Chesapeake Bay	Upper Eastern Shore	Elk River (ELKOH)	A10003EU1_2981_0000	NEW CASTLE
			A10003EU1_2983_0000	NEW CASTLE
		C&D Canal (C&DOH_MD)	A10003EU0_3010_0000	NEW CASTLE
		C&D Canal (C&DOH_DE)	A10003EU0_3011_0000	NEW CASTLE
		Bohemia River (BOHOH)	A10003EU0_3201_0000	NEW CASTLE
		Sassafras River (SASOH)	A10003EU0_3361_0000	NEW CASTLE
		Upper Chester River (CHSTF)	A10003EU2_3520_0001	NEW CASTLE
			A10001EU2_3520_0001	KENT
	Middle Eastern Shore	Upper Choptank River (CHOTF)	A10001EM2_3980_0001	KENT
			A10001EM3_4326_0000	KENT
	Lower Eastern Shore	Middle Nanticoke River (NANOH)	A10001EL2_4400_4590	KENT
			A10001EL2_4590_0001	KENT
			A10005EL2_4590_0001	SUSSEX
			A10005EL0_4591_0000	SUSSEX
			A10005EL0_4594_0000	SUSSEX
			A10005EL0_4597_0000	SUSSEX
		Upper Nanticoke River (NANTF_DE)	A10001EL0_4560_4562	KENT
			A10005EL0_4560_4562	SUSSEX
			A10005EL0_4561_4562	SUSSEX
			A10005EL0_4562_0001	SUSSEX
			A10005EL0_4631_0000	SUSSEX
			A10005EL0_4632_0000	SUSSEX
			A10005EL0_4633_0000	SUSSEX
			A10005EL2_4630_0000	SUSSEX
		Pocomoke River (POCTF)	A10005EL2_5110_5270	SUSSEX
		Wicomico River (WICMH)	A10005EL0_5400_0001	SUSSEX

Figure 1: Delaware Drainage Basins and Land River Segments (DCIW, 2012)

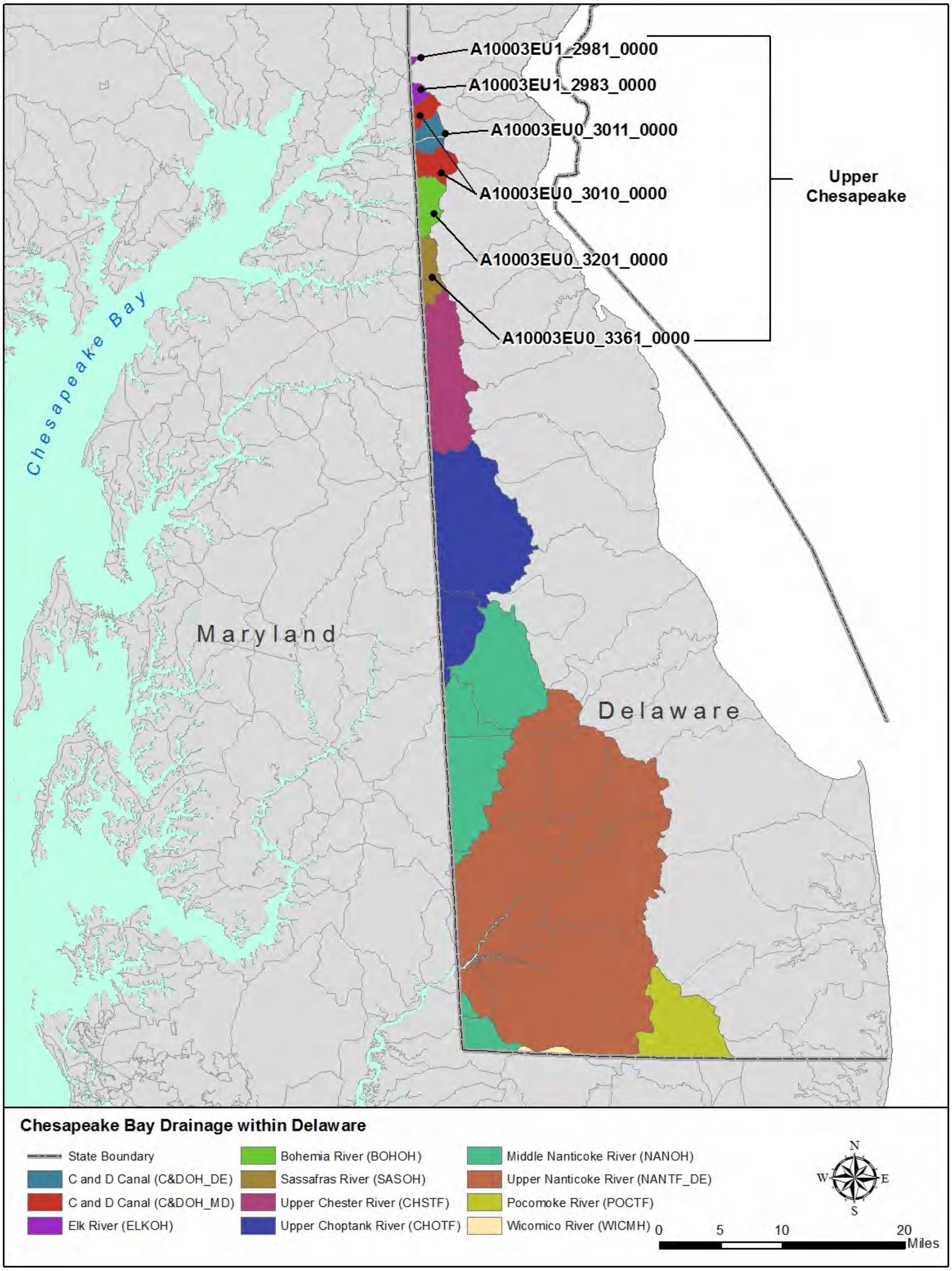

Figure 2: Delaware Chesapeake Bay Drainage and Upper Chesapeake Planning Unit

2.2 Upper Chesapeake

The Upper Chesapeake planning unit used in this current plan includes the Elk, Bohemia, and Sassafras Rivers and the C & D Canal which all originate in New Castle County, Delaware, and drain to the west into Maryland's upper eastern shore, primarily in Cecil County. The Upper Chesapeake includes 23,351.7 acres or 36.5 square miles of land area (Table 1). Figure 3 shows the location of each of the segments within the Upper Chesapeake Planning unit, and each is described here.

2.2.1 Elk River

The Elk River land river segment is made up by two small headwaters segments including Elk Creek to the north and Perch Creek just further south, both of which drain into Cecil County, Maryland into the Elk River. The majority of the Elk River system lies in Maryland and Pennsylvania and includes Big Elk Creek, Little Elk Creek and the Upper and Lower Elk Rivers. Perch Creek confluences with the Elk River south of Elkton, Maryland. Of the total 109 square miles in the Elk River drainage, the Delaware portion contributes just 2.43 square miles.

2.2.2 C & D Canal

The C & D Canal in Delaware comprises 17.06 square mile and includes four small headwater segments - Long Creek, Guthrie Run, Back Creek, and an additional unnamed tributary. All segments drain to the C & D Canal, which drains into the Elk River. Although the C & D Canal is considered part of the Elk River watershed, for the purposes of this watershed management plan, the C & D Canal will be analyzed and discussed separately.

2.2.3 Bohemia Creek

Bohemia Creek in Delaware includes as 8.84 square mile drainage area with headwaters beginning around Middletown, Delaware flowing west into Cecil County, Maryland and into the Bohemia River before entering the Elk River and the Chesapeake Bay. The Delaware portion of the drainage includes tributaries to Great Bohemia Creek which is just north of Little Bohemia Creek.

2.2.4 Sassafras River

The Sassafras River, located immediately south of Bohemia Creek, includes 5,219.8 acres, or 8.16 square miles of headwaters in Delaware. The Sassafras flows west into Maryland with the northern portion of the watershed located in Cecil County and the southern portion in Kent County, Maryland.

Table 1: Upper Chesapeake Watershed Drainage Area and Stream Miles

Watershed	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
Elk River	1,554.8	2.4	3.9
C & D Canal	10,918.3	17.1	26.2
Bohemia River	5,658.9	8.8	15.5
Sassafras River	5,219.8	8.2	15.1
TOTAL	**23,351.7**	**36.5**	**60.7**

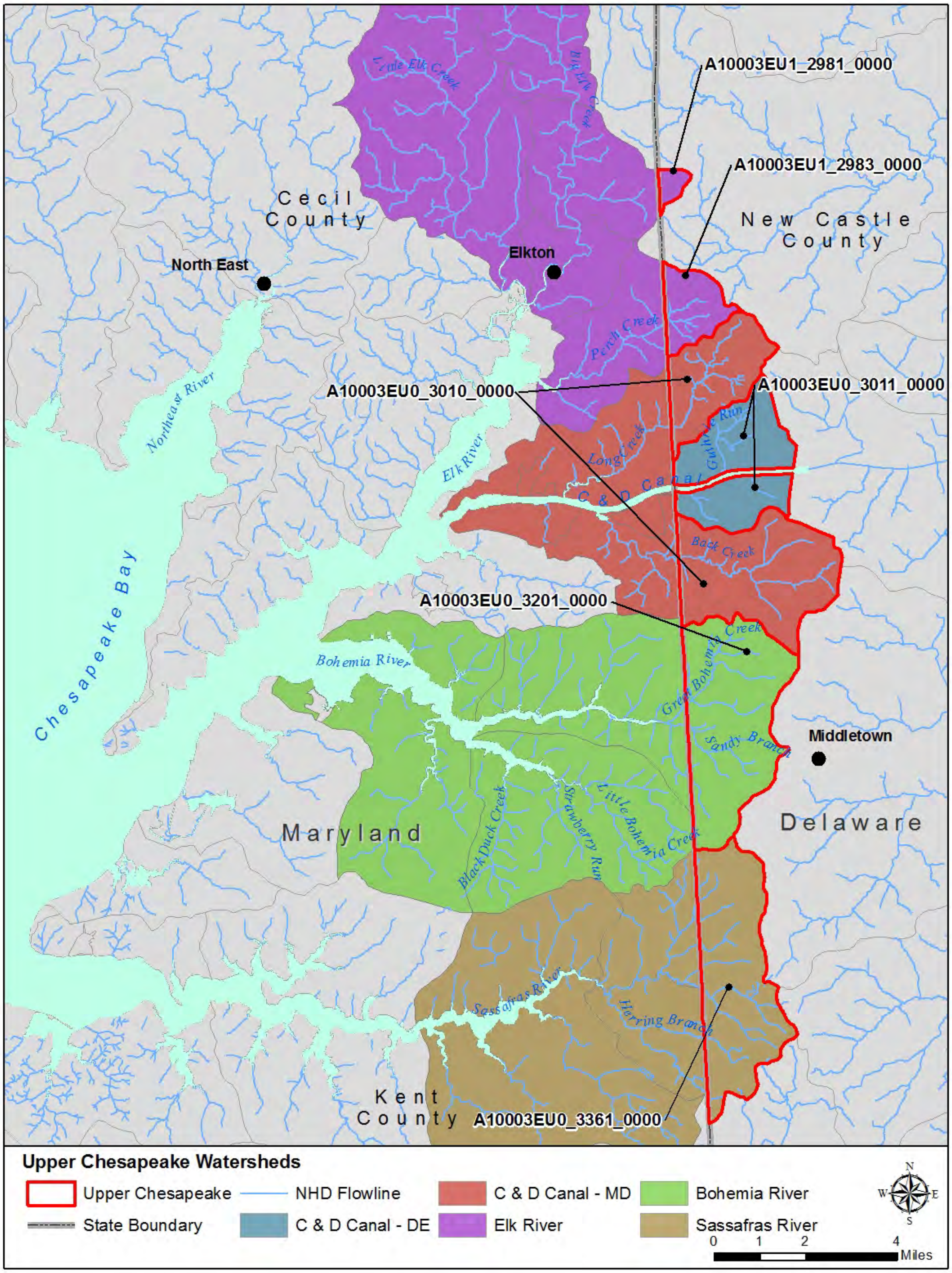

Figure 3: Upper Chesapeake Planning Unit Watershed Locations

2.3 Land Use

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not slow stormwater flow—increasing the amount of pollutants entering streams. Increased stormflow can negatively affect stream habitat by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also increase nutrients and bacteria in streams.

See Figure 4, Figure 6, Figure 8, and Figure 10, for aerial imagery of each subwatershed. 2007 land use data from the Delaware Office of State Planning Coordination (2008) and 2007 impervious surface data from the State of Delaware, Office of Management and Budget (2008) are presented in Figure 5, Figure 7, Figure 9, and Figure 11. Land use data presented in the figures below were used to show potential sources and were not used in calculations.

2.3.1 Existing Land Use

The Upper Chesapeake as a whole is made up of a mixture of land use, primarily including agriculture, forest, and developed lands (Table 2). Over two-thirds of the Upper Chesapeake is agricultural use (38.4%) or developed land (34.0%) with the remaining land use largely comprised of forest (27.1%). Water makes up the small remainder (0.4%). Information presented in the table below is from the Chesapeake Bay Program (CBP) 2010 land use dataset.

Table 2: 2010 Upper Chesapeake Land Use

Watershed	Land Use Description							
	Agriculture		Developed		Forest		Water	
	Acres	%	Acres	%	Acres	%	Acres	%
Elk	194.0	12.5	684.3	44.0	676.4	43.5	0.0	0.0
C & D Canal	3,404.8	31.2	5,376.4	49.2	2,059.5	18.9	77.6	0.7
Bohemia	2,943.1	52.0	1,450.3	25.6	1,250.8	22.1	14.7	0.3
Sassafras	2,433.1	46.6	436.3	8.4	2,349.7	45.0	0.7	0.0
Total	**8,975.0**	**38.4**	**7,947.4**	**34.0**	**6,336.4**	**27.1**	**93.0**	**0.4**

2.3.2 Imperviousness

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Impervious surfaces make up just 10.8% of the overall Upper Chesapeake drainage. See Figure 4, Figure 5, Figure 6, and Figure 7 for mapped impervious surfaces. Impervious surfaces in Elk Creek and Perch Creek are very similar and make up 8.2% and 7.9% respectively. The C & D Canal drainage is 8.1% and 7.1% impervious, Maryland and Delaware land river segments, respectively. Impervious surfaces cover 3.8% of the Bohemia Creek watershed which includes US Route 301 which transects the southeastern portion of the watershed. The Sassafras drainage is the least developed portion of the Upper Chesapeake at 1.6% imperviousness.

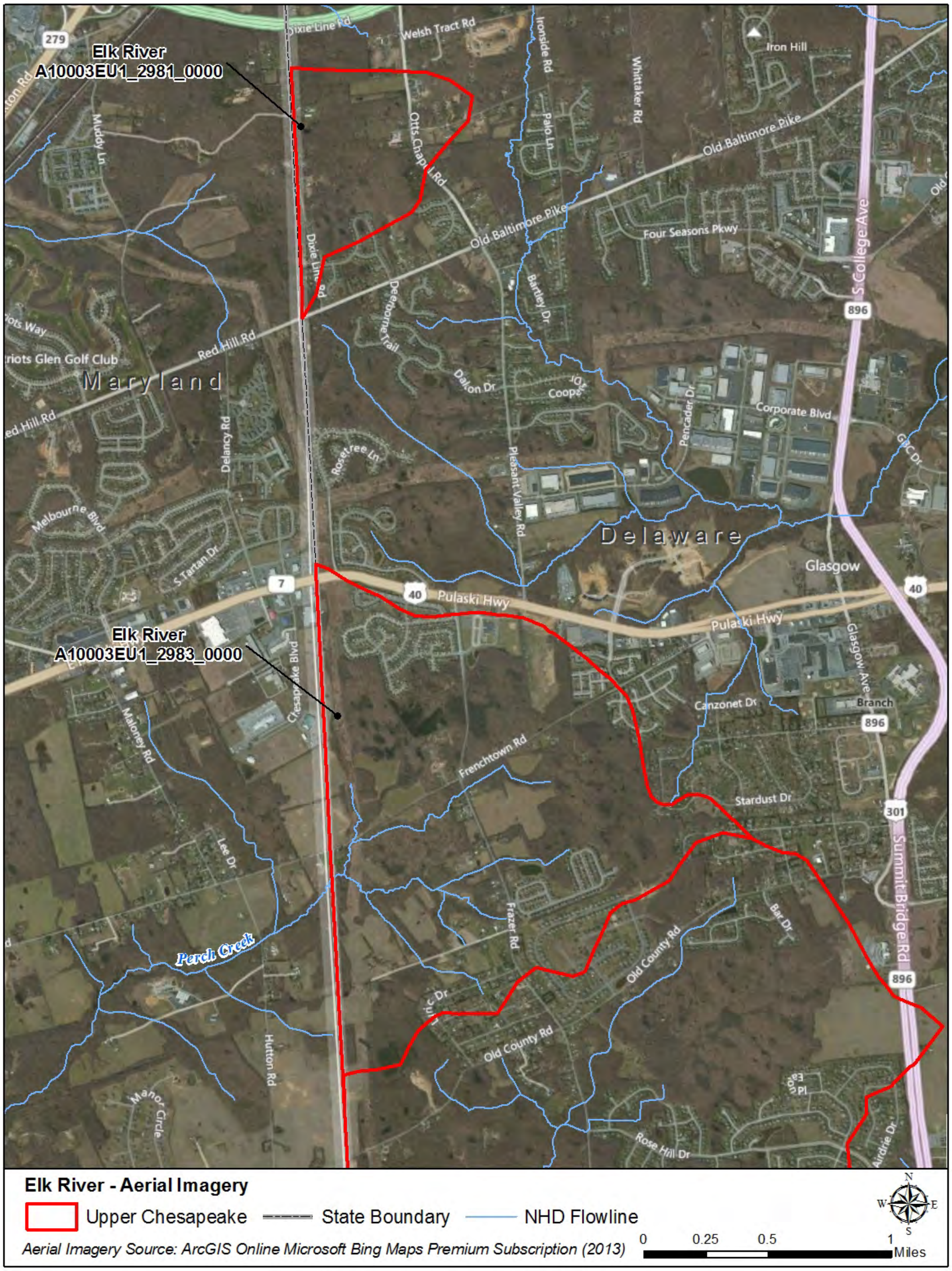

Figure 4: Elk River Aerial Imagery

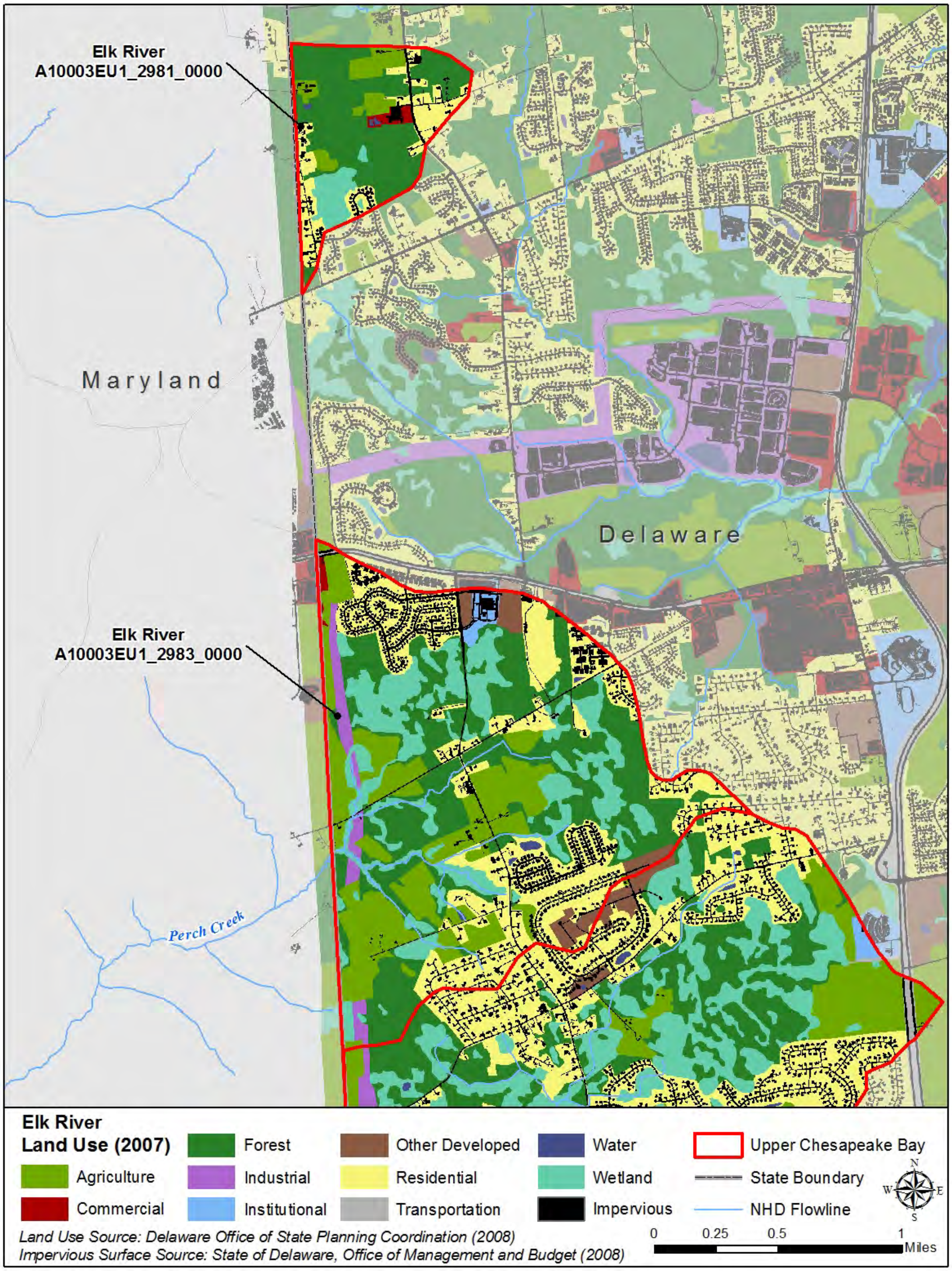

Figure 5: Elk River Land Use and Impervious Surface

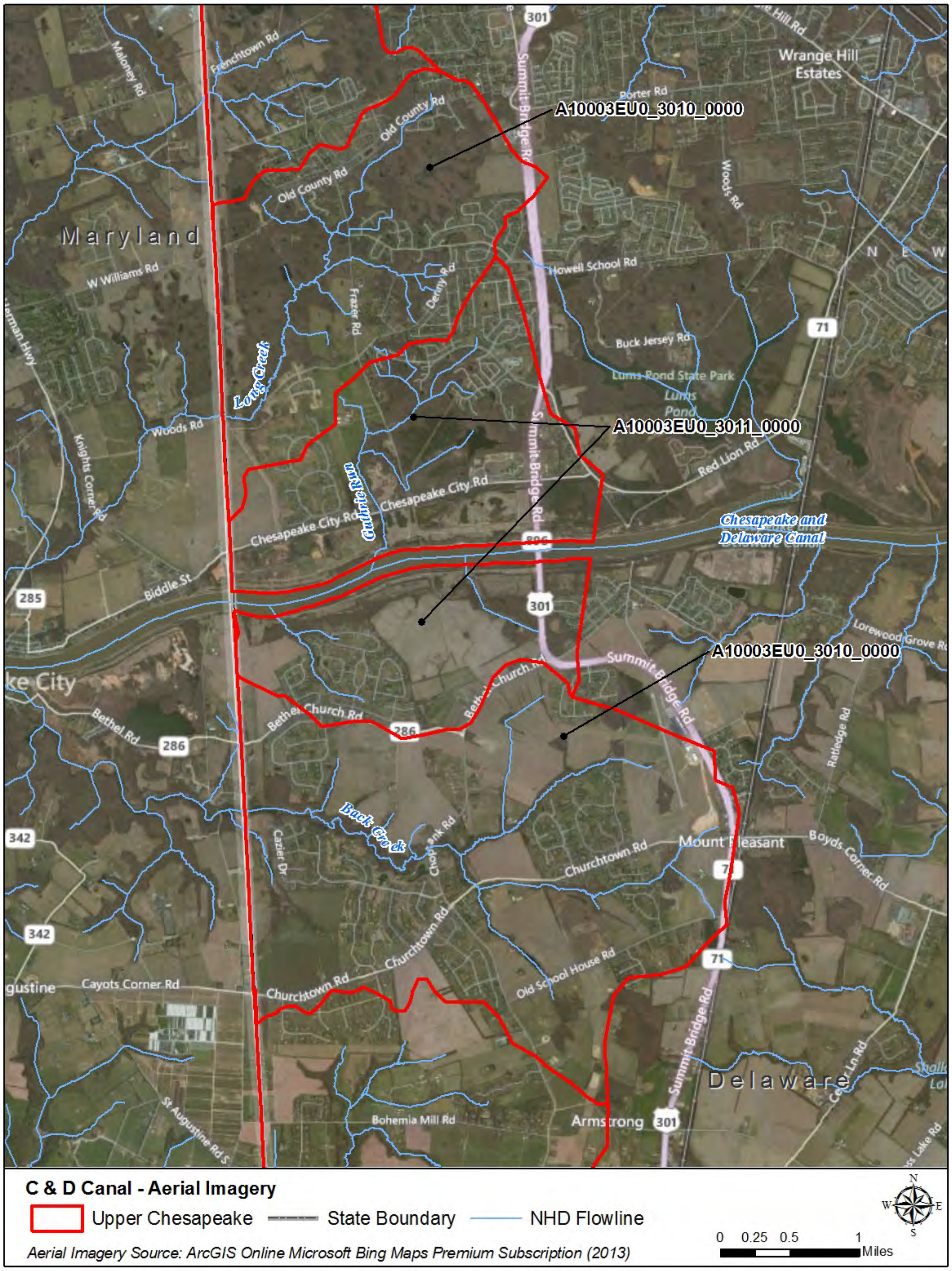

Figure 6: C & D Canal Aerial Imagery

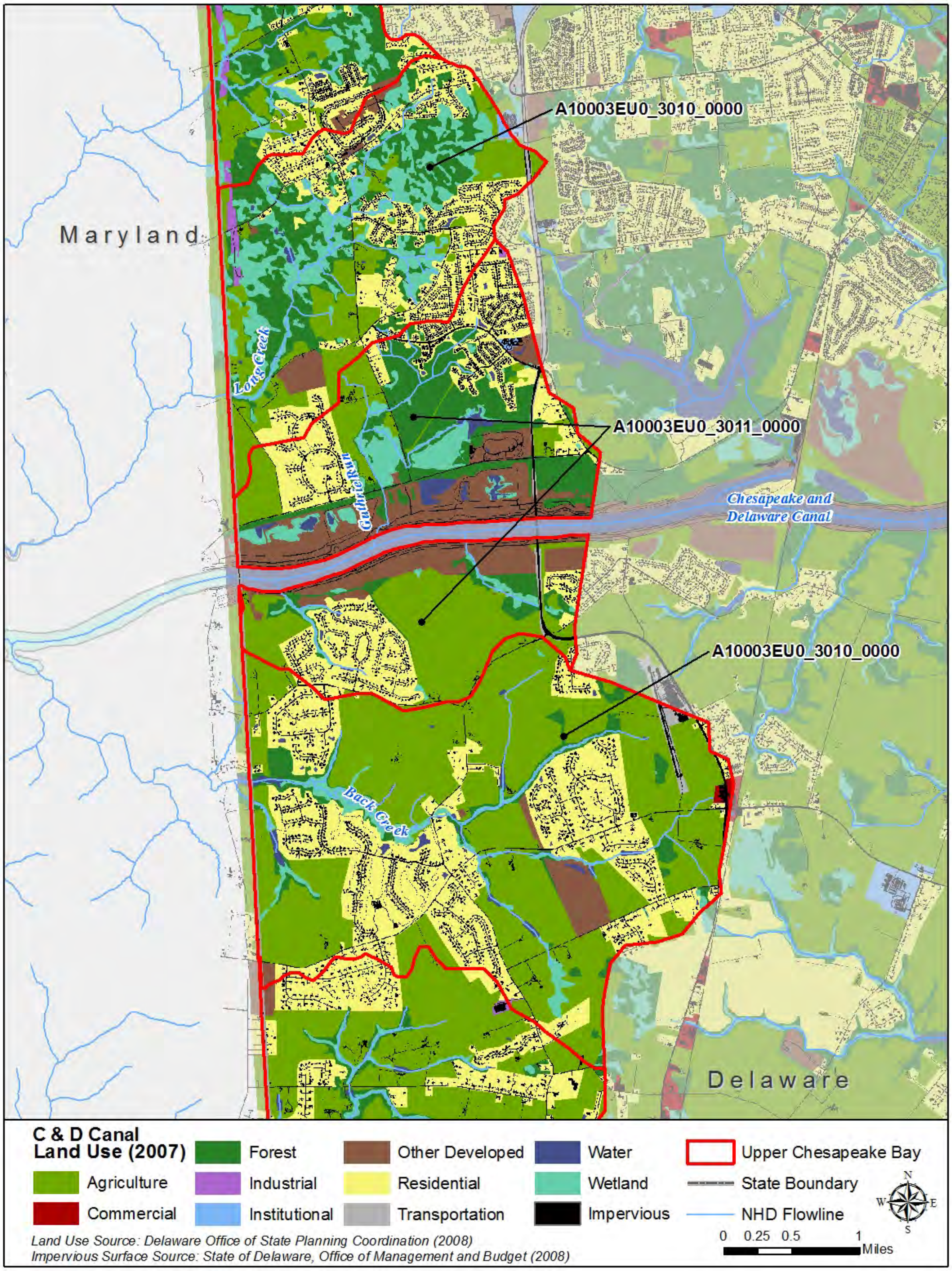

Figure 7: C & D Canal Land Use and Impervious Surface

Figure 8: Bohemia River Aerial Imagery

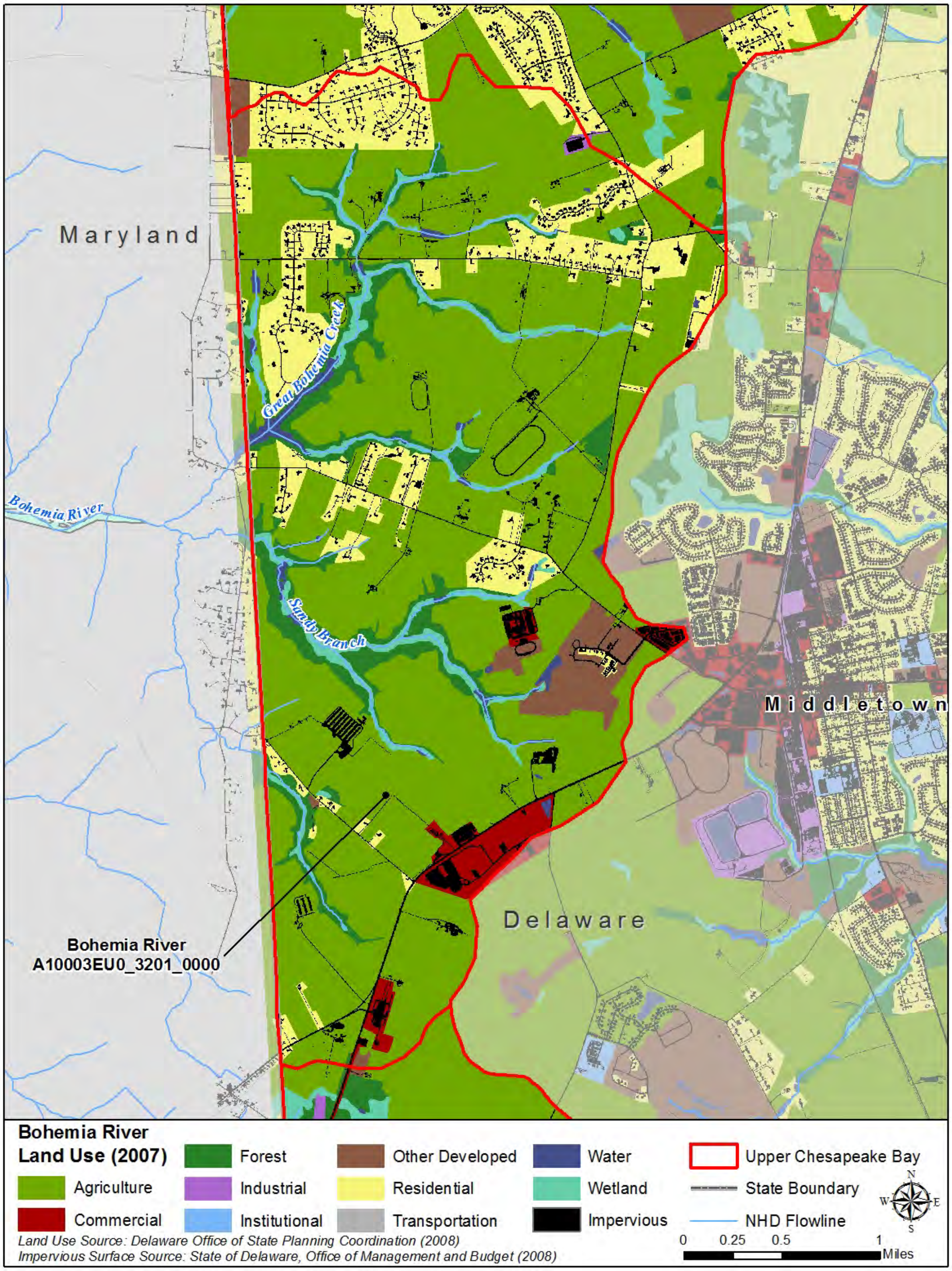

Figure 9: Bohemia River Land Use and Impervious Surface

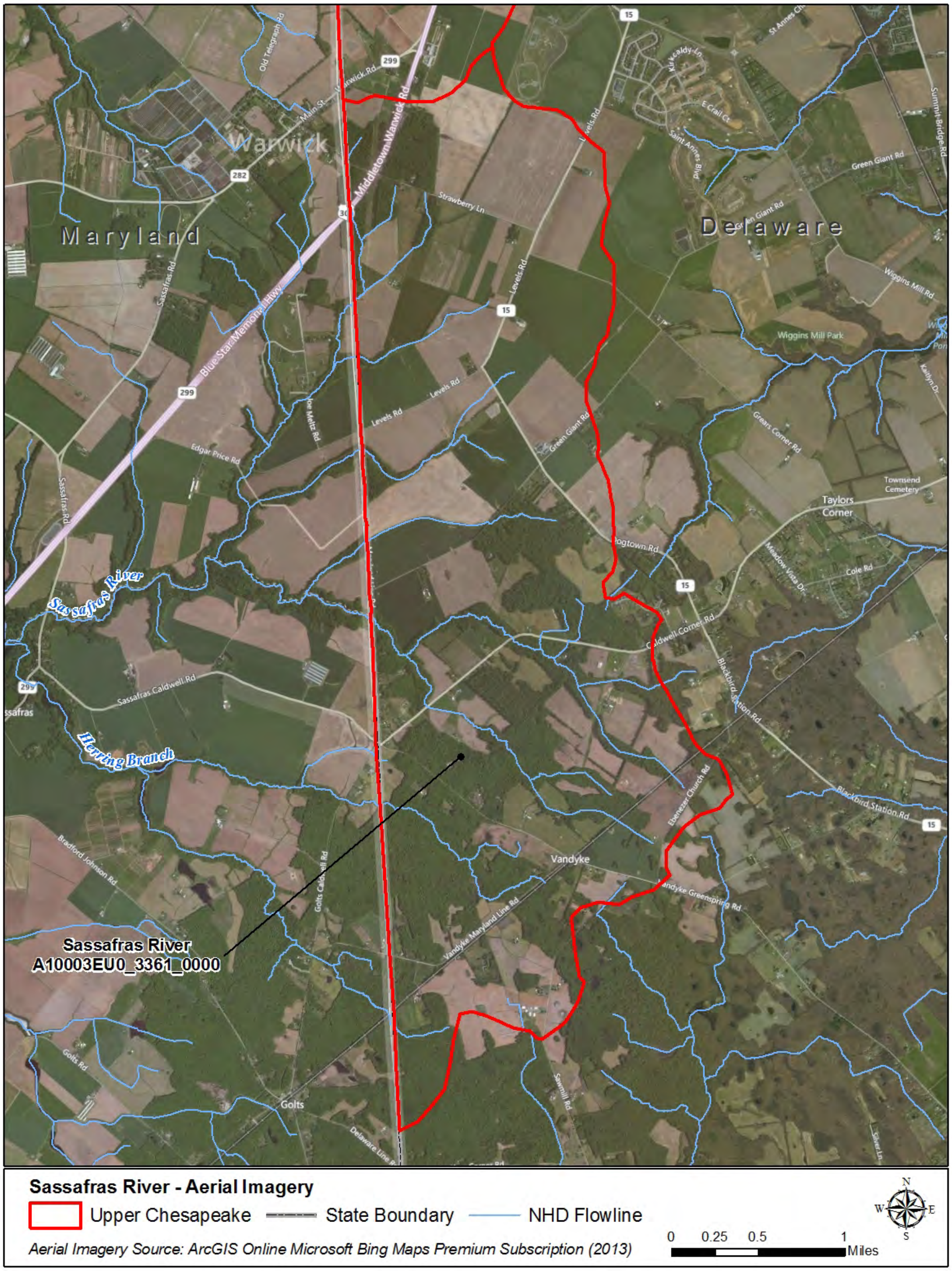

Figure 10: Sassafras River Aerial Imagery

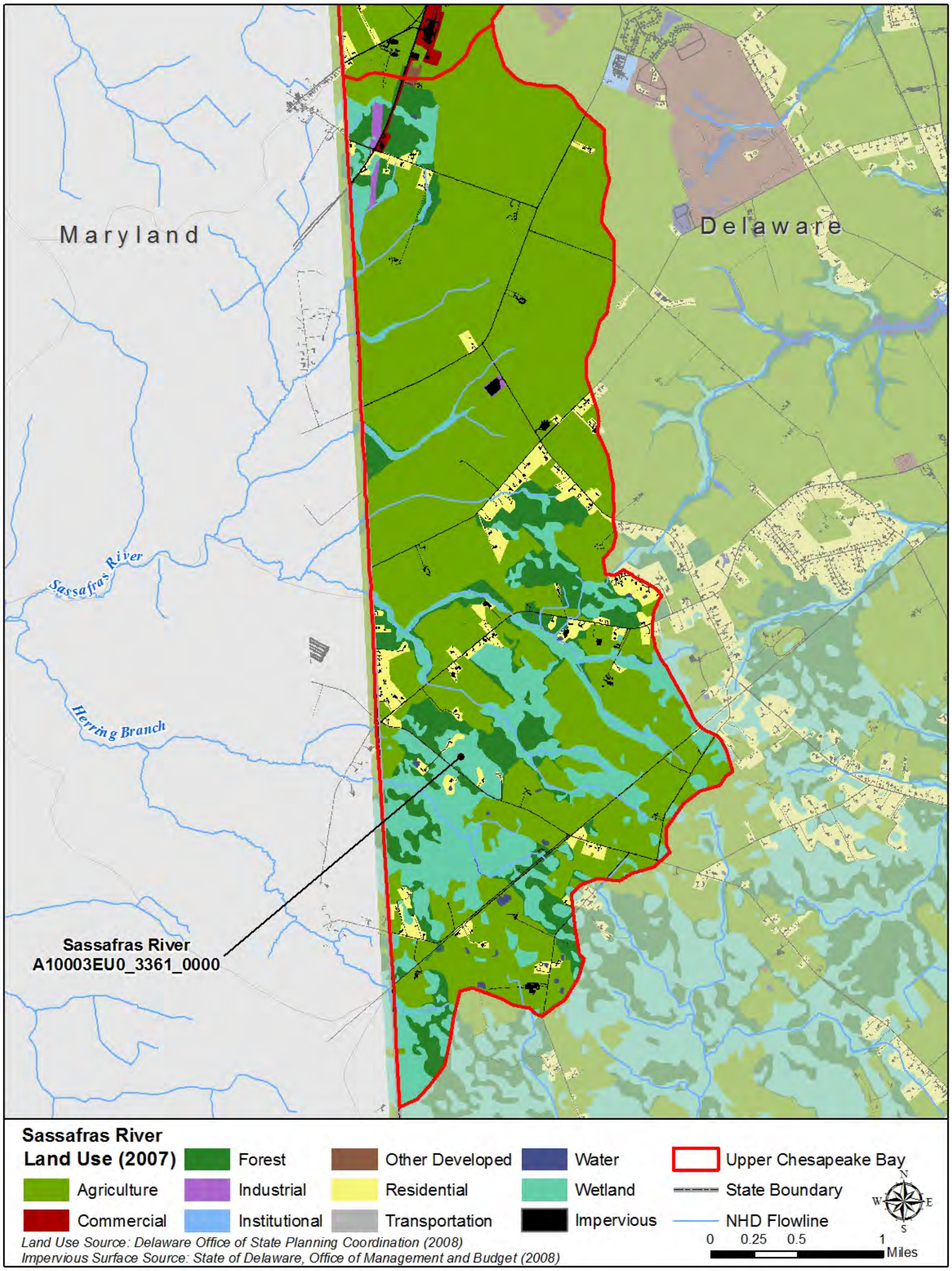

Figure 11: Sassafras River Land Use and Impervious Surface

2.4 Water Quality

2.4.1 Use Designations

Following Title 7 of Delaware's Administrative Code for Natural Resources & Environmental Control (7400 Watershed Assessment Section, 7401 Surface Water Quality Standards), the Use Designations for the Upper Chesapeake waterbodies are presented in Table 3. The designations for each waterbody in the planning unit are identical and include water supply, contact recreation and aquatic life uses.

Table 3: Use Designations of Upper Chesapeake

Waterbody	Elk Creek	Perch Creek	Bohemia Creek	Sassafras River	C&D Canal
Public Water Supply Source	-	-	-	-	-
Industrial Water Supply	X	X	X	X	X
Primary Contact Recreation	X	X	X	X	X
Secondary Contact Recreation	X	X	X	X	X
Fish, Aquatic Life & Wildlife*	X	X	X	X	X
Cold Water Fish (Put-and-Take)	-	-	-	-	-
Agricultural Water Supply**	X	X	X	X	-
ERES Waters***	-	-	-	-	-
Harvestable Shellfish Waters	-	-	-	-	-

Source: http://regulations.delaware.gov/AdminCode/title7/7000/7400/7401.pdf
*waters of Exceptional Recreational or Ecological Significance
**freshwater segments only
*** Includes shellfish propagation

2.4.2 303(d) Impairments

According to Delaware's 2010 303(d) list of impaired waters (DNREC, 2010), several segments within the Upper Chesapeake planning unit are listed for water quality impairments. Category 5 waters, which include those waters that are not meeting their use designation and require a TMDL, include two tributaries of the Elk River drainage and two tributaries of the Sassafras River. The stressors for the Elk and Sassafras include biology and habitat with non-point sources indicated as the probable source of impairment. The mainstem of the C&D canal and five of its tributaries are also listed as requiring a TMDL. The mainstem is listed for nutrients, PCBs, dioxins, dieldrin, and chlordane, which the tributaries are listed for biology, dissolved oxygen and habitat, with non-point sources listed as the probable sources.

2.4.3 NPDES

The Federal Clean Water Act requires a NPDES permit to discharge pollutants through a point source into a "water of the United States". In Delaware, New Castle County and the Delaware Department of Transportation (DelDOT) are co-permittees on the State's only MS4 NPDES permit. Current data indicates that there are no regulated impervious or pervious developed areas within the Upper Chesapeake planning area.

2.5 Anticipated Growth

According to the Phase II WIP, future growth is expected to occur across the Chesapeake drainage dependent on local land use and planning. The Upper Chesapeake is located entirely within New Castle County, DE. The New Castle County Comprehensive Plan was last updated in 2011. The primary developed area included in this section is Middletown, Delaware in the headwaters of Bohemia Creek. Middletown has experienced rapid growth in recent years, increasing its population by almost 100% from 2000 to 2008 (DWIC, 2012). According to the 2000 census data, Middletown's population density is between 501-1,888 people per square mile, with densities between 101-500 in surrounding areas (DWIC, 2012). Urban increases are anticipated to continue for the Upper Chesapeake, with projections from 2001 to 2025 to be between a 21-40% increase for Elk River, a 61-80% increase for Bohemia Creek, and a 0-20% increase for the Sassafras River drainage (DWIC, 2012).

Middletown and New Castle County have a goal to implement regional wastewater service for the entire New Castle County portion of the Bay watershed by 2025 through a 'Septic Elimination Program'. Additionally, to reduce the use of septic systems in future growth in areas targeted as Long Term Wastewater Expansion Areas, the County has established large lot subdivision requirements and has passed ordinances restricting private utility wastewater treatment plants (DWIC, 2012).

New Castle County continues to utilize strategies such as limiting impervious cover, promoting low impact development, and implementing stormwater retrofits for water quality treatment. The County will continue to work with (DelDOT) to address requirements of the NPDES MS4 permit including meeting TMDL goals.

3 Causes and Sources of Impairment (a)

The causes and sources of impairment and expected load reductions for the Upper Chesapeake watersheds were identified using data from the Chesapeake Bay Program (CBP) Partnership Watershed Model (WSM) (USEPA, 2010b). This is the same model that was used to establish the load allocations for the 2010 Chesapeake Bay TMDL for Nitrogen, Phosphorus, and Sediment (Bay TMDL) USEPA, 2010a). The WSM is calibrated to multiple decades of monitoring data from hundreds of stations in the Chesapeake Bay. The monitoring stations located in DE include those in Table 4.

Table 4: Monitoring stations located in DE and used to calibrate the Watershed Model.

Station	Segment	Description
1483700	DE0_3791_0001	ST JONES RIVER AT DOVER, DE
1484100	DE0_4231_0001	BEAVERDAM BRANCH AT HOUSTON, DE
1487000	EL0_4562_0003	NANTICOKE RIVER NEAR BRIDGEVILLE, DE
1488500	EL2_4400_4590	MARSHYHOPE CREEK NEAR ADAMSVILLE, DE

The Bay TMDL covers the entirety of the Upper Chesapeake watershed. The Bay TMDL was established using the initial conditions of 2010. These initial conditions include animal numbers, land use, and septic systems. The 2010 initial conditions are held constant for evaluating causes and sources, expected load reductions, and management measures. The Bay TMDL requires all new and increased loads to be offset. A change in initial conditions would result in new or increased loads. Offsetting new and increased loads is addressed in the section: Management Measures. However, there are a few BMPs that change the land use, such as forest buffers so these data are different than the pre-BMP land use presented in Section 2. The land use changes that result from BMPs are reflected in the data presented in Sections 3-5 (a, b, c).

The Upper Chesapeake has 8,603 acres of agricultural land, 7,856, acres of urban land, and 6,800 acres of forest, including buffered areas (Figure 12). Approximately 93 acres are lakes, rivers, streams, or other waterbodies. The Upper Chesapeake does not vary significantly on a spatial basis because it is all the same physiographic region. Therefore, the analysis of causes and sources was conducted on land use. The land use for the entire Upper Chesapeake is presented in the following pie charts. The loads for each of the subwatersheds within the Upper Chesapeake are presented in tabular form at the end of this section.

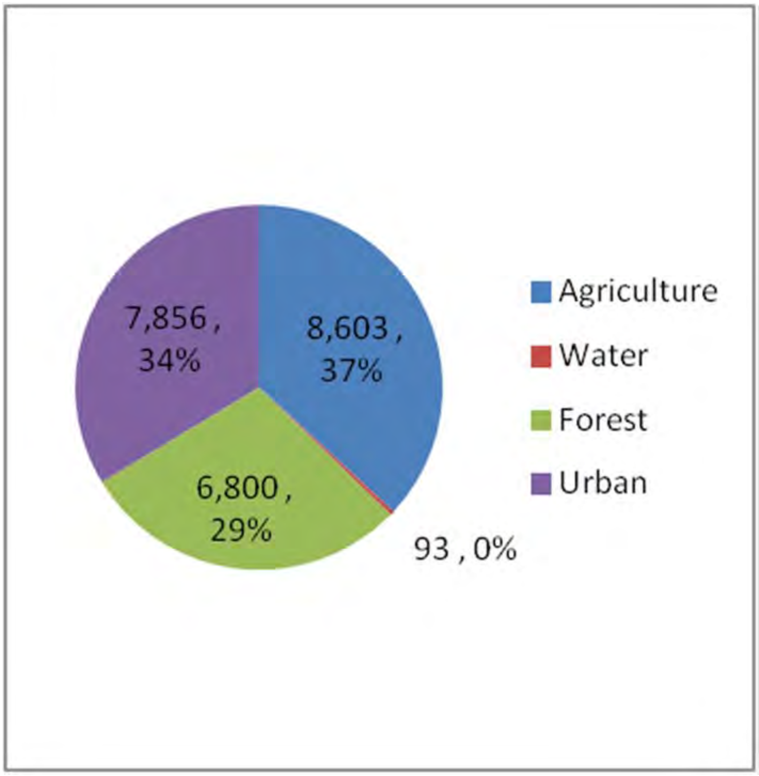

Figure 12: Land use for Upper Chesapeake watersheds using the 2010 Bay TMDL land use data with BMPs applied through June 30, 2012.

To quantify the current loads from the various source sectors, loads were evaluated using the WSM and includes existing management measures implemented through June 30, 2012. The BMPs are from the data reported by DNREC to the Chesapeake Bay Program in the 2012 Progress Review. The loads are those that are delivered to the Chesapeake Bay. The primary source of TN, TP, and TSS is from the agricultural sector (Figure 13, Figure 14, and Figure 15).

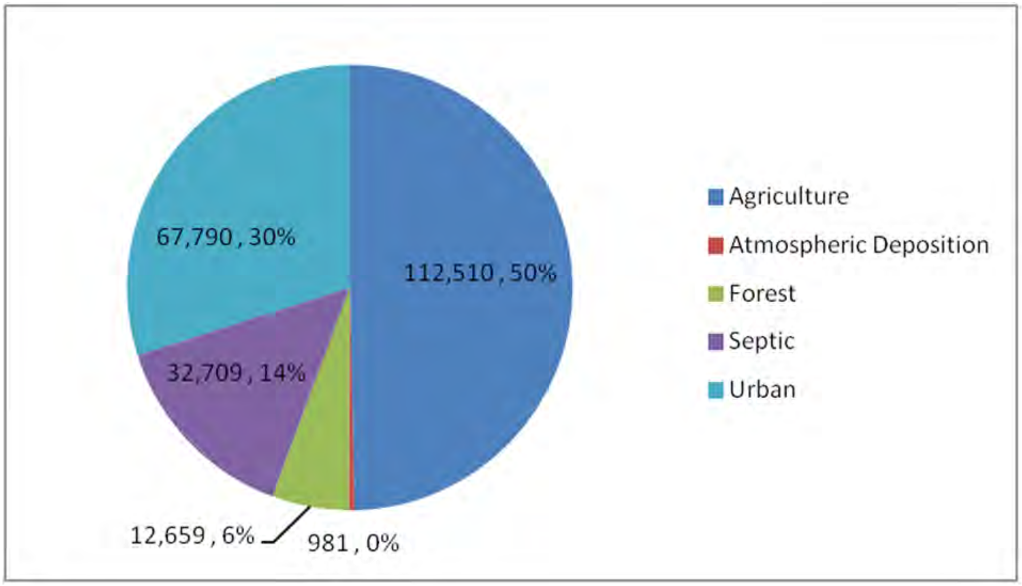

Figure 13: Total nitrogen by source sector in the Upper Chesapeake as of June 30, 2012.

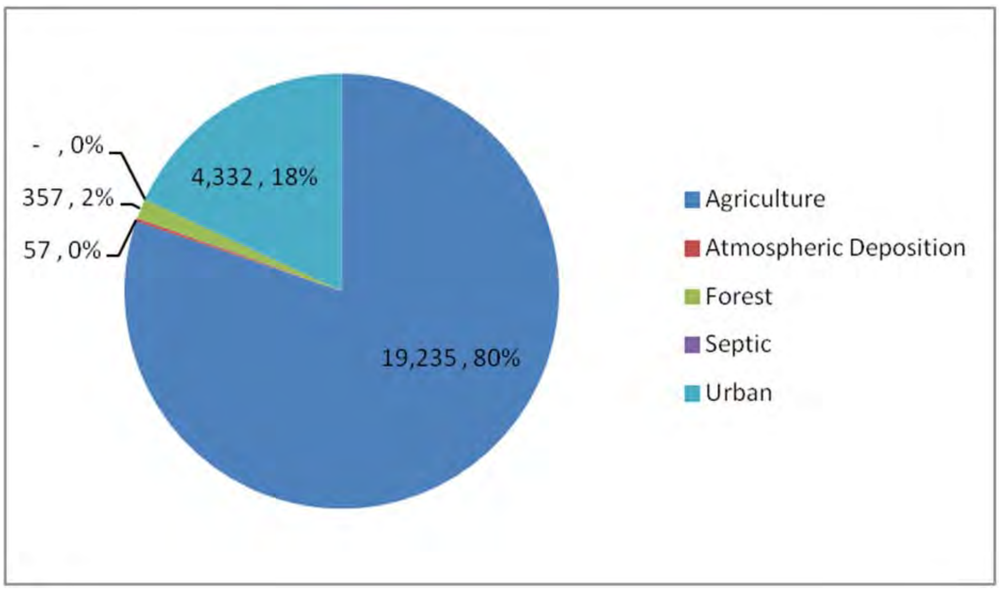

Figure 14: Total phosphorus by source sector in the Upper Chesapeake as of June 30, 2012.

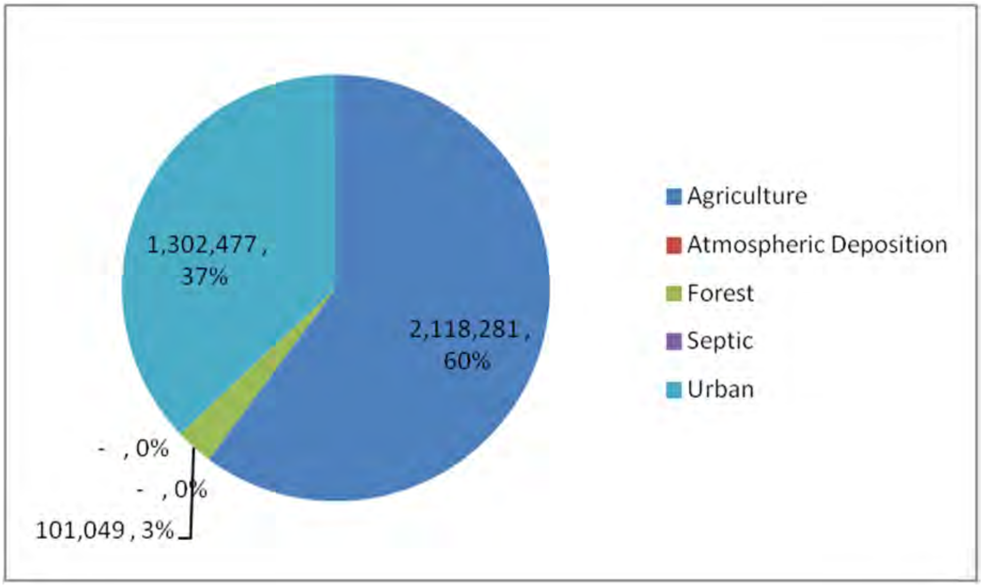

Figure 15: Total suspended solids by source sector in the Upper Chesapeake as of June 30, 2012.

3.1 Wastewater

There are no permitted WWTP, CSO, or Industrial facilities in the Upper Chesapeake watershed.

3.2 Urban

The urban sector in the Upper Chesapeake watershed is comprised of construction land area and nonregulated developed land. There are no municipal separate storm sewer systems (MS4s), according to the Chesapeake Bay Program land use that was used in the Bay TMDL. The construction land use has the highest loads per acre, and therefore the most recovery potential (Table 5).

3.3 Agriculture

The agricultural land uses include crop, nursery, pasture and hay, and the animal production area. Cropland includes those high and low till areas with and without nutrient management. Nursery includes nursery operations under glass as well as outdoors. Pasture/hay includes alfalfa as well as pasture and hay. The production areas are those areas that are designated as animal feeding operations or concentrated animal feeding operations. These are the areas where the animals are located when not in pasture. The production areas receive nutrients from storage loss but do not include nutrients spread on crops.

Crop land generates 86% of the total delivered nitrogen, 83% of the total delivered phosphorus, and 92% of the total delivered suspended solids (Table 5). Since there are many USDA cost-shared practices to control these loads, cropland is a critical area with a high recovery potential.

There are no permitted CAFOs in the Upper Chesapeake. However, there are numerous notices of intent under consideration. This analysis considered the number of animals, rather than the permit status of the facility.

3.4 Septic

Septic systems are modeled as one type of system. They are assumed solely to deliver nitrogen. When looking at all sources of total nitrogen, septic systems contribute 32,709 pounds per year or 14%.

3.5 Forest

The forested land is a low loading land use. Many management measures seek to convert less productive land into forest, improve forest harvesting techniques, or to add a forested buffer down slope from a higher loading land use. The TN load from forest is 6%, TP is 1%, and TSS is 3%.

3.6 Summary

The critical sources of nitrogen, phosphorus and sediment each of the subwatersheds in the Upper Chesapeake watershed are cropland and construction land uses. These are also land uses with high recovery potential. While septic systems are not the most substantial source of nitrogen, it is a fairly easily addressed load. Table 5 captures the nutrient and sediment loads for the subwatersheds in the Upper Chesapeake. The overall goals of this watershed management plan and the Chesapeake Bay TMDL are presented in Table 6.

Table 5: Nitrogen, phosphorus and sediment loads for each of the subwatersheds in the Upper Chesapeake as of June 30, 2012.

Subwatershed/Sector	Total Nitrogen Delivered (lbs/year)	Total Phosphorus Delivered (lbs/year)	Total Suspended Solids Delivered (lbs/year)
Bohemia River			
Agriculture	**37,131**	**6,310**	**476,081**
Crop	32,063	5,233	438,312
Nursery	428	136	1,329
Pasture/hay	1,516	425	35,330
Production area	3,125	516	1,109
Atmospheric Deposition	**155**	**9**	**-**
Forest	**2,624**	**74**	**14,699**
Septic	**5,275**	**-**	**-**
Urban	**11,575**	**747**	**135,095**
Construction	819	157	56,683
Impervious developed	1,878	192	42,719
Pervious developed	8,879	398	35,692
C&D Canal			
Agriculture	**42,962**	**7,300**	**1,035,290**
Crop	37,096	6,054	953,306
Nursery	495	157	2,892
Pasture/hay	1,753	492	76,679
Production area	3,618	598	2,413
Atmospheric Deposition	**819**	**47**	**-**

Subwatershed/Sector	Total Nitrogen Delivered (lbs/year)	Total Phosphorus Delivered (lbs/year)	Total Suspended Solids Delivered (lbs/year)
Forest	**4,275**	**121**	**42,419**
Septic	**20,155**	**-**	**-**
Urban	**46,324**	**2,938**	**1,008,632**
Construction	2,319	444	372,597
Impervious developed	8,175	858	358,415
Pervious developed	35,830	1,636	277,620
Elk River			
Agriculture	**2,449**	**416**	**40,406**
Crop	2,114	345	37,197
Nursery	28	9	113
Pasture/hay	100	28	3,002
Production area	207	34	94
Atmospheric Deposition	**-**	**-**	**-**
Forest	**1,314**	**37**	**9,556**
Septic	**4,238**	**-**	**-**
Urban	**6,062**	**402**	**96,254**
Construction	355	68	31,401
Impervious developed	1,210	127	39,696
Pervious developed	4,497	206	25,158
Sassafras River			
Agriculture	**29,967**	**5,209**	**566,505**
Crop	25,777	4,318	521,716
Nursery	353	112	1,582
Pasture/hay	1,253	351	41,886
Production area	2,584	427	1,321
Atmospheric Deposition	**7**	**0**	**-**
Forest	**4,446**	**126**	**34,374**
Septic	**3,041**	**-**	**-**
Urban	**3,828**	**246**	**62,496**
Construction	150	29	14,965
Impervious developed	821	86	29,587
Pervious developed	2,857	131	17,944
Grand Total	**226,648**	**23,981**	**3,521,806**

4 Expected Load Reductions (b)

The load reductions necessary to meet the 2010 Bay TMDL, which includes the Upper Chesapeake, were estimated using the Chesapeake Bay Program Partnership Watershed Model Phase 5.3.2. This is the same model that was used to establish the expected loads for this Upper Chesapeake Watershed

Management Plan. There is no other TMDL currently in effect for any of the Upper Chesapeake subwatersheds. Projected reductions in loads are a result of applying various BMPs at various levels. The Watershed Model calculates the annual loads under various management scenarios. The suite of BMPs that produced the loads discussed in this section is discussed in detail in Section 5: Management Measures.

The expected load reductions are accurate assuming constant initial conditions. As land use changes from agriculture to developed, more of the nonpoint load will come from those developed source sectors (urban, septic). The total load cannot increase because of the requirements of the 2010 Bay TMDL which requires growth offset measures. Section 5: Management Measures addresses offsetting new and increased loads.

The load reductions proposed in this section meet or exceed the allocations for the Upper Chesapeake in the Bay TMDL. The allocations were established to ensure that Delaware implements adequate pollution control practices to meet the Bay water quality standards. These load reductions are specific to each source. Each source is broken into various land uses, and these land uses are addressed separately. The load reduction for each subwatershed is presented for each land use at the end of the section.

By targeting the most effective BMPs to the critical areas with the greatest recovery potential, the TN agriculture load can be decreased from 112,510 to 60,365 pounds per year, or almost by half. The TN urban load was the second largest load and can be reduced from 67,790 to 60,138 pounds per year. The TN load from septic systems can be reduced from 32,709 to 29,722 pounds per year (Figure 16). With these reductions, the Bay TMDL allocation is met.

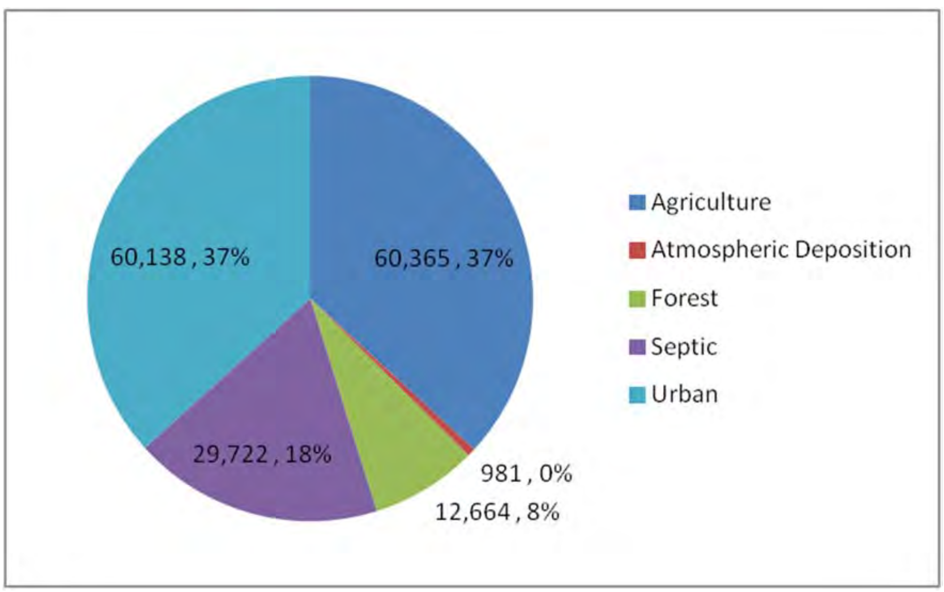

Figure 16: Expected TN loads by source sector in the Upper Chesapeake.

The agricultural TP loads in the Upper Chesapeake can be reduced in from 19,235 to 6,134 pounds per year. Urban TP loads can be reduced from 4,332 to 3,668 pounds per year (Figure 17). These radical reductions are possible because of the management measures that can be taken to reduce excreted phosphorus concentrations from animals, and are discussed in Section 5: Management Measures. With these reductions, the Bay TMDL allocation is met.

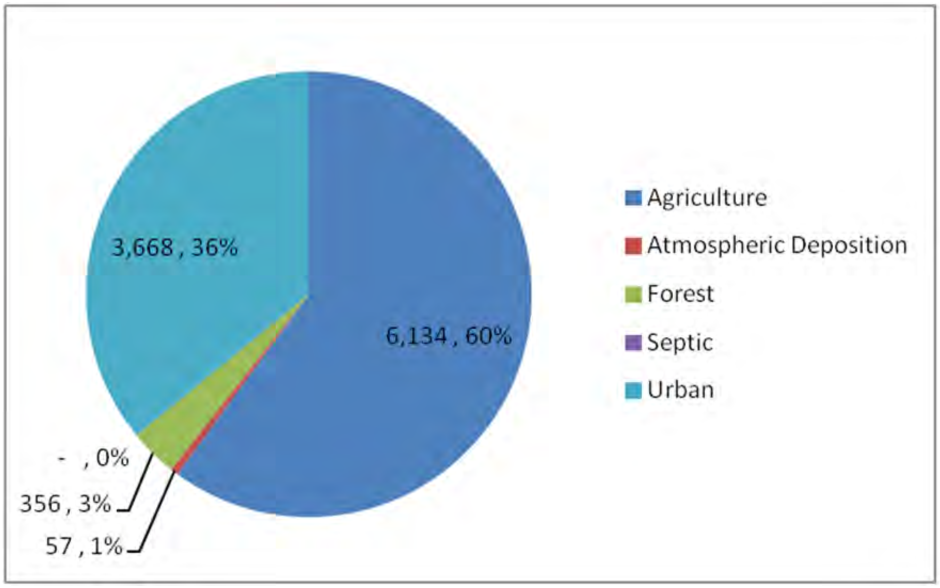

Figure 17: Expected TP loads by source sector in the Upper Chesapeake.

The TSS load from agriculture can be reduced from 2,118,281 to 1,276,211 pounds per year. The urban TSS load can be reduced from 1,302,477 to 1,117,774 pounds per year (Figure 18). With these reductions, the Bay TMDL allocation is met.

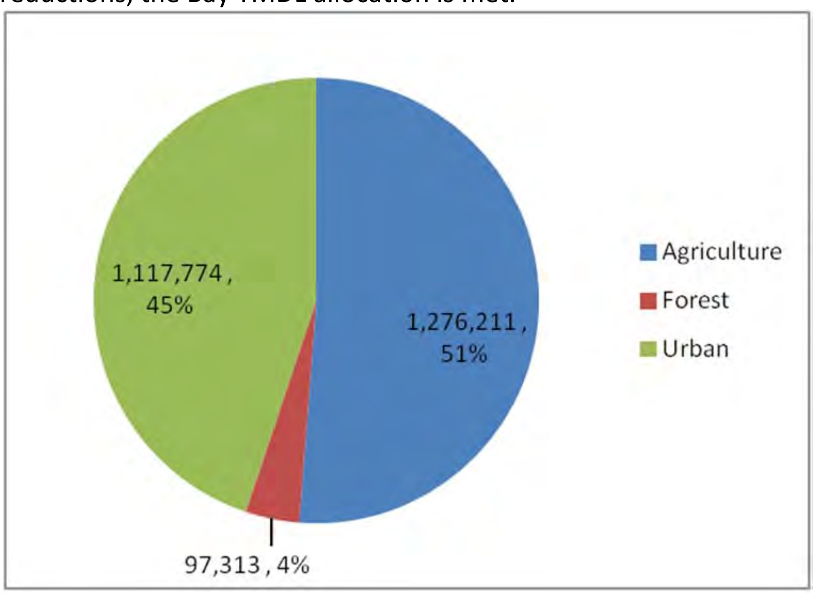

Figure 18: Expected TSS loads by source sector in the Upper Chesapeake.

Table 6 provides a summary of the projected TN, TP, and TSS pounds per year once all recommended management measures are implemented and take effect. That is, implementing a forest buffer may not take full effect for five to ten years, since the trees must approach maturity before the full nutrient and sediment reduction benefit is realized. However, the table reflects the load once the BMPs take effect. Also, there will be lag time related to groundwater and storage within the stream system. These projected loads are consistent with the Bay TMDL allocation for the Upper Chesapeake.

Table 6: Projected loads by sector and subwatershed to meet the Bay TMDL.

Sectors	TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)
Bohemia River			
Agriculture	**19,931**	**2,015**	**287,282**
Crop	14,754	1,198	241,469
Nursery	428	136	1,329
Pasture/hay	1,969	240	43,796
Production area	2,780	442	688
Atmospheric Deposition	**155**	**9**	**-**
Forest	**2,598**	**73**	**13,854**
Septic	**4,522**	**-**	**-**
Urban	**11,148**	**682**	**125,431**
Construction	616	96	34,473
Extractive	-	-	-
Impervious developed	2,078	219	49,066
Pervious developed	8,454	367	41,892
C&D Canal			
Agriculture	**22,863**	**2,326**	**623,769**
Crop	16,895	1,383	524,254
Nursery	495	157	2,892
Pasture/hay	2,269	276	95,145
Production area	3,204	509	1,479
Atmospheric Deposition	**819**	**47**	**-**
Forest	**4,286**	**120**	**40,407**
Septic	**19,154**	**-**	**-**
Urban	**40,342**	**2,445**	**853,558**
Construction	1,737	269	224,690
Extractive	-	-	-
Impervious developed	8,175	859	352,793
Pervious developed	30,429	1,317	276,074
Elk River			
Agriculture	**1,303**	**133**	**24,326**
Crop	962	79	20,430
Nursery	28	9	113
Pasture/hay	129	16	3,725
Production area	183	29	58
Atmospheric Deposition	**-**	**-**	**-**
Forest	**1,249**	**35**	**8,614**

Sectors	TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)
Septic	**4,038**	**-**	**-**
Urban	**5,292**	**333**	**82,880**
Construction	265	41	18,908
Extractive	-	-	-
Impervious developed	1,200	126	38,624
Pervious developed	3,827	166	25,348
Sassafras River			
Agriculture	**16,268**	**1,660**	**340,834**
Crop	12,012	987	286,685
Nursery	353	112	1,582
Pasture/hay	1,618	197	51,762
Production area	2,284	363	805
Atmospheric Deposition	**7**	**0**	**-**
Forest	**4,532**	**127**	**34,437**
Septic	**2,008**	**-**	**-**
Urban	**3,356**	**208**	**55,905**
Construction	112	17	8,987
Extractive	-	-	-
Impervious developed	815	86	28,804
Pervious developed	2,430	105	18,114
Grand Total	**163,871**	**10,214**	**2,491,298**
Bay TMDL Allocation for Upper Chesapeake	**163,871**	**10,214**	**2,491,298**

In the urban sector, the majority of the TN and TP load reductions will come from the pervious developed land use. This land use generally is the most cost-effective to treat. The urban TSS loads will primarily be reduced from the construction land use where there are many sediment controls that can be implemented.

The agricultural sector will see the majority of reductions from crop land. Some of these reductions will be by converting crop land to pasture or hay. Therefore, there is an increase in the pasture/hay land use loads, but an overall reduction in agriculture.

Nitrogen load reductions from septic systems are expected by increasing pump out, inspection and utilizing advanced treatment for septic systems. Hookups to wastewater treatment plants (WWTPs) will also reduce the septic load.

The forest sector is a low loading land use. By adding almost 200 more acres of land into forest, reductions are gained.

Atmospheric deposition is a source that is not planned to be addressed by Delaware. Rather, EPA's Clean Air Act is anticipated to address this load. Much of the nitrogen air deposition in Delaware is generated in other states. Delaware is focusing its efforts on increasing forest land cover which trap air-borne nitrogen so that it does not enter the waterways.

The specific recommended management measures are addressed in the following section.

5 Management Measures (c)

Best management practices (BMPs) are either already implemented or are planned for implementation to achieve the TMDL load allocations as discussed in the previous section—4: Expected Load Reductions. The type and level of BMPs implementation included in this section, will meet the reduction and loading goals of the TMDL. This section discusses the planned BMPs and compares them to the baseline BMPs. Baseline BMPs are those that were implemented through June 30, 2012.

Each BMP provides a reduction for nitrogen, phosphorus, and/or suspended solids. An annual pollutant load that meets the 2010 Bay TMDL allocation is estimated for each source sector with the indicated BMPs implemented. The pollutant load was determined using the Chesapeake Bay Program Partnership Watershed Model.

Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. The Watershed Model calculates BMPs as a group, much like a treatment train. For those BMPs with individual effectiveness values, the load reduction can vary depending on other BMPs that are implemented. This is because some BMPs are land use change BMPs and also because some BMPs are mutually exclusive or overlapping. This section presents the level of BMP implementation.

5.1 Wastewater

There are no permitted WWTP, CSO, or Industrial facilities in the Upper Chesapeake watershed. Consideration of a wastewater treatment plant may be considered to reduce septic loads. Growth projections will inform if this is a cost effective approach to reducing septic loads.

5.2 Urban

The urban sector is currently making use of six structural BMPs to reduce nitrogen, phosphorus and sediment loads. When cost-effective, the use of these practices will be expanded and refocused to assure recovery. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls. The practices include:

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants.
- **Bioswales** —A bioswale is a stormwater conveyance that reduces loads because, unlike other open channel designs, there is now treatment through the soil. A bioswale is designed to function similarly to bioretention.
- **Extended detention (ED) dry ponds** — Dry extended detention basins are depressions created by excavation or berm construction that temporarily store runoff and release it slowly via

surface flow or groundwater infiltration following storms. Dry extended detention basins are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. As such, they are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness.

- **Filtering practices** (biofiltration, filter strip, filtration, forebay micropool) — Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance.
- **Infiltration** — A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil, they are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approved to build is issued. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it to an open water system at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached nutrients/toxics. Until recently, these practices were designed specifically to meet water quantity, not water quality objectives. There is little or no vegetation living within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

Along with the structural BMPs listed above, the urban sector is also providing treatment through non-structural measures. These are treatments that rely on programs that continue throughout the year. These were selected because there is the public will to adopt, they are cost effective, and have proven success in improving water quality. Erosion and sediment control, listed below, is a major component of this plan, as it addresses construction, one of the leading sources of sediment.

- **Nutrient management —** Urban nutrient management involves the reduction of fertilizer to grass lawns and other urban areas. The implementation of urban nutrient management is based on public education and awareness, targeting suburban residences and businesses, with emphasis on reducing excessive fertilizer use. This does not account for the recent laws passed to remove P from fertilizer. As an added margin of safety providing reasonable assurance that fertilizer will be appropriately managed in the urban and suburban environment, a voluntary program known as Delaware Livable Lawns, administered through the Delaware Nursery and Landscape Association, has been developed to provide education, outreach, and certification for suburban fertilizer use and certification of lawn care companies. The Delaware Livable Lawns Program is a voluntary homeowner education and commercial lawn-care certification program.
- **Tree planting** —Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting.

- **Street sweeping**. —Street sweeping should occur twice a month or 26 times a year on urban streets. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment. DelDOT is planning to track sweeping by incorporating GPS into the sweepers.
- **Erosion and sediment control**. —These measures are implemented on construction sites to mitigate erosion. Construction areas are one of the critical areas with a high recovery potential. Delaware's Sediment and Stormwater Program is currently managed by the Division of Watershed Stewardship in the Department of Natural Resources and Environmental Control. The existing Delaware Sediment and Stormwater Regulations require erosion and sediment control during construction and post-construction for water quality. The DSSR effectively cover the entire development process, from the time construction begins, through project completion, and permanent maintenance of stormwater management facilities. Unless specifically exempted, any proposed land development project that disturbs more than 5,000 square feet must comply with the DSSR. The DSSR are effective Statewide, and are applicable for new development, redevelopment, MS4s and non-MS4s. In order to comply with these regulations, projects must employ stormwater Best Management Practices (BMPs) to address both water quality as well as water quantity impacts. The Sediment & Stormwater Management Plans are vigorously reviewed by local delegated agencies and are only approved if it is deemed that they meet minimum State-wide regulatory requirements. These delegated agencies also ensure these approved plans are constructed properly in the field through a process of frequent inspections on a regular basis that ensures regulatory compliance with the DSSR that includes a final inspection and close-out process. The penalty section of the DSSR provides DNREC with the authority to pursue both civil and criminal actions should enforcement for non-compliance be necessary. The delegated agencies responsible for enforcing these regulations and their areas of responsibility are included in the Final Phase 2 CBWIP 03301012A on pages 76-77.

Table 7 compares the implementation for existing BMPs with the planned levels of implementation. Note the substantial increase in erosion and sediment control. This BMP is prioritized because it targets the sediment load from construction, a major source of pollution. This increase in implementation will achieve the loads shown in Table 6. These loads are equivalent to the Bay TMDL allocations for the Upper Chesapeake.

Table 7: Urban BMP implementation, 2012 and planned 2025 levels for each of the subwatersheds in the Upper Chesapeake.

Urban Practices	Unit	2012 Implementation	2025 Planned Implementation
Bohemia River			
Bioretention	acres	28	0
BioSwale	acres	107	0
ED Dry Ponds	acres	22	22
Filtering Practices	acres	44	34
Infiltration	acres	27	0
Wet ponds and wetlands	acres	184	92
Nutrient Management	acres	1	1,131
Tree Planting	acres	0	0
Street sweeping	acres	0	64
Erosion and Sediment Control	acres	0	45

Urban Practices	Unit	2012 Implementation	2025 Planned Implementation
C&D Canal			
Bioretention	acres	1	1
BioSwale	acres	59	0
ED Dry Ponds	acres	80	82
Filtering Practices	acres	128	128
Infiltration	acres	0	0
Wet ponds and wetlands	acres	375	368
Nutrient Management	acres	297	4,092
Street sweeping	acres	0	252
Erosion and Sediment Control	acres	0	128
Elk River			
Extended Dry Ponds	acres	10	10
Filtering Practices	acres	16	16
Wet ponds and wetlands	acres	43	44
Nutrient Management	acres	0	514
Street sweeping	acres	0	37
Erosion and Sediment Control	acres	0	20
Sassafras River			
ED Dry Ponds	acres	7	7
Filtering Practices	acres	11	10
Wet ponds and wetlands	acres	28	28
Nutrient Management	acres	0	327
Street sweeping	acres	0	25
Erosion and Sediment Control	acres	0	8

The measured effectiveness for each of these practices may be found in Table 8.

Table 8: Urban BMP effectiveness

BMP	Nitrogen Effectiveness (%)	Phosphorus Effectiveness (%)	Sediment Effectiveness (%)
Bioretention	70	75	80
Bioswale	70	75	80
ED Dry Ponds	20	20	60
Filtering Practices	40	60	80
Infiltration	85	85	95
Wet Ponds and Wetlands	20	45	60
Nutrient Management	17	22	0
Tree Planting	Land use change to forest-no effectiveness value assigned		
Street Sweeping	3	3	9
Erosion and Sediment Control	25	40	40

5.3 Agriculture

The agricultural sector is planning to make use of 22 BMPs to reduce nitrogen, phosphorus and sediment loads. The use of the existing practices will be expanded and in some cases refocused. Several new practices will be added to the suite of existing practices to more effectively target cropland loads. The cropland loads were among the highest loading land uses and have a high recover potential. Therefore, many of the BMPs were selected because they target cropland. These BMPs include continuous no-till, nutrient management planning, cover crops, buffers and wetland restoration. Another major source of pollution is from animal production areas. Manure control BMPs were selected to target this source of pollution. Each BMP included in this plan was evaluated to ensure that it met the following three criteria: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in a variety of types of operations. The entire suite of planned and existing practices includes:

- **Alternative Crops**—Alternative crops is a BMP that accounts for those crops that are planted and managed as permanent, such as warm season grasses. This functions as a conversion of the Watershed Model land uses that are cropland to the hay land use.
- **Animal Waste Management System**—Practices designed for proper handling, storage, and utilization of wastes generated from confined animal operations. Reduced storage and handling loss is conserved in the manure and available for land application.
- **Barnyard Runoff Control**—Includes the installation of practices to control runoff from barnyard areas. This includes practices such as roof runoff control, diversion of clean water from entering the barnyard and control of runoff from barnyard areas. Different efficiencies exist if controls are installed on an operation with manure storage or if the controls are installed on a loafing lot without manure storage.
- **Conservation Tillage** —Conservation tillage requires: (a) a minimum 30% residue coverage at the time of planting, and (b) a non-inversion tillage method.
- **Continuous No Till**—The Continuous No-Till (CNT) BMP is a crop planting and management practice in which soil disturbance by plows, disk or other tillage equipment is eliminated. CNT involves no-till methods on all crops in a multi-crop, multi-year rotation. When an acre is reported under CNT, it will not be eligible for additional reductions from the implementation of other practices such as cover crops or nutrient management planning. Multi-crop, multi-year rotations on cropland are eligible. Crop residue should remain on the field. Planting of a cover crop might be needed to maintain residue levels. The system must be maintained for a minimum of five years. All crops must be planted using no-till methods.
- **Cover Crop** —A winter crop planted at a specified time with a specified seeding method. The crop may be neither fertilized nor harvested. A commodity cover crop may be harvested.
- **Cropland Irrigation Management**—Cropland under irrigation management is used to decrease climatic variability and maximize crop yields. The potential nutrient reduction benefit stems not from the increased average yield (20-25%) of irrigated versus non-irrigated cropland, but from the greater consistency of crop yields over time matched to nutrient applications. This increased consistency in crop yields provides a subsequent increased consistency in plant nutrient uptakes over time matched to applications, resulting in a decrease in potential environmental nutrient losses. The current placeholder effectiveness value for this practice has been proposed at 4% TN, 0% TP and 0% TSS, utilizing the range in average yields from the 2002 and 2007 NASS data for irrigated and non-irrigated grain corn as a reference. The proposed practice is applied on a per acre basis, and can be implemented and reported for cropland on both lo-till and hi-till land uses that receive or do not receive manure.

- **Decision Agriculture**—A management system that is information and technology based, is site specific and uses one or more of the following sources of data: soils, crops, nutrients, pests, moisture, or yield for optimum profitability, sustainability, and protection of the environment. This BMP is modeled as a land use change to a nutrient management land use with an effectiveness value applied to create an additional reduction. It is intended to be more effective than regular nutrient management.
- **Forest Buffers**—Agricultural riparian forest buffers are linear wooded areas along rivers, streams and shorelines. Forest buffers help filter nutrients, sediments and other pollutants from runoff as well as remove nutrients from groundwater. The recommended buffer width for riparian forest buffers (agriculture) is 100 feet, with a minimum width of 35 feet required.
- **Grass Buffers; Vegetated Open Channel** —Agricultural riparian grass buffers are linear strips of grass or other non-woody vegetation maintained between the edge of fields and streams, rivers or tidal waters that help filter nutrients, sediment and other pollutants from runoff. The recommended buffer width for riparian forests buffers (agriculture) is 100 feet, with a minimum width of 35 feet required. Vegetated open channels are modeled identically to grass buffers.
- **Land Retirement to hay without nutrients (HEL)** —Converts land area to hay without nutrients. Agricultural land retirement takes marginal and highly erosive cropland out of production by planting permanent vegetative cover such as shrubs, grasses, and/or trees. Agricultural agencies have a program to assist farmers in land retirement procedures.
- **Land Retirement to pasture (HEL)** —Converts land area to pasture. Agricultural land retirement takes marginal and highly erosive cropland out of production by planting permanent vegetative cover such as shrubs, grasses, and/or trees. Agricultural agencies have a program to assist farmers in land retirement procedures. acres
- **Mortality Composters**—A physical structure and process for disposing of any type of dead animals. Composted material land applied using nutrient management plan recommendations.
- **Nutrient Management**—Nutrient management plan (NMP) implementation (crop) is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. A NMP details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Plans should be revised every 2 to 3 years.
- **Off Stream Watering without Fencing**—This BMP requires the use of alternative drinking water sources away from streams. The BMP may also include options to provide off-stream shade for livestock, and implementing a shade component is encouraged where applicable. The hypothesis on which this practice is based is that, given a choice between a clean and convenient off-stream water source and a stream, cattle will preferentially drink from off-stream water source and reduce the time they spend near and in streams and streambanks. Alternative watering facilities typically involves the use of permanent or portable livestock water troughs placed away from the stream corridor. The source of water supplied to the facilities can be from any source including pipelines, spring developments, water wells, and ponds. In-stream watering facilities such as stream crossings or access points are not considered in this definition. The modeled benefits of alternative watering facilities can be applied to pasture acres in association with or without improved pasture management systems such as prescribed grazing or precision intensive rotational grazing.
- **Poultry Phytase** —Phytase is an enzyme added to poultry-feed that helps poultry absorb phosphorus. The addition of phytase to poultry feed allows more efficient nutrient uptake by poultry, which in turn allows decreased phosphorus levels in feed and less overall phosphorus in poultry waste.

- **Soil Conservation and Water Quality Plans**—Farm conservation plans are a combination of agronomic, management and engineered practices that protect and improve soil productivity and water quality, and to prevent deterioration of natural resources on all or part of a farm. Plans may be prepared by staff working in conservation districts, natural resource conservation field offices or a certified private consultant. In all cases the plan must meet technical standards.
- **Stream Restoration** — Stream restoration is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape, Restoration also helps improve habitat and water quality conditions in degraded streams by reducing erosion and sedimentation.
- **Tree Planting**—Tree planting includes any tree planting, except those used to establish riparian forest buffers, targeting lands that are highly erodible or identified as critical resource areas.
- **Upland precision intensive rotational grazing**— This practice utilizes more intensive forms pasture management and grazing techniques to improve the quality and quantity of the forages grown on pastures and reduce the impact of animal travel lanes, animal concentration areas or other degraded areas of the upland pastures. PIRG can be applied to pastures intersected by streams or upland pastures outside of the degraded stream corridor (35 feet width from top of bank). The modeled benefits of the PIRG practice can be applied to pasture acres in association with or without alternative watering facilities. They can also be applied in conjunction with or without stream access control. This practice requires intensive management of livestock rotation, also known as Managed Intensive Grazing systems (MIG), that have very short rotation schedules. Pastures are defined as having a vegetative cover of 60% or greater.
- **Water Control Structures**—Installing and managing boarded gate systems in agricultural land that contains surface drainage ditches.
- **Wetland Restoration**—Agricultural wetland restoration activities re-establish the natural hydraulic condition in a field that existed prior to the installation of subsurface or surface drainage. Projects may include restoration, creation and enhancement acreage. Restored wetlands may be any wetland classification including forested, scrub-shrub or emergent marsh.

Agricultural areas will add these new BMPs to the suite of BMPs currently used to control pollution: alternative crops, continuous no-till, crop irrigation management, decision agriculture, forest buffers, land retirement to pasture, stream restoration, tree planting, grazing practices, and water control structures. These new BMPs, in combination with refocusing existing BMPs will reduce the loads to the Bay TMDL allocations. Table 9 compares the implementation for existing BMPs and the planned levels of implementation. This increase in implementation will achieve the loads shown in Table 6. These loads are equivalent to the Bay TMDL allocations for the Upper Chesapeake.

Table 9: Agricultural BMP implementation, 2012 and planned 2025 levels, for each of the subwatersheds within the Upper Chesapeake.

Agricultural Practices	Unit	2012 Implementation	2025 Planned Implementation
Bohemia River			
Animal Waste Management Systems	AU	4	No change
Barnyard Runoff Control	acres	-	3
Alternative Crops	acres	-	19
Commodity Cover Crops	acres	1	281

Agricultural Practices	Unit	2012 Implementation	2025 Planned Implementation
Soil and Water Conservation Plans	acres	18	2,723
Conservation Tillage	acres	1,034	1,773
Continuous No Till	acres	-	3
Cover Crops	acres	1,267	722
Crop irrigation management	acres	-	1,755
Decision Agriculture	acres	-	4,196
Grass Buffers	acres	3	111
Land Retirement to hay without nutrients	acres	22	190
Land Retirement to Pasture	acres	-	9
Mortality Composting	AU	49	No change
Stream Restoration	feet	-	896
Nutrient Management	acres	2,448	148
Off stream watering without fencing	acres	10	9
Poultry Phytase	AU	21	Full Implementation
Upland Precision Intensive Rotational Grazing	acres	-	31
Water Control Structures	acres	-	51
Wetland Restoration	acres	122	81
C&D Canal			
Animal Waste Management Systems	AU	4	No change
Barnyard Runoff Control	acres	-	3
Alternative Crops	acres	-	22
Commodity Cover Crops	acres	-	325
Soil and Water Conservation Plans	acres	21	3,151
Conservation Tillage	acres	1,196	2,051
Continuous No Till	acres	-	3
Cover Crops	acres	1,465	835
Crop irrigation management	acres	-	2,031
Decision Agriculture	acres	-	4,854
Grass Buffers	acres	3	128
Land Retirement to hay without nutrients	acres	26	220
Land Retirement to Pasture	acres	-	11
Mortality Composting	AU	56	No change
Stream Restoration	feet	-	1,036
Nutrient Management	acres	2,832	172
Off stream watering without fencing	acres	12	10
Poultry Phytase	AU	42	Full Implementation
Upland Precision Intensive Rotational Grazing	acres	-	35
Water Control Structures	acres	-	59
Wetland Restoration	acres	141	94

Agricultural Practices	Unit	2012 Implementation	2025 Planned Implementation
Elk River			
Animal Waste Management Systems	AU	-	0
Barnyard Runoff Control	acres	-	0.195
Alternative Crops	acres	-	1.229
Commodity Cover Crops	acres	-	18.497
Soil and Water Conservation Plans	acres	1	179.533
Conservation Tillage	acres	68	116.887
Continuous No Till	acres	-	0.187
Cover Crops	acres	83	47.565
Crop irrigation management	acres	-	115.716
Decision Agriculture	acres	-	276.618
Grass Buffers	acres	-	7.301
Land Retirement to hay without nutrients	acres	1	12.537
Land Retirement to Pasture	acres	-	0.618
Mortality Composting	AU	3	0
Stream Restoration	feet	-	59.06
Nutrient Management	acres	161	9.777
Off stream watering without fencing	acres	1	0.58
Poultry Phytase	AU	42	Full Implementation
Upland Precision Intensive Rotational Grazing	acres	-	2.022
Water Control Structures	acres	-	3.378
Wetland Restoration	acres	8	5.34
Sassafras River			
Animal Waste Management Systems	AU	3	No change
Barnyard Runoff Control	acres	-	2
Alternative Crops	acres	-	15
Commodity Cover Crops	acres	335	232
Soil and Water Conservation Plans	acres	15	2,251
Conservation Tillage	acres	855	1,466
Continuous No Till	acres	-	2
Cover Crops	acres	1,231	596
Crop irrigation management	acres	-	1,451
Decision Agriculture	acres	-	3,469
Grass Buffers	acres	2	92
Land Retirement to hay without nutrients	acres	18	157
Land Retirement to Pasture	acres	-	8
Mortality Composting	AU	40	No change
Stream Restoration	feet	-	741
Nutrient Management	acres	2,024	123

Agricultural Practices	Unit	2012 Implementation	2025 Planned Implementation
Off stream watering without fencing	acres	8	7
Poultry Phytase	AU	21	Full Implementation
Upland Precision Intensive Rotational Grazing	acres	-	25
Water Control Structures	acres	-	42
Wetland Restoration	acres	101	67

*Nutrient management has historically been reported at 100% in DE. DE is working through a process of adapting their tracking to more accurately reflect implementation. Therefore, a reduction from 2012 represents only a correction in data.

The measured effectiveness for each of these practices may be found in Table 10.

Table 10: Agricultural BMP effectiveness

BMP	Nitrogen Effectiveness	Phosphorus Effectiveness	Sediment Effectiveness
Alternative Crops	Land use change to a lower loading land use		
Animal Waste Management Systems	Applied as a change in the manure load on the production area		
Barnyard Runoff Control	20	20	40
Conservation Tillage	Land use change to a lower loading land use		
Continuous No Till	10-15	20-40	70
Cover Crop (effectiveness varies depending on variety, plant date, and plant method and if it is commodity or not)	5-45	0-15	0-20
Cropland Irrigation Management	4	0	0
Decision Agriculture (land use change to nutrient management plus efficiency)	3.5	0	0
Forest Buffers (land use change plus efficiency)	0-65	0-45	0-60
Grass Buffers; Vegetated Open Channel - Agriculture	Land use change to a lower loading land use		
Land Retirement to hay w/o nutrients (HEL)	Land use change to a lower loading land use		
Land Retirement to pasture (HEL)	Land use change to a lower loading land use		
Mortality composting	Applied as a change in the manure load		
Nutrient Management	Land use change to a lower loading land use		
Off Stream Watering Without Fencing	5	8	10
Poultry Phytase	Applied as a change in the manure nutrient concentration		
Upland precision intensive rotational grazing	9-11	24	30
Soil Conservation and Water Quality Plans	3-8	5-15	8-25
Stream Restoration	Load Reduction-not modeled with an effectiveness value		
Tree Planting	Land use change to a lower loading land use		
Water Control Structures	33	0	0
Wetland Restoration (land use change plus efficiency)	7-25	12-50	4-15

To provide added assurance of BMP effectiveness, Delaware has instituted a comprehensive Nutrient Management Law that controls the minimum set of management practices that are included in nutrient management plans. In regard to phosphorus in soils, it is important to note that Delaware's NMP's are p-based and have been for many years. The application of phosphorus is limited on high phosphorus soils, and utilizes a three year crop removal policy to restrict phosphorus application in certain conditions on high phosphorus soils. High phosphorus soils are determined based on the Phosphorus-Site Index analysis. In the absence of phosphorus data, yield based assessments are conducted using the four highest yield goals out of the last seven years. In addition to the phosphorus and nitrogen limiting plans, Delaware has a manure relocation program aimed at reducing phosphorus in soils. To obtain appropriate agronomic rates for application of manure, biosolids, and organic byproducts, the Nutrient Management Plan incorporates soil testing, manure testing, phosphorus index, and crop needs. Delaware allows three and one year NMPs, with the majority being one year plan. In addition, feedback from NMP writers indicates that most Delaware's producers and NM Consultants are utilizing yearly soil test data regardless of plan length. Additional information on the enforcement of this law is specified in the Final Phase 2 CBWIP 03301012A beginning on page 154.

5.4 Septic

The Department's Ground Water Discharges Section is developing revisions to its statewide onsite wastewater disposal regulations. The proposed changes would require new or replacement systems within 1,000 feet of tidal waters and associated tidal wetlands to comply with a 20mg/l limit for Total Nitrogen. There are no additional performance requirements for individual septic systems proposed in the regulations. Under the proposed regulations, all larger onsite wastewater treatment systems would be required to meet a performance standard based on the system size, age, and location.

Individual OWTDS are required by permit conditions to have the septic tank pumped out once every three years. Any OWTDS with a design flow of 2,500 gpd and above are required by the current Regulations Governing the Design Installation and Operation of On-site Wastewater Treatment and Disposal Systems to have a licensed operator to oversee operations of the OWTDS, and submit compliance reports with monitoring data on a routine basis as established in the operating permit. All OWTDS's with a design flow of 2,500 gallons per day or greater are issued individual operating permits with a maximum 5-year term. The On-Site Regulations are currently open for review and several modifications resulting in increased nutrient reduction are being proposed on a state-wide basis. Penalties for noncompliance include but are not limited to: voluntary compliance agreements, verbal warning, manager's warning letter, non-compliance notifications, Notice of Violation (NOV), and Secretary Order, which could include fines. For voluntary and/or incentive-based programs identified in the WIP as currently controlling nutrient and sediment loads, programs verify that controls are installed and maintained through Department inspections and monitoring data (effluent, ground water, and soils). Repercussions and penalties for false reporting or improper installation or maintenance of voluntary practices are listed under chapter 60 DE code. Fines can be as high as $10,000 a day.

A three-fold approach to reducing nitrogen loss from septic systems is planned: 1) upgrades, 2) pump-outs, 3) connections. Systems within 1,000 feet of tidal waters and associated tidal wetlands will be upgraded to advanced treatment (septic denitrification) technologies. More frequent septic pump-outs are also being required. Septic pumping will be increased from 29 in 2012 to 2,643. Lastly, Delaware is planning to connect 168 systems to a wastewater treatment plant by 2025.

5.5 Forest

The Forest Service has identified ways to better sustain the forests in Delaware. In terms of water quality, an increase in forest harvesting practices is planned. In 2012, Delaware had 68 acres of forest harvested using optimal forest harvesting practices. This will be increased to 174 acres, allowing Delaware to meet its nitrogen, phosphorus and sediment allocation.

5.6 Offsetting Nutrient and Sediment Loads from Future Growth

The 2010 Bay TMDL requires that any new or increased load be offset. Delaware has determined that an offset program is a cost-effective means of complying with this requirement. "Offset" means an alternate to strict adherence to the regulations including, but not limited to trading, banking, fee-in-lieu, or other similar program that serves as compensation when the requirements of these regulations cannot be reasonably met on an individual project basis.

Three options are identified to offset new and increased loads:

1. Revised stormwater regulations
2. Stormwater in-lieu fee if site constraints prevent achievement of water quality goals on a specific parcel
3. Offsetting residual nutrient loads on another site within the same basin.

5.6.1 Statewide Stormwater Regulations

The Department's Sediment and Stormwater Program is on track to implement new statewide stormwater regulations in 2012, see Chapter 7. The new regulations contain the following language: Stormwater in-lieu fee: Working with the Center for Watershed Protection, Delaware's Sediment and Stormwater Program has developed a "common currency" for all shortfalls equivalent to the cost of treating unmanaged runoff volume. The cost of $23 per cubic foot of runoff volume is based on land acquisition, construction and maintenance costs for unmanaged volume.

5.6.2 Establish in-lieu fee for stormwater impacts

Under current state law, the Department has the authority to establish an in-lieu fee for erosion and sediment control. The Sediment and Stormwater Program, by the end of 2012, will determine which entities may collect the fees, how the fees would be collected and spent, and how projects would be prioritized and implemented. Programs may be operated and money spent at the local government or conservation district level under guidelines established by DNREC. The Department will also determine specific uses for the in-lieu fee.

5.6.3 Establish a statewide program that provides additional flexibility for offsets

Delaware is evaluating the necessary components that need to be a part of a state-wide program for offsets. EPA is currently establishing Technical Memorandums that will inform the development of this program.

Additional information on development of offset approaches is specified in the Final Phase 2 CBWIP 03301012A beginning on page 140.

5.6.4 Adaptive management

Adaptive management is a critical component of achieving the Bay TMDL and this Watershed Management plan. The two-year milestones provide interim planning targets. These are reevaluated against progress and revised to ensure that Delaware is on track to meet its goals. Progress is evaluated on an annual basis through the Chesapeake Bay Program annual review. All BMPs implemented everywhere by all people are tracked and reported. The Chesapeake Bay Program provides loads for each watershed to assess how much progress is made annually. This information is used to modify the milestones. There also is a mid-point assessment scheduled for 2017. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated by the Chesapeake Bay Program Partnership. The milestones, progress, mid-point assessment and annual progress review all contribute to constant reassessment of management plans, and adapting responses accordingly. Coordination and participation with the Chesapeake Bay Program Partnership is a priority for Delaware. Delaware has members who currently serve as the lead on an expert panel evaluating poultry litter, chair of the Water Quality Goal Implementation Team, and are represented on at least 10 other workgroups, at last count. This participation is critical to Delaware because it is the work of the Bay Program that provides the resources for projecting loads under different management actions and the coordination of science that supports the management decisions critical to reducing nitrogen, phosphorus and sediment pollution.

5.7 Summary

The practices and implementation levels proposed here meet the 2010 Bay TMDL allocations which apply to all of the Upper Chesapeake subwatersheds. The management measures outlined in this section are well within the capacity of Delaware to administer given existing funding programs, public will, and systems in place. These management measures have been reported to the Chesapeake Bay Program through a National Environmental Information Exchange Network (NEIEN) network node. Delaware also tracks implementation on various other tools, all of which feed data to NEIEN in the appropriate format. This tracking ability allows Delaware to nimbly refocus efforts and funding resources where implementation is not proceeding as planned. New technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control.

6 Technical and Financial Assistance Needs (d)

Technical Needs

Technical assistance to meet the reductions and goals of the WIP takes on many forms including DNREC assistance to local governments, state and local partner assistance to both DNREC and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to WIP planning and implementation.

DNREC has and will provide technical assistance to local governments through training, outreach and tools, including recommendations on ordinance improvements, technical review and assistance for implementation of best management practices at the local level, and identification of potential financial resources for implementation (DWIC, 2012).

DNREC has many partners that provide outreach to homeowners and communities in the form of technical assistance, education, and funding for implementation of best management practices within local communities. Partners include, but are not limited to the Delaware Nature Society, Delaware

Forest Service, University of Delaware Cooperative Extension, Sussex Conservation District, Kent Conservation District, New Castle Conservation District, Master Gardeners/Cooperative Extension Service, Delaware Center for Horticulture. These partners provide all levels of support for various programs (DWIC, 2012).

Consultants can be contracted to provide a variety of technical services. For example, Tetra Tech has provided the Local Governments with a review of local ordinances along with a set of recommendations for consideration as they review and update ordinances. Tetra Tech has also provided model ordinances for consideration. State and local governments can contract with consultants through standard means, or through grant and funding assistance programs such as the National Fish and Wildlife Foundation's (NFWF) Technical Assistance Program. DNREC may also hire consultants to provide assistance.

Technical assistance for the Upper Chesapeake can take all of these forms; however as the Upper Chesapeake is primarily an agricultural watershed, and with a majority of load reductions anticipated from the agricultural section (See Section 4), it follows that technical assistance to farmers will be a focus. Support from the University of Delaware Cooperative Extension, New Castle County Conservation District, Delaware Department of Agriculture (DDA), Farm Service Agency (FSA) as well as federal assistance from the United States Department of Agriculture (USDA) Natural Resources Conservation District (NRCS) and Farm Services Agency (FSA). The DDA oversees Delaware's Nutrient Management Plan program. The state has recently updated the Nutrient Management Program State Technical Standards, and the DDA will facilitate technical assistance to develop and implement Nutrient Management Plans. In 2011, two Strategic Watershed Action Team (SWAT) planners were hired by the Sussex Conservation District as part of an agreement between the USDA - NRCS, DNREC-Division of Watershed Stewardship, and the Kent and New Castle Conservation Districts. The planners are stationed in the Sussex Conservation District office but have statewide responsibility in the Chesapeake Bay Watershed. The SWAT planners were hired to complete 112 Comprehensive Nutrient Management Plans (CNMP) in the watershed over the next two years.

Technical assistance for Public Participation and Education, and for Monitoring will also be necessary to fully implement and track progress towards meeting the goals of the WIP. These elements are discussed in sections 7 and 9 of this plan.

Financial Needs

According to Delaware's Phase II WIP as of the planning and estimates made up to March of 2012, the total projected cost to implement the management measures described in this plan for the Upper Chesapeake is $11,120,640. Costs for capital and one-time expenses have been listed directly. For the programmatic management measures or additional staffing costs, annual costs have been converted to total costs my multiplying by 12, the number of years remaining to the target year of 2012. Table 11 below includes a summary of funding need per source sector. In this estimate, projected annual costs do not include current staff required for the various programs to implement programs. Anticipated BMPs and funding requirements for each sector are discussed in the sections below.

Table 11: Summary of Funding Needs per Source Sector

Source Sector	Total Cost	Proportional Total Cost Upper Chesapeake
Wastewater	$0	$0
Urban	$3,392,000	$566,668
Agriculture	$233,614,158	$10,102,910
Septic	$2,700,000	$451,062
Forest	$0	$0
Total, 2013-2025	**$239,706,158**	**$11,120,640**

6.1 Wastewater

There are no permitted WWTP, CSO, or Industrial facilities in the Upper Chesapeake watershed and as a result there is no requirement for funding improvements in this sector.

6.2 Urban

Within the Chesapeake Bay Watershed communities, DNREC has determined by analyzing land use patterns, that retrofits are not the solution to reduction of pollution loading. As a result, Delaware is not currently focusing efforts on structural stormwater retrofits due to their expense. Instead, stormwater funding is focused on building capacity to meet growing demands for source reduction strategies. These include GIS data management, tracking and reporting inspections, updating regulations, and training and outreach programs. They also include activities included under the Land Use category in the WIP, which involves developed areas. Detailed cost data per individual BMP and BMP type for the urban sector are not currently available for Delaware, as opposed to the agricultural sector which has a much more refined unit cost structure; therefore Table 12 shows the overall funding requirements for the urban sector pro-rated for the Upper Chesapeake subwatershed.

Table 12: Projected Funding Requirements, Urban Stormwater BMPs (2013-2025)

BMP	Total Cost	Proportional Total Cost Upper Chesapeake
Projects		
GIS data management and system upgrades,	$5,000	$835
Revised regulations for industrial storm water management	$69,000	$11,527
New and revised technical standards and Regulations for Stormwater management practices	$315,000	$52,624
Additional training program for staff, permittee, and system owners and operators	$50,000	$8,353
Outreach to system owners and operators regarding new requirements	$50,000	$8,353
Urban retrofits inventory	$150,000	$25,059
Municipal urban storm water retrofit demonstration projects, at least one per community, ten communities	$200,000	$33,412

BMP	Total Cost	Proportional Total Cost Upper Chesapeake
Develop nutrient offset regulations	$105,000	$17,541
Work with local governments to develop master plans	$252,000	$42,099
Annual Practices		
Additional maintenance inspections on storm water facilities in Kent and Sussex Counties	$1,440,000	$240,567
Staff to conduct increased number of industrial compliance inspections and enforcement	$756,000	$126,297
Manage nutrient offset program	$840,000	$140,330
Total, 2013-2025	$3,392,000	$566,668

6.3 Agriculture

Projected agricultural practices implemented within the Upper Chesapeake watersheds from 2013 through 2025 are presented in Table 13. Overall, approximately $10,102,910 of funding is necessary for implementation, $8,661,907 of which will be needed for annual practices. A total of 23 practices will be implemented on private lands – 13 non-annual practices and 10 annual practices, with seven BMPs implemented on public lands – two non-annual practices and five annual practices. Delaware is dedicated to incorporate new practices to its existing BMP regime and will include four new farming practices in 2013-2025 with 11 evolving practices currently under evaluation. Unit costs for several practices are not included because there are no funding requirements for the implementation of the practice, such as forest harvesting.

Table 13: Projected Funding Requirements, Agricultural BMPs (2013-2025)

BMP	Unit	Unit Cost	Cost of Land Rental/ Interest/ Maintenance	Total Units	Ac. for Add'l Costs (Rental, Interest, Main.)	Total Cost	Proportional Total Cost Upper Chesapeake
Private Lands							
Heavy Use Poultry Area Pads	structure	$4,661.00	-	857	-	$3,994,477	$172,746
Livestock Waste Structures							
Swine	structure	$25,000.00	-	10	-	$250,000	$10,812
Equine	structure	$15,000.00	-	28	-	$420,000	$18,163
Dairy	structure	$60,000.00	-	26	-	$1,560,000	$67,464
Bovine	structure	$50,000.00	-	10	-	$500,000	$21,623.
Water Control Structures	unit	$5,000.00	-	65	-	$325,000	$14,055
Stream Protection With Fencing	acre	$20.00	-	258	-	$5,160	$223
Stream Protection Without Fencing	acre	$700.00	-	325	-	$227,500	$9,838
Upland Prescribed Grazing	acre	-	-	1,134	-	-	-
Poultry Waste Structures	structure	$27,005.00	-	723	-	$19,524,615	$844,364
Runoff Control Systems	system	$10,500.00	-	120	-	$1,260,000	$54,490
Mortality Composters	composter	$1,105.00	-	723	-	$798,915	$34,550
Shoreline Erosion Control	acre	-	-	15,343	-	-	-
Retire Highly Erodible Lands	acre	$300.00	-	697	-	$209,100	$9,043
Land Retirement	acre	-	-	416	-	-	-
Forest Harvesting Practices	acre	-	-	2,070	-	-	-
Annual Practices 2013-2025							
Traditional Cover Crops							
Min	acre	$30.00	-	644,080	-	$19,322,400	$835,619
Max	acre	$50.00	-	644,080	-	$32,204,000	$1,392,699
Commodity Cover Crops							
Min	acre	$15.00	-	253,207	-	$3,798,105	$164,253

BMP	Unit	Unit Cost	Cost of Land Rental/ Interest/ Maintenance	Total Units	Ac. for Add'l Costs (Rental, Interest, Main.)	Total Cost	Proportional Total Cost Upper Chesapeake
Max	acre	$30.00	-	253,207	-	$7,596,210	$328,507
Nutrient Management Compliance	acre	-	-	-	-	TBD	TBD
Soil Conservation and Water Quality Plans	acre	-	-	-	-	-	-
Conservation Tillage	acre	$13.00	-	2,882,348	-	$37,470,524	$1,620,455
Continuous No-Tillage Conservation	acre	$40.00	-	1,000	-	$40,000	$1,730
Decision/Precision Agriculture	acre	$30.00	-	2,551,164	-	$76,534,920	$3,309,840
Large Animal Mortality Program							
Min	animal	$175.00	-	1,430	-	$250,250	$10,822
Max	animal	$250.00	-	1,430	-	$357,500	$15,460
Manure Relocation	ton	$4.32	-	1,088,841	-	$4,703,793	$203,421
Streamside Grass Buffers (implementation, land rental, and interest)	acre/year	$300.00	$100.17	1,734	17,997	$2,322,959	$100,459
Streamside Forest Buffers (implementation, land rental, interest, and maintenance)	acre/year	$425.00	$178.60	5,571	57,712	$12,675,038	$548,146
Wetland Restoration (implementation, land rental, and maintenance)	acre/year	$1,072.00	$143.00	721	7,466	$1,840,550	$79,597
Public Lands							
Tree Planting	acre	$400.00	-	108	-	$43,200	$1,868
Natural Filters on Other Public Lands	acre	$300.00	-	750	-	$225,000	$9,730
Annual Practices 2013-2025							
Cover Crops	acre	$70.00	-	3,559	-	$249,130	$10,774
Wetlands Restoration	acre	$1,702.00	-	121	-	$205,261.20	$8,877
Streamside Forested Buffers	acre	$425.00	-	234	-	$99,450	$4,301
Streamside Grass Buffers	acre	$300.00	-	2,077	-	$623,100	$26,94
Ag Strategies on DNREC/DDA Lands	acre	-	-	44,972	-	-	-
New Farming Practices							
CAFO Setbacks	acre	-	-	1,750	-	-	-
Vegetative Environmental Buffers	system	$4,000.00	-	222	-	$888,000	$38,403

BMP	Unit	Unit Cost	Cost of Land Rental/ Interest/ Maintenance	Total Units	Ac. for Add'l Costs (Rental, Interest, Main.)	Total Cost	Proportional Total Cost Upper Chesapeake
Streamside/Tax Ditch Restoration	linear ft	$75.00	-	41,200	-	$3,090,000	$133,631
Annual Practices 2013-2025							
Cropland Irrigation Management	acre	-	-	1,303,500	-	-	-
Evolving Practices							
Phosphorus-sorbing materials	-	-	-	-	-	-	-
In-house poultry ammonia emission control	-	-	-	-	-	-	-
Agronomic Improvements	acre	-	-	-	-	-	-
Voluntary Practices	-	-	-	-	-	-	-
Carbon Sequestration/Alternative Crops	-	-	-	-	-	-	-
Alternative Use of Manure	tons	-	-	-	-	-	-
Revised Phosphorus Index for Nutrient Management Planning	acre	-	-	-	-	-	-
Dairy Manure Incorporation Technology	-	-	-	-	-	-	-
Poultry Manure Incorporation Technology	-	-	-	-	-	-	-
Windrowing	-	-	-	-	-	-	-
Poultry House Remediation	-	-	-	-	-	-	-
					TOTAL COST	**$233,614,158**	**$10,102,910**

6.4 Septic

The Chesapeake Bay WIP proposed several activities to reduce nutrient discharges from Onsite Wastewater Disposal Systems, including upgrades to failed systems, pumpouts, and connections to sewer systems. Funding for upgrades and maintenance is the responsibility of the system owner; however, there are additional annual costs required in order to increase inspections and manage the program. These are described in Table 14. The proportional total was derived from the proportion of developed land use in the Chesapeake Bay watersheds.

Table 14: Projected Funding Requirements, Onsite Wastewater BMPs (2013-2025)

BMP	Total Cost	Proportional Total Cost Upper Chesapeake
Projects		
Outreach, staffing, and technical resources for permitting and inspection	$2,700,000	$451,062
Total, 2013-2025	**$2,700,000**	**$451,062**

6.5 Forest

Better management of forests in Delaware is the only management measure planned for the Upper Chesapeake watershed. The effort will be managed by existing personnel and no additional costs are foreseen.

6.6 Funding Sources

Funding required to implement the WIP in the Upper Chesapeake would represent a fraction of the overall cost. There are cost savings associated with economies of scale by staffing for areas broader than the Upper Chesapeake and also for program development that is statewide.

Funding for WIP implementation comes from sources including federal grants from EPA, USDA, and USFWS. Restoration funds are provided through grant programs such as the Chesapeake Bay Implementation Grant (CBIG) funded by the EPA, the National Fish and Wildlife Foundation (NFWF), and various agricultural cost share programs.

Examples of current funding sources are presented in Table 15.

Table 15: Summary of Sectors covered by Funding Sources

Funding Sources	Waste-water	Urban	Agricultural	Septic	Forest
Chesapeake Bay Implementation Grant (CBIG)		•	•		•
Chesapeake Bay Regulatory and Accountability Grant (CBRAP)			•		
National Fish and Wildlife (NFWF) Chesapeake Bay Stewardship Fund		•	•		•
Section 106 Grant		•	•		

Funding Sources	Waste-water	Urban	Agricultural	Septic	Forest
Clean Water State Revolving Fund Program	•	•	•	•	•
Financial Assistance Branch of DNREC	•	•	•	•	•
The Delaware Nonpoint Source Program		•	•	•	•
Resource Conservation and Development Fund		•			
State of Delaware Conservation Cost Share Program			•		
Delaware Conservation Reserve and Enhancement Program (CREP)			•		•
Delaware Nutrient Relocation			•		
Delaware Confined Animal Feeding Operations (CAFO)			•		
New Castle Conservation District Cost-Share Program			•		•
Delaware Nutrient Management Programs			•		
Federal USDA/NRCS Technical Assistance and Cost share programs					
Chesapeake Bay Watershed Initiative (CBWI)			•		•
Agricultural Management Assistance Program (AMA)			•		•
Wetland Reserve Program (WRP)			•		•
Wildlife Habitat Incentives Program (WHIP)			•		•
Environmental Quality Incentives Program (EQIP)			•		•
Conservation Reserve Program (CRP) – USDA and FSA			•		•

Two programs are noted here in more detail. The USDA/NRCS Chesapeake Bay Watershed Initiative (CBWI) through funding from the Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill) authorized the initiative and provided $23 million in 2009. Congress authorized additional funding levels of: $43 million in 2010; $72 million in 2011; and $50 million in 2012. The initiative is delivered through the Environmental Quality Incentives Program (EQIP). The Farm Bill is currently up for reauthorization.

The New Castle Conservation District (NCCD) Cost-Share Program provides cost-share funding, technical assistance, and outreach/educational services. The Cost-Share Program assists landowners and land managers to design and install site-specific conservation practices, for those agricultural BMP types approved by the NCCD's Board of Supervisors, on their property within New Castle County. The cost-share rates and limitations vary according to the practice; however cost-share rates range from 30-75%.

7 Public Participation / Education (e)

Delaware's Phase II WIP describes in great detail the outreach and education components that were employed for both Phases of the WIP development process, and provides recommended outreach strategies. The outreach completed to date as part of the WIP process is summarized here, with the most relevant outreach and education strategies to the Upper Chesapeake. Aside from the Sassafras River, portions of the planning unit are relatively small in Delaware, and somewhat disconnected (Elk Creek, Perch Creek) from larger watersheds with active volunteer organizations, therefore the most useful strategies for the Upper Chesapeake as a whole will likely include partners and programs that operate statewide and with a broad focus.

The Sassafras River Association (SRA) and Sassafras RIVERKEEPER® are quite active with full time staff, board members and an active membership. The SRA and RIVERKEEPER® have public outreach campaigns in place including an Agricultural Outreach program, a Residential/Homeowner Outreach program, Responsible Recreation Outreach, Youth Outreach, and holds educational forums. The groups are active in the community and will be the best first resource to implement public outreach and engagement campaigns in the Upper Chesapeake Bay.

In December 2010, the WIP Communications Team (WIPCT) was formed and membership was expanded from an informal team composed of staff from DNREC, DDA, and the USDA Delaware Office to include communications professionals from DNREC's Office of Planning, the Delaware Department of Transportation, and partner organizations – the Delaware Nature Society, Nanticoke Watershed Alliance, and the Delaware Home Builders Association. The goal was to communicate WIP efforts and develop communications and outreach materials.

The Team's role and responsibilities include:

- Develop key messages and education/outreach materials
- Support the education and outreach efforts of the WIP Subcommittees
- Develop a communications strategy and plan with measurable outcomes, focusing on the Delaware waterways of the Chesapeake watershed (and applicable to all of Delaware).
- Develop a watershed wide outreach program that encourages and inspires individuals to take actions for cleaner water.
- Maintain the flow of information and provide liaison between: Federal and state agencies; state and local governments; stakeholder groups; media outlets; collaborating agencies and organizations; and the general public.
- Strengthen and/or create partnerships with other agencies/stakeholders, public and private, and solicit Delaware volunteers from these partnerships (DWIC, 2012).

Public outreach during the development of the Phase I WIP included public meetings, forums and presentations with stakeholders and general public given opportunities to ask questions and voice concerns both during the meeting and following the meeting by submitting questions in writing. Forums and venues for the meetings included Town meetings (e.g. Blades, Dover, Seaford, Georgetown, Bridgetown), Conservation District Board meetings, the Positive Growth Alliance Board in Lewes, and the Nanticoke Tributary Action Team. Perhaps the most geographically relevant to the current planning unit was a presentation to the Upper Chesapeake Tributary Team.

Outreach and education components continued during the Phase II WIP development, including preparation of fact sheet, brochures, posters, and frequently asked questions covering a wide range of WIP, water quality, and agricultural based topics. Press releases supplemented the outreach materials covering topics such as grant funding, CAFOs, stormwater regulations, and general water quality information. Public forums and workshops were held in addition to a full suite of special events aimed at raising general awareness, distributing rain barrels, providing information sharing and training among agencies and professionals, and reaching out to the agricultural community.

The DWIC identified many partners to assist in public participation and educational campaigns. The opportunities most relevant to the Upper Chesapeake are outlined here. The Delaware Nature Society (DNS) is the pre-eminent non-profit environmental organization in the state. DNS is unique in the way it integrates education as a vital element in its role in preservation, conservation and advocacy. Currently thousands of members support this important work and/or participate in programs, while more than 1,000 volunteers assist the 32 member core staff and interns.

The DNS has extensive experience with education and outreach efforts, which will help inform residents, businesses and visitors of actions that they can take to improve water quality. While the focus of the DNS as reported in the Phase II WIP is on the Nanticoke Watershed, the statewide reach of the group makes it an attractive partner for Upper Chesapeake programs. The DNS conducted a “Choose Clean Water” presentation to 80 attendees at a Middletown Town Council Meeting.

The DNS goals for 2012, included acquiring funding for the “We Choose Clean Water” campaign to:

- Build capacity for building the base of stakeholder support.
- Shape and promote local policy,
- Expand outreach to farmers, homeowners and businesses to increase adoption of best management practices,
- Initiate and actively manage on-the-ground implementation projects.

Additionally the group is expanding the Backyard Habitat ™ certification program in the Chesapeake Bay watershed which will:

- Educate the public about the connection of land use & water quality,
- Teach sustainable gardening practices to homeowners,
- Collect measurable data on nutrient reduction through the certification program.

These programs and others like them could be implemented in the Upper Chesapeake.

In addition to the DNS, the following organizations have been identified for possible partnerships for WIP communications, education and outreach for the Upper Chesapeake.

- Master Gardeners
- Audubon Society
- Students for the Environment
- Delaware civic associations and service clubs in Chesapeake drainage areas:
  - Delaware Home Builders Assoc.
  - Alliance for The Chesapeake Bay, Inc.
  - Sierra Club – Delaware Chapter Coalition for Natural Stream Valleys, Inc.
  - Sassafras River Association
  - Chesapeake Bay Foundation
  - Chesapeake Bay Trust
  - Delmarva Poultry Industry
  - Delmarva Power
  - Delaware Electric Cooperative
  - Delaware Farm Bureau
  - Nature Conservancy
  - AgroLab, Inc.
  - University of Delaware

- Delaware State University
- Delaware Technical and Community College

The Communications Subcommittee developed a Communications and Marketing Plan and initiated the Communications and marketing campaign in 2012. The goals of the campaign are to (1) to increase understanding by stakeholders and the general public of the need, value and regulatory elements of the WIP and (2) to increase voluntary changes in behavior that will support the overall plan goals. The Upper Chesapeake area can tap into this resource and adapt programs and messaging as needed to reach out the general public, farmers, developers, policy-makers, legislators (local and national), businesses, educators, environmental groups, and non-profits.

The Communications and Marketing Campaign is seeking to include new messaging that will emphasize:

- Individual responsibility to improve water quality with targeting messaging
  - Responsibility relating to pesticide/fertilizer use
  - Responsibility relating to headwater forested areas

- Individual voluntary actions that will improve water quality in the watershed:
  - Installing Rain Gardens
  - Installing rain barrels
  - Creating permeable surfaces
  - Testing lawn chemistry and reducing lawn fertilizer. Pesticides
  - Switching grass lawns to Xeriscaping
  - Planting riparian buffers

Refer to Appendix A for a list of WIP communications updates as of March 1, 2012.

8 Implementation Schedule and Milestones (f & g)

This section presents the target loads and the activities required to achieve those targets based on 2-year milestones, and the 2017 and 2025 interim and final loads and implementation targets. The following schedule and milestones are approved by the CBP.

8.1 Loading Allocations and Milestone Targets

The timeline for meeting the goals and commitments of the Bay TMDL include reductions to meet interim and final loads in 2017 and 2025 respectively. The loading targets for nitrogen, phosphorus, and sediment for Delaware (DWIC, 2012) are presented here in Table 16.

Table 16: Interim and Final Nutrient / Sediment Loads from Delaware (Phase II WIP Planning Targets)

	Nitrogen Load (lbs/yr)	Phosphorus Load (lbs/yr)	Sediment Load (lbs/yr)
2009 Load	4,474,253	345,140	98,946,818
2017 Interim Load (60% of 2025 load)	3,824,331	304,155	99,455,089
2025 Final Load	3,391,050	276,832	99,793,936
Percent Reduction between 2009 and 2025	24%	20%	-1%

The loads were then allocated across each of the contributing source sectors, including agriculture, wastewater, stormwater, septic, forest, non-tidal water deposition.

In the wastewater sector, no municipal or industrial wastewater facilities occur in the Upper Chesapeake planning unit. Likewise sectors and sources such as CAFOs do not exist in the Upper Chesapeake, and resource extraction has not been considered a significant source in Delaware.

For the stormwater sector, Delaware has combined the urban/suburban lands and the associated stormwater sources including construction, post-construction, MS4, and industrial discharges. The compilation of these regulated stormwater discharges per each of the Upper Chesapeake's land river segments is included in Table 17.

Table 17: Aggregate Wasteload Allocations for Regulated Stormwater (delivered loads)

Watershed	Total Nitrogen WLA (lbs/yr)	Total Phosphorus WLA (lbs/yr)	Total Suspended Solids WLA (lbs/yr)
Elk River	2,193	317	31,854
C&D Canal	21,214	3,220	477,041
Bohemia River	5,059	807	65,521
Sassafras River	266	42	5,525
Total	28,732	4,386	579,941

Load allocations per source sector for nitrogen, phosphorus, and sediment are presented in Table 18, Table 19, and Table 20 (DWIC, 2012). The loads were determined through the EPA-CBP Watershed Model Phase 5.3.2 with best management practice implementation scenarios that are expected to occur by 2025.

Table 18: Nitrogen Load Allocations (lbs/yr) (delivered loads)

Watershed	Agriculture	Unregulated Stormwater	Septic	Forest	Non-Tidal Water Deposition	Total
Elk River	1,851	-	4,612	1,849	-	8,312
C&D Canal	28,485	-	15,392	8,080	900	52,858
Bohemia River	22,771	-	4,200	3,949	150	31,069
Sassafras River	19,300	-	1,365	5,193	9	25,867
Total	72,407	-	25,569	19,071	1,059	118,106

Table 19: Phosphorus Load Allocations (lbs/yr) (delivered loads)

Watershed	Agriculture	Unregulated Stormwater	Septic	Forest	Non-Tidal Water Deposition	Total
Elk River	315	-	-	126	-	441
C&D Canal	4,852	-	-	531	52	5,456
Bohemia River	3,857	-	-	269	9	4,134
Sassafras River	3,275	-	-	354	1	3,629
Total	12,299	-	-	1,280	62	13,660

Table 20: Sediment Load Allocations (lbs/yr) (delivered loads)

Watershed	Agriculture	Unregulated Stormwater	Septic	Forest	Non-Tidal Water Deposition	Total
Elk River	51,700	-	-	12,685	-	64,385
C&D Canal	1,162,604	-	-	77,230	-	1,239,835
Bohemia River	493,334	-	-	21,327	-	514,661
Sassafras River	602,721	-	-	39,950	-	642,671
Total	2,310,359	-	-	151,192	-	2,461,552

The Phase II WIP outlined interim load reductions for 2-year milestones beginning in 2011 on a state-wide basis. Milestone values for each sector are not yet determined for 2015, 2019, 2021, and 2013. Total values for those years are interpolated using the assumption that implementation progress will be linear. Statewide milestone loads for nitrogen, phosphorus, and sediment are included here in Table 21, Table 22, and Table 23.

Table 21: Total Nitrogen Two-Year Milestone Loads Statewide (lbs/yr)

TN (lbs/yr)	Waste-water	Agriculture	Urban Runoff	Septic	Forest	Non-Tidal Water Deposition	All Sources
2009[a]	141,000	3,448,962	389,661	154,877	322,148	17,604	4,474,253
2010[a]	53,610	3,400,845	382,215	156,940	320,387	17,604	4,331,600
2011							4,353,096[c]
2013[b]	217,046	3,300,162	371,530	154,622	355,122	17,604	4,396,087
2015							4,128,826[c]
2017[b]	217,046	2,818,916	354,269	120,048	333,680	17,604	3,861,564[d]
2019							3,717,029[c]
2021							3,572,493[c]
2023							3,427,957[c]
2025[b]	217,046	2,277,229	337,009	97,939	336,595	17,604	3,283,422[e]

a–Values based on progress runs.
b–Values based on Phase 2 WIP and Milestone input decks.
c–Interpolated value.
d–Phase 2 WIP Target of 3,824,331
e–Phase 2 WIP Target of 3,391,050

Table 22: Total Phosphorus Two-Year Milestone Loads Statewide (lbs/yr)

TP (lbs/yr)	Waste-water	Agriculture	Urban Runoff	Septic	Forest	Non-Tidal Water Deposition	All Sources
2009[a]	5,530	310,639	20,868	0	7,411	692	345,140
2010[a]	5,571	300,333	20,878	0	7,381	692	334,854

TP (lbs/yr)	Waste-water	Agriculture	Urban Runoff	Septic	Forest	Non-Tidal Water Deposition	All Sources
2011							325,462[c]
2013[b]	10,997	267,597	19,677	0	7,714	692	306,677
2015							287,437[c]
2017[b]	10,997	229,880	18,957	0	7,671	692	268,198[d]
2019							260,101[c]
2021							252,004[c]
2023							243,907[c]
2025[b]	10,997	198,159	18,238	0	7,724	692	235,810[e]

a–Values based on progress runs.
b–Values based on Phase 2 WIP and Milestone input decks.
c–Interpolated value.
d–Phase 2 WIP Target of 304,155
e–Phase 2 WIP Target of 276,832

Table 23: Total Suspended Solids Two-Year Milestone Loads Statewide (lbs/yr)

TSS (lbs/yr)	Waste-water	Agriculture	Urban Runoff	Septic	Forest	Non-Tidal Water Deposition	All Sources
2009[a]	202,599	63,944,699	28,844,315	0	5,955,244	0	98,946,818
2010[a]	25,920	60,201,715	30,558,647	0	5,892,496	0	96,678,778
2011							91,152,326[c]
2013[b]	869,917	44,990,117	27,682,062	0	6,557,326	0	80,099,422
2015							77,978,076[c]
2017[b]	869,917	41,234,173	27,505,829	0	6,246,811	0	75,856,730[d]
2019							74,847,825[c]
2021							73,838,921[c]
2023							72,830,016[c]
2025[b]	869,917	37,365,581	27,329,592	0	6,256,020	0	72,821,111[e]

a–Values based on progress runs.
b–Values based on Phase 2 WIP and Milestone input decks.
c–Interpolated value.
d–Phase 2 WIP Target of 99,455,089
e–Phase 2 WIP Target of 99,793,936

Milestone loads for 2013 for each Upper Chesapeake watershed are available and are presented in Table 24 below. Milestones for 2015 will be developed in late 2013 and early 2014.

Table 24: 2013 Upper Chesapeake Milestones Loads (lbs/yr) (delivered loads)

Watershed	Nitrogen	Phosphorus	Suspended Solids
Elk River	13,320	589	121,574
C&D Canal	103,426	6,109	1,630,819

Watershed	Nitrogen	Phosphorus	Suspended Solids
Bohemia River	48,991	3,617	474,568
Sassafras River	35,016	2,660	490,793
Total	200,753	12,975	2,717,754

8.2 Implementation Milestones

To meet the loading allocations and milestones outlined in the previous section, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 25 details the implementation for each tracked BMP, segregated by urban and agricultural type with the associated unit of measure. The 2012 data reflects existing BMPs while the 2013 milestone data presents the planned levels of implementation as of 2013, as developed in 2011. The 2017 and 2025 values reflect the planned implementation for those years as of the 2010 Bay TMDL WIP.

Table 25: Upper Chesapeake Planning Milestones for Implementation

BMP	Unit	2012 Implementation	2013 Milestone	2017 Planned	2025 Planned
Urban					
Bioretention with underdrains	acres	29.4	1.5	1.5	1.5
Bioswales	acres	165.9	0.1	0.1	0.1
Erosion and sediment control	acres	na	187.4	187.4	201.7
Extended detention dry ponds	acres	119.1	111.8	111.8	121.1
Filtering practices	acres	197.9	174.5	174.4	188.9
Infiltration	acres	27.3	0.04	0.04	0.05
Nutrient management	acres	298.2	1,120.6	3,361.8	6,063.7
Street sweeping	acres	na	69.5	208.4	377.7
Tree planting	acres	95.0	99.0	99.0	99.0
Wet ponds or wetlands	acres	630.3	493.3	493.3	532.2
Agricultural					
Alternative crops	acres	0	12.2	35.0	56.8
Animal Waste Management Systems	Animal units	11.2	0.0	0.0	0.0
Barnyard Runoff Control	acres	0.3	1.8	5.3	9.0
Conservation tillage	acres	3,152.9	5,547.3	5,399.5	5,407.1
Continuous No-till	acres	0	6.7	7.6	8.7
Cover Crops-all types	acres	4,719.0	927.9	1,623.8	3,056.0
Crop irrigation management	acres	0	2,910.8	4,075.1	5,352.8
Decision Agriculture	acres	0	13,804.4	13,166.2	12,796.0
Forest Buffers	acres	0	942.7	1,510.4	303.3

BMP	Unit	2012 Implementation	2013 Milestone	2017 Planned	2025 Planned
Grass Buffers	acres	9.2	446.8	1,380.2	337.7
Land Retire to hay without nutrients	acres	68.0	567.6	567.6	579.9
Land Retirement to pasture	acres	0	8.4	15.7	28.6
Mortality Composting	Animal units	147.9	0.0	0.0	0.0
Nutrient Management *	acres	7,466.2	464.1	451.3	452.4
Off stream watering without fencing	acres	31.3	6.1	18.2	26.8
Poultry Phytase	Animal units	126.9	Full imple-mentation	Full imple-mentation	Full imple-mentation
Soil conservation & water quality plans	acres	55.1	8,512.5	8,320.7	8,304.8
Stream Restoration	feet	0	534.8	1,604.4	2,731.9
Tree Planting	acres	0	7.9	23.6	40.2
Upland precision intensive rotational grazing	acres	0	22.1	58.5	93.6
Water Control Structures	acres	0	70.5	97.8	156.2
Wetland Restoration	acres	744.7	96.1	289.9	494.1
Forest					
Forest Harvest BML		68	12.5	50.4	174

*Nutrient management has historically been reported at 100% in DE. DE is working through a process of adapting their tracking to more accurately reflect implementation. Therefore, a reduction from 2012 represents only a correction in data.

8.3 Implementation Priorities

To meet the loading allocations and milestones outlined in the previous sections, implementation should be prioritized based on current 303(d) listings (i.e., categories 4a and 5) with highest priority given to listed segments located in headwaters. Impairments to headwater streams are carried and experienced downstream; therefore, improvements made to headwater streams will maximize the length of implementation impacts.

Stream segments that should be prioritized for implementation within the Upper Chesapeake watersheds include the following (DNREC, 2010):

- Tributaries of Elk River
    - First eastern tributary after the headwaters of Great Bohemia Creek
    - Easter tributary of the headwaters of Back Creek to its confluence
- Tributaries of Sassafras River
    - Western tributary of the headwaters of Sassafras River to its confluence
    - From the confluence of the headwaters of Sassafras River to the next larger stream order

- Tributaries of C&D Canal
  - Scott Run from the headwaters to the confluence with the C&D canal
  - Crystal Run from the headwaters to the confluence with the C&D canal
  - Joy Run from the headwaters to the confluence with the C&D canal
  - Eastern tributary on Lums pond from the headwaters to the confluence with Lums Pond

9 Load Reduction Evaluation Criteria (h)

Progress evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

Implementation will be measured by determining whether the targets for implementation shown in Table 25 are being met in according to the milestone schedule presented. For both urban and agricultural BMPs, the Watershed Assessment Section of DNREC currently collects this information annually.

Load reductions for the Upper Chesapeake Bay watersheds are estimated annually by the Chesapeake Bay Program using the Phase 5.3.2 Watershed Model. Updates are based on the information provided by DNREC described above. For purposes of comparison with TMDL target milestones, this is the most consistent method of estimating reductions, as the same model and input data are used. As an alternative for more frequent tracking, DNREC has the ability to generate loads and load reductions through the CAST.

Overall program success will be evaluated using trends identified through the long term monitoring program described below in Section 10.

TMDL compliance status will be evaluated to determine if the Watershed Management Plan needs to be updated. If the WLAs are revised during assessment of the overall Bay Program TMDL, the plan will be reevaluated and updated accordingly. If it is found during the evaluation of BMP implementation and load reductions that the milestone targets are not being met, a revision of the plan may be necessary.

Adaptive management is a critical component of achieving the Bay TMDL and this Watershed Management plan. The two-year milestones provide interim planning targets. These are reevaluated against progress and revised to ensure that Delaware is on track to meet its goals. Progress is evaluated on an annual basis through the Chesapeake Bay Program annual review. All BMPs implemented everywhere by all people are tracked and reported. The Chesapeake Bay Program provides loads for each watershed to assess how much progress is made annually. This information is used to modify the milestones. There also is a mid-point assessment scheduled for 2017. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated by the Chesapeake Bay Program Partnership. The milestones, progress, mid-point assessment and annual progress review all contribute to constant reassessment of management plans, and adapting responses accordingly. Coordination and participation with the Chesapeake Bay Program Partnership is a priority for Delaware. Delaware has members who currently serve as the lead on an expert panel evaluating poultry litter, chair of the Water Quality Goal Implementation Team, and are represented on at least 10 other workgroups, at last count. This participation is critical to Delaware because it is the work of the Bay Program that provides the resources for projecting loads under different management actions and the coordination of science that supports the management decisions critical to reducing nitrogen, phosphorus and sediment pollution.

10 Monitoring (i)

A robust and comprehensive monitoring program will be necessary to document that implemented strategies are having the desired effect and that water quality goals are being met. Water quality monitoring has provided evidence of changes in water quality and necessary data to develop models and TMDLs to meet the Clean Water Act goals for restoring the physical, chemical, and biological properties of the Delaware's waters. Monitoring will be needed to document changes as the Delaware and Chesapeake Bay TMDLs are implemented.

Delaware's Surface Water Quality Monitoring Program (DNREC, 2012) is the primary program to be used in monitoring TMDL compliance. The program is used to calculate annual loads and determine water quality trends over time in major water bodies. Delaware follows a five-year rotating basin scheme to monitor all surface waters of the State. During every five-year cycle, each watershed within the State is monitored monthly for two years and every other month for the remaining three years.

As DNREC's 2012 statewide monitoring plan states, because monitoring budgets are limited, the numbers and locations of monitoring sites are being prioritized based on critical needs. Sites retained from previous years, or added as funding becomes available, fall into two categories:

- C1 – high priority monthly stations co-located with USGS gages for loading analysis and long term trends, generally positioned stations at the mouth of a tidal river
- C2 – stations monitored monthly or bi-monthly on a five-year rotating basis.

Surface waters of the State, including waters within the Chesapeake Bay Drainage, are monitored for a suite of 24 parameters including nutrients, chlorophyll a, turbidity, bacteria, organics, pH, dissolved oxygen, etc. It is estimated that water quality monitoring costs for the Chesapeake basin be about $110,000 for fiscal year 2011. For fiscal years 2012, 2013, and 2014 when monitoring frequency for most stations are reduced to every other month, the monitoring cost is estimated to be about $60,000. These estimates exclude monitoring for metals that occurs at some stations in the basin and also exclude quality control sampling and other monitoring plans and programs.

Analytical results from the stations are promptly published in the EPA STORET system and are available as part of the STORET network. More details for the Surface Water Quality Monitoring Plan (SWQMP) are available on DNREC's website.

Citizen monitoring, as reported in the Phase II WIP is conducted by the DNS and the Nanticoke Watershed Alliance, however no programs specific to the Upper Chesapeake are mentioned. The Sassafras River Association (SRA) runs a 'Sassafras Samplers' program, monitoring both tidal and non-tidal waters. Monitoring in the Sassafras for the Bay TMDL should be coordinated with the SRA.

Chesapeake Bay drainage was monitored as part of the five-year rotating basin program in 2010 and 2011 and will be sampled again in 2015 and 2016. Monitoring to develop annual loads to track changes over time will involve establishing C1 type sites in the Upper Chesapeake. There is an added complexity to monitoring these subwatersheds due to the MD and DE state border and the position of Delaware's drainage. The tidal receiving waters are located in Maryland, leaving no USGS gaging stations within the Delaware portion of the watershed on the smaller tributaries.

From a practical standpoint is not feasible nor is it necessary to monitor each BMP or each subwatershed individually. DNREC will establish monitoring stations in representative areas to monitoring and demonstrate the effectiveness of management measures. As funding becomes available, DNREC will establish 2-3 monitoring stations on freshwater tributaries located downstream of areas with varying levels of planned implementation in the Upper Chesapeake subwatersheds, In this manner DNREC can track loading reductions over time that can be attributed to changes in the upstream condition. Data from these stations will also be used to further calibrate and verify water quality models which will allow for further extrapolation of the results to other portions of the Bay drainage.

DNREC can also work with neighboring downstream monitoring programs in Maryland through Maryland Department of the Environment and the Maryland Department of Natural Resources. Maryland's monitoring in the Elk, Bohemia, and Sassafras will be relevant to the Upper Chesapeake at the major water body scale.

11 References

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Appendix A: WIP Communications – 2013

WIP Communications Updates as of 3/1/12

Videos

- Water Quality Monitoring on the Nanticoke (Reach: 187 and counting)
- Septics 101 (Reach: 134 and counting)
- Managing Stormwater: Roads to Rivers (Reach: 78 and counting)
- Explore Your Nanticoke (Reach: 216 and counting)
- Monitoring the Murderkill with UD DNREC and Kent County Wastewater Treatment Facility (Reach: 283 and counting)
- Certified Wildlife Habitats (Reach: 338 and counting)
- Seaford Schoolyard Habitats (Reach: 438 and counting)
- What's a septic system got to do with it? (Currently shooting)

Social Media

- New Delaware Watersheds Facebook Account
- New Delaware Watersheds Twitter Account
- New Delaware Watersheds Quarterly Newsletter
- Email Blasts
- Social Media Releases
- New Social Media monthly promotion (Rain Barrel Giveaway)
- Race for Our Rivers Facebook page for event that DNREC will now be organizing

Events, Presentations and Demonstrations

- 2012 DOWRA's Annual Conference. Presentation on Septic Rehabilitation Loan Program (Reach: 300)
- 2012 Nanticoke Riverfest exhibit and demonstrations (Reach: 60)
- 2012 Ellendale Family Fun Day (Reach: 53)
- 2012 Coast Day (Reach: 1750)
- 2012 Delmarva Chicken Festival (Reach: 60)
- 2012 Delaware State Fair exhibit and demonstrations (Reach: 25,000)
- 2012 Event to highlight funds received by Greenwood, Bethel and Laurel from the National Fish and Wildlife Foundation for WIP related projects (Reach: 40)
- 2013 Nanticoke Riverfest exhibit and demonstrations (Reach: 200)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in New Castle (Reach: 90)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in Harrington (Reach: 90)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in Lewis (Reach: 90)
- 2013 Earth Day at R&R outreach event and rain barrel sale/presenting pledge campaign (Reach: 55)

- 2013 Nanticoke River Park Festival: Demonstrations on how to reduce stormwater runoff by building rain barrels, planting rain gardens, using pervious surfaces, creating certified wildlife habitats, etc. (Reach: 65)
- 2013 Delaware State Fair exhibit and demonstrations (Reach: 25,000)

Workshops

- 2012 Kickoff of event/Workshop for Septic Rehabilitation outreach initiative. (Reach: 60)
- 2012 Septic Rehabilitation Loan Program Workshop at Coverdale Community Center in Bridgeville, DE (Reach: 24)
- 2012 Septic Rehabilitation Loan Program Workshop at Coverdale Community Center at Mt Joy Civic Association in Millsboro. (Reach: 22)
- 2012 Presentation to DOWRA's planning committee (Reach: 31)
- 2013 Presented information at a Nanticoke Watershed Alliance “Homeowners workshop” on DNREC’s Septic Rehabilitation Loan Program and other efforts individuals can take to help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 25)
- 2013 Nanticoke Watershed Alliance Rain Barrel Workshop: Presented information on DNREC’s pledge campaign- Individuals pledge to take specific efforts to help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 29)
- 2013 Nanticoke Rotary Club: Presented information on DNREC’s video series as a resource for individuals looking for information pertaining to efforts that help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 24)
- 2013 Local Govt. Workshop- Delaware’s Chesapeake Bay Communities: Action Today for Tomorrow’s Healthy Water: Topics include funding mechanisms for local governments; sources of grant funding; matching your project concept to potential funding sources; conceiving, organizing, and costing a project; grant writing tips. (Reach: 75)
- 2013 Sussex County Strong Communities Initiative Meeting: Presented information on DNREC’s “Rain Barrel Building Workshop” opportunities and other information on reducing stormwater runoff. (Reach: 27)

Promotional Materials

- 2012 Septic Rehabilitation loan program large display
- 2012 Septic Rehabilitation loan program mini display
- 2012 Septic Rehabilitation Loan Program brochure
- 2012 Septic Rehabilitation Loan Program lawn signs
- 2013 New WIP Messaging Branding Strategy developed: Delaware Watersheds brand and logo - to be used on new promotional materials and social media accounts, and for events.
- 2013 New homewoners brochure: An invitation to a healthy home and yard
- 2013 New mini display: An invitation to a healthy home and yard

Advertising

- 2012 radio advertising campaign for the Septic Rehabilitation Loan Program on WDSD 94.7
- 2012 Printed advertising campaign for the Septic Rehabilitation Loan Program: The Guide
- 2012 Printed advertising campaign for the Septic Rehabilitation Loan Program: Placemat advertising.
- 2013 Raido advertising for Septic Rehabilitation Loan Program: WDSD 94.7
- 2013 radio advertising for Septic Rehabilitation Loan Program: WXDE 105.9

WIP Committee/Subcommittee Meetings

- WIP Implementation team meets quarterly
- A WIP Communications Subcommittee meets quarterly with new partners being encouraged to attend and strengthening existing partnerships with groups such as the Nanticoke Watershed Alliance, the Delaware Nature Society, DelDot, USDA, DE Forestry and DOA. The subcommittee is working to develop new branding strategies including a WIP mascot and slogan.
- Bi-weekly Chesapeake Bay staff meetings
- Monthly Chesapeake Bay Program Communications Workgroup meetings

Websites

- 2012 New webpage has been made to be used as an area where individuals, agriculture, businesses and organizations can find resources of information, support, and guidance for reducing nutrient and sediment pollution.
- New homepage for Watershed Stewardship (Release TBD)
- New webpage for Wetland Advisory Committee (Release TBD)
- 2013 Updates to Delaware Watersheds website
- 2013 Updates to partnering Delaware Invasive Species Council website
- 2013 Updates to Watershed Assessment and Management website

Television/Radio Interviews

- 2012 Interview by 94.7 WDSD: promotion of The Septic Rehabilitation Loan program (Reach: Delaware)
- 2013 Featured on WBOC TV's Delmarva Life discussing how individuals can help protect Delaware's waterways that lead to the Chesapeake Bay (Reach: Delmarva)
- 2013 DNREC Earth Day Event: Presented information to WBOC TV on DNREC's Septic Rehabilitation Loan Program, rain barrels, rain gardens, and other efforts individuals can take to help reduce nutrient and sediment pollution entering Delaware's waterways. (Reach: Delmarva)

Databases

- A database of available funding resources and sources for which various publics can apply has been compiled. The list is being updated continuously and will is available online and used in marketing materials and presentations.
- A database of brochures pamphlets and videos has been created, and a new webpage has been made to be used as an area where individuals, agriculture, businesses and organizations can find resources of information, support, and guidance for reducing nutrient and sediment pollution.

Pledge Campaign

- 180 pledges collected at events throughout the Chesapeake Bay Watershed
- Approximately 1,700 pledges collected at the 2013 Delaware State Fair

BMP Displays in Home Improvement stores

- How to build a rain barrel out of simple supplies from your local hardware store

Appendix B: State of Delaware Ambient Surface Water Quality Monitoring Program – FY 2012

State of Delaware Ambient Surface Water Quality Monitoring Program - FY 2012

Department of Natural Resources and Environmental Control Watershed Assessment Branch

Executive Summary

Delaware's Surface Water Quality Monitoring Program for Fiscal Year 2012 is described in this report. Delaware maintains a General Assessment Monitoring Network (GAMN) of 134 stations. GAMN stations are considered long term stations whose data is used to do long term status and trend assessments of water quality conditions or the State's surface waters and support compilation of Watershed Assessment Reports as mandated by the Clean Water Act under section 305(b). This plan implements an updated monitoring strategy that monitors 23 stations monthly, and the remaining stations either 6 or 12 times a year on a rotating basin basis. Some stations in selected watersheds are monitored for the dissolved forms of key metals in the water column.

Ambient Surface Water Quality Monitoring Program - FY 2012

The purpose of the Ambient Surface Water Quality Monitoring Program is to collect data on the chemical, physical and biological characteristics of Delaware's surface waters. The information that is collected under this Program is used to:

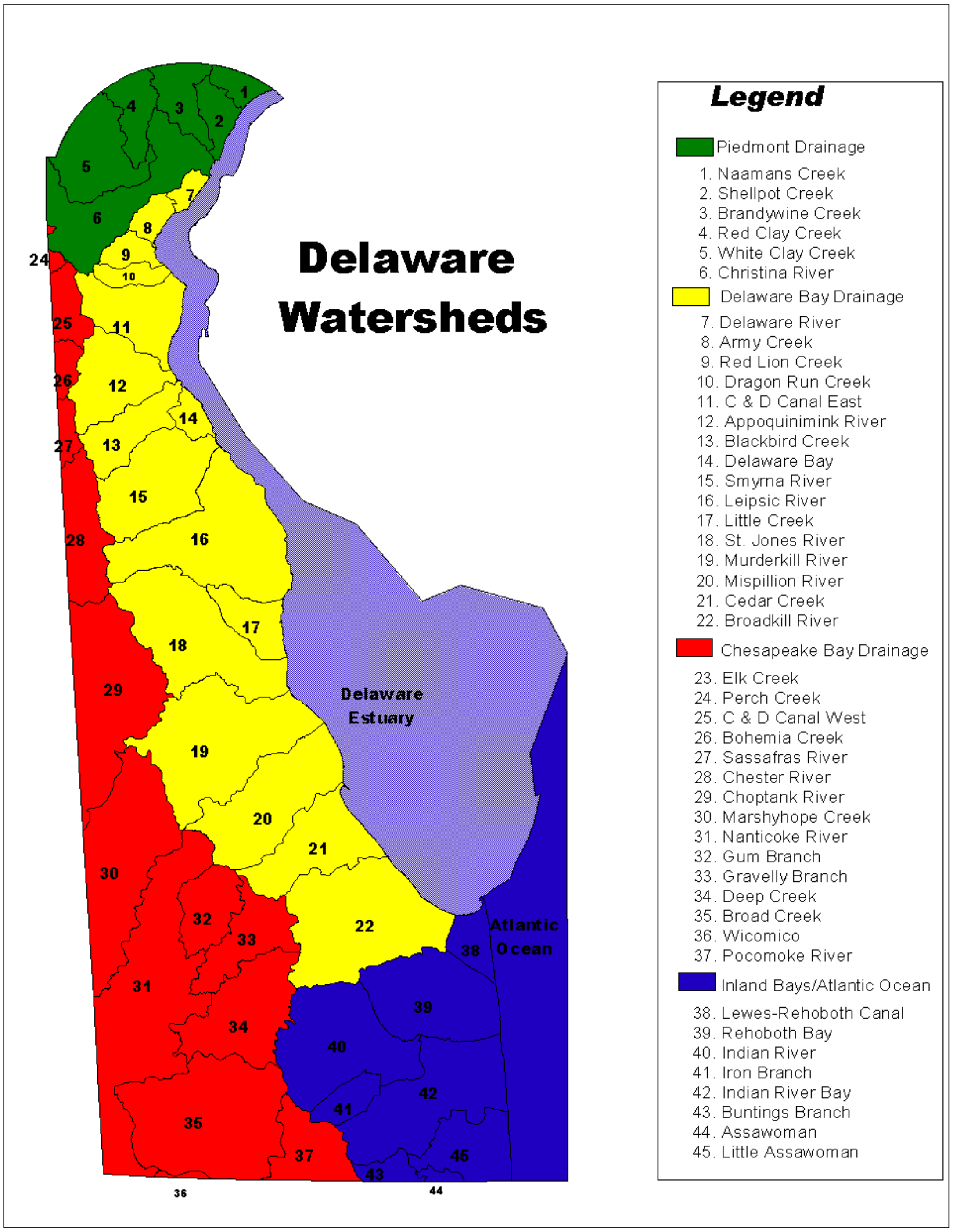
- Describe general surface water quality conditions in the State;
- Identify long term trends in surface water quality;
- Determine the suitability of Delaware surface waters for water supply, recreation, fish and aquatic life, and other uses;
- Monitor achievement of Surface Water Quality Standards;
- Identify and prioritize high quality and degraded surface waters;
- Calculate annual nutrient loads and track progress toward achieving Total Maximum Daily Loads (TMDLs) targets; and
- Evaluate the overall success of Delaware's water quality management efforts.

There are four major components to Delaware's Surface Water Quality Monitoring Program:

- General Assessment Monitoring
- Biological Assessment Monitoring
- Toxics in Biota Monitoring
- Toxics in Sediment Monitoring

This report discusses the General Assessment Monitoring and Biological Assessment Monitoring. Current Toxics in Biota and Sediment Monitoring plans are available on request.

Figure 1. State of Delaware Basins



Part I The General Assessment Monitoring Network (GAMN)

The General Assessment Monitoring Network (GAMN) provides for routine water quality monitoring of surface waters throughout Delaware. Each station is monitored for conventional parameters such as nutrients, bacteria, dissolved oxygen, pH, alkalinity, and hardness. Some stations are monitored for dissolved metals. See tables 2 and 3 for parameters and methods. See Appendix A for a sampling schedule and estimated costs for the surface water component. The data from this monitoring is entered into the STORET database, is reviewed and then analyzed in assessing the water quality of each basin for the Watershed Assessment Report (CWA Section 305 (b) Report). The Department anticipates co-operating with EPA in migrating from the STORET platform to the new WQX platform.

The plan provides for monitoring at stations within each watershed in the state. The network was recently reviewed and updated. The review is discussed in section I.1. See also Table 1: FY 2012 Monitoring Plan and Schedule.

I.1 Changes for Surface Water Quality Monitoring Plan

Over the past several years, a main objective of the Watershed Assessment Section's Ambient Surface Water Quality Monitoring Program was to collect water quality data that could be used for developing and calibrating hydrodynamic and water quality models. These models were used to establish Total Maximum Daily Loads (TMDLs) for nutrients and bacteria in impaired waters of the State.

Now, with the establishment of nutrient and bacteria TMDLs for most impaired waters of the State, a major objective of the Ambient Surface Water Quality Monitoring Program is to collect appropriate data that can be used to track water quality changes and to determine if TMDL requirements are being met.

Considering this (and other emerging) needs, and since the Department's monitoring budget is limited, surface water quality monitoring plan has been prepared with the following changes: Monitoring stations in earlier monitoring plans were reviewed to determine which stations were critical to meet data needs and which could be dropped. The retained stations fall into 2 categories;

Stations were assigned to one of the following categories:

a. C1 – Category 1 stations are high priority stations that will be used for calculating annual loads and/or long-term trends. These stations are generally co-located with a USGS stream gaging station, or are located at the mouth of a tidal river. Because of importance of these stations, monitoring at these stations will be conducted monthly, regardless of priority basin schedule (23 stations)
b. C2 – The remaining stations are part of Category 2 stations and monitoring frequency at these stations follow Priority Basin schedule.

2. A Rotating Basin Monitoring Plan is implemented. In this scheme of monitoring, the State is divided into 5 Monitoring Basins. Every year, two of the Basins are considered "Priority Basins" and all stations in a Priority Basin are monitored

monthly. Monitoring frequency for stations in other basins are conducted bimonthly. Priority Basin monthly monitoring will be conducted according to the following schedule:

a. FY 2009 – Lower Delaware River/Bay, Piedmont
b. FY 2010 – Piedmont, Chesapeake
c. FY 2011 – Chesapeake, Inland Bays
d. FY 2012 – Inland Bays, Upper Delaware River/Bay
e. FY 2013 – Upper Delaware, Lower Delaware River/Bay

I.2 Objectives

The objective of this monitoring is to collect water quality data for status and trends assessment on all basins within Delaware. The data will also be compared to water quality standards to assess designated use support, as mandated by Section 305(b) of the Clean Water Act. In addition, the data will be used to calculate annual nutrient loads and to track progress toward achieving TMDL targets.

I.3 Scope of Monitoring

Table 1 provides a listing of all stations to be monitored during FY 2012, and predicted sampling needs for upcoming fiscal years.

Table 2 provides a listing of parameters that will be monitored at all stations in the network. Stations shown for metals testing in Table 1 shall be sampled according to the specifications in Table 3.

Part II Special Project Monitoring

Special project monitoring is needed from time to time in specific watersheds to address specific concerns. These projects are generally short term in nature. The Department is not conducting any special projects during the FY 2012 monitoring year.

II.1 Special Surveys

The purpose of special survey monitoring is to collect data that are not obtained using other monitoring activities and are needed for modeling purposes as described above. Special surveys include deployment of continuous monitors (YSI Data Sondes) and sediment sampling. No special survey sediment sampling is called for in this monitoring year.

II.2 Continuous Monitoring

The Department is implementing a network of continuous water quality monitoring stations to collect data for dissolved oxygen and other parameters several times each day using YSI (or similar) datasondes. The Department is cooperating with Delaware Geological Survey (DGS) and the United States Geological Survey (USGS) in operating a number of continuous monitors in the State. The information from these continuous monitoring sites are available on real-time basis via the USGS website and via the Delaware Environmental Observing System (DEOS) website. The Department had also put into place a special highly sophisticated on-site monitoring station/automated lab device to collect and analyze samples for nutrients and other parameters at the outlet to Millsboro Pond. The data from this station were used to assess nutrient loads leaving the pond and entering the Delaware Inland Bays and thereby monitor TMDL implementation progress. It is planned to move this automatic data analyzer to the Nanticoke River Watershed during FY 2012 and deploy it at the Bridgeville stream flow gaging site.

Boat run surveys

Boat run surveys should be conducted within one day of tributary sampling in the watershed.

Part III Field and Laboratory Procedures

Field procedures for sample collection activities are detailed in the Quality Assurance Management Plan, Environmental Laboratory Section. Method references, STORET codes and reporting levels for parameters listed in Table 2 are from an Access database maintained by the Environmental Laboratory Section. Any deviation from standard field, laboratory procedures, or this sampling plan shall be documented with a complete description of the alteration.

Part IV Quality Assurance, Documentation, Data Usage and Reporting

The quality assurance objectives and quality control procedures for these surveys are documented in the Quality Assurance Management Plan, Environmental Laboratory Section. A duplicate water column sample will be collected and analyzed on 10% of the samples from this project. All analytical results from the duplicate analyses shall be reported with the other data.

All analytical results shall be reported to the Watershed Assessment Section digitally and on paper (using standard Environmental Laboratory Section data report forms).

Table 1 Station Locations, Descriptions Parameters and Sampling Frequency

STATION INFORMATION - FY 2012	***STORET #***	***Cu, Pb & Zn***	***As***	***Fe***	***DIN & DIP***	***Storm Events***	***No. of Samples in 2011***
PIEDMONT DRAINAGE							
Brandywine Creek							
Brandywine Creek @ Foot Bridge in Brandywine Park	104011	✓					6
Brandywine Creek @ New Bridge Rd. (Rd. 279)(USGS gage 01481500)	104021	✓				3 storms	12
Brandywine Creek @ Smith Bridge Rd. (Rd. 221)	104051	✓					6
Christina River							
Christina River beneath Rt. 141 in Newport off Water St.	106021	✓					6
Little Mill Creek @ DuPont Rd.	106281	✓					6
Christina River @ Conrail Bridge (USGS tide gage 01481602)	106291	✓					12
Christina River @ Nottingham Rd. (Rt. 273) above Newark	106191	✓					6
Christina River @ Sunset Lake Rd. (Rt. 72) (USGS 01478000 at Cooches bridge)	106141	✓				3 storms	12
Smalleys Dam Spillway @ Smalleys Dam Rd.	106031	✓					6
Red Clay Creek							
Red Clay Creek @ W. Newport Pike (Rt. 4) Stanton (USGS gage 01480015)	103011	✓					6
Burrough's Run @ Creek Rd. (Rt 82)	103061	✓					6
Red Clay Creek @ Barley Mill Rd. (Rd. 258A) Ashland	103041	✓					6
Red Clay Creek @ Lancaster Pike (Rt. 48) Wooddale (USGS gage 01480000)	103031	✓				3 storms	12
White Clay Creek							
White Clay Creek @ Delaware Park Blvd. (Race Track) (USGS gage 014790000)	105151	✓				3 storms	12
White Clay Creek @ McKees Lane	105171	✓					6
White Clay Creek @ Chambers Rock Rd. (Rd. 329)	105031	✓					6
Naamans Creek							
Naaman Creek @ State Line near Hickman Rd.	101021						6
Naaman Creek @ RR crossing in Steel Plant	101041						6
Naamans Creek at Rt 3 (Marsh Road)	101061						6
Shellpot Creek							
Shellpot Creek @ Hay Rd. (Rd. 501)	102041			✓			6
Rt. 13 Bus (Market Street) Bridge, USGS station is located about 700 ft downstream.	102051					3 storms	12
Shellpot Crk at Carr Road Bridge	102081						6
CHESAPEAKE BAY DRAINAGE							
Chester River							
Sewell Branch @ Sewell Branch Rd. (Rd. 95)	112021						6
Choptank River							
Cow Marsh Creek @ Mahan Corner Rd. (Rd. 208)	207021						6
Tappahanna Ditch @ Sandy Bend Rd. (Rd. 222)	207081						6
Culbreth Marsh Ditch @ Shady Bridge Rd. (Rd. 210)	207091						6
White Marsh Branch @ Cedar Grove Church Rd. (Rd. 268)	207111						6

STATION INFORMATION - FY 2012	***STORET #***	***Cu, Pb & Zn***	***As***	***Fe***	***DIN & DIP***	***Storm Events***	***No. of Samples in 2011***
Marshyhope Creek							
Marshyhope Creek @ Fishers Bridge Rd. (Rd. 308)	302031					8 storms	12
Nanticoke River							
Nanticoke River @ buoy 45 (near state line)	304071	✓					6
Nanticoke River @ buoy 66 (confluence with DuPont Gut)	304151	✓					6
Nanticoke River Tributaries							
Racoon Prong @ Pepperbox Rd. (Rd. 66)	304671	✓					6
Nanticoke River @ Rifle Range Rd. (Rd. 545)	304191	✓				8 storms	12
Concord Pond @ German Rd. (Rd. 516)	304311	✓					6
Williams Pond @ East Poplar St. (across from Hospital)	304321	✓					6
Bucks Branch @ Conrail Rd. (Rd. 546)	304381	✓					6
Nanticoke River @ Rt. 13	304471	✓					6
Records Pond @ Willow St.	307011	✓					6
Horseys Pond @ Sharptown Rd. (Rt. 24)	307171	✓					6
Gravelly Branch @ Coverdale Rd. (Rd. 525)	316011	✓					6
Trap Pond on Hitch Pond Branch @ Co. Rd. 449 or Trap Pond Rd	307081	✓					6
Deep Creek above Concord Pond, near Old Furnace at Rd. 46	304591	✓					6
Gravelly Branch at Deer Forest Road (Rd 565) on west edge of Redden State Forest Jester Tract	316031	✓					6
Broad Creek at Main Street in Bethel (Rd 493)	307031	✓					6
Nanticoke River at Beach HWY (Ellendale Greenwood HWY) on east edge of Greenwood	304681	✓					6
Pocomoke River							
Pocomoke River @ Bethel Rd. (Rd. 419)	313011						6
DELAWARE BAY DRAINAGE							
Appoquinimink River							
Drawyer Creek off DuPont Parkway. (Rt. 13) at parking area	109071	✓					12
Shallcross Lake @ Shallcross Lake Rd. (Rd. 428)	109191	✓					12
Noxontown Pond @ Noxontown Rd. (Rd. 38)	109131	✓					12
Appoquinimink River @ DuPont Prkwy. (Rt. 13)	109041	✓					12
Appoquinimink River @ MOT Gut (west bank)	109171	✓					12
Deep Creek Br of Appoquinimik River at Rt. 71 Bridge (Middletown Natural Area), duplicate with 109081	109251	✓				3 storms	12
Appoquinimink River @ Silver Run Rd. (Rt. 9) NE side	109121	✓					12
Appoquinimink River @ confluence with Delaware River	109091	✓					12
Army Creek							
Army Creek @ River Rd. (Rt. 9)	114011						12
Chesapeake & Delaware Canal							
C & D Canal @ DuPont Pky. (Rt. 13) St. Georges Bridge	108021						12
Lums Pond @ Boat ramp	108111						12
Dragon Run							

STATION INFORMATION - FY 2012	STORET #	Cu, Pb & Zn	As	Fe	DIN & DIP	Storm Events	No. of Samples in 2011
Dragon Creek @ Wrangle Hill Rd. (Rt. 9)	111011						12
Dragon Creek @ S. DuPont Hgwy. (Rt. 13)	111031						12
Red Lion Creek							
Red Lion Creek @ Bear Corbitt Rd. (Rt. 7)	107011						12
Red Lion Creek @ Rt. 9	107031						12
Blackbird Creek							
Blackbird Creek, Road 463 East of RR Tracks. USGS gage	110011					3 storms	12
Blackbird Landing Rd 455	110031						12
Blackbird Creek @ Taylors Bridge Rd. (Rt. 9)	110041						12
Leipsic River							
Garrisons Lake @ DuPont Highway (Rt. 13)	202021						12
Leipsic River @ Denny St. (Rt. 9)	202031						12
Upstream of Masseys Millpond at Rt. 15	202191						12
Little River							
Little River @ Bayside Dr. (Rt.9)	204031						12
Little River @ N. Little Creek Rd. (Rt. 8)	204041						12
Smyrna River							
Mill Creek @ Carter Rd. (Rd. 137)	201021						12
Smyrna River @ Rt. 9 (Flemings Landing)	201041						12
Duck Creek @ Smyrna Landing Rd. (Rd. 485)	201051						12
201011 Mill Creek at Rt. 13	201011						12
Providence Creek @ Duck Creek Rd. (Rt.15)	201161						12
Broadkill River							
Ingram Branch, Savanah Ditch @ Rd. 246	303011						6
Ingram Branch @ Rd. 248	303021						6
Rt. 5 Bridge	303031					3 storms	12
Rt. 1 Bridge (Mainstem)	303041						6
Broadkill River 0.10 Miles From Mouth of Broadkill	303061						12
Red Mill Pond at Rt. 1	303051						6
Beaverdam Creek at Rd. 88	303171						6
Beaverdam Creek above Rd. 259, Hunters Mill Pond	303181						6
Round Pole Branch at Rd. 88	303311						6
Waples Pond at Rt. 1	303331						6
Pemberton Branch at Rt. 30 above Wagamons Pond	303341						6
Cedar Creek							
Swiggetts Pond @ Cedar Creek Rd. (Rt. 30)	301021						6
Cedar Creek @ Coastal Hgwy. (Rt. 1)	301031						6
Cedar Creek @ Cedar Beach Rd. (Rt. 36)	301091						6
Mispillion River							
Mispillion River @ Rt. 1	208021						6
Mispillion River/Cedar Creek confluence @ Lighthouse	208061						12
Mispillion River @ mouth of Fishing Branch	208121						6
Abbotts Pond @ Abbotts Pond Rd. (Rd. 620)	208181						6
Silver Lake @ Maple Ave.	208211						6
Beaverdam Branch @ Deep Grass Ln. (Rd. 384)	208231						6
Delaware Bay							
Roosevelt Inlet, Mouth	401011						6

STATION INFORMATION - FY 2012	STORET #	Cu, Pb & Zn	As	Fe	DIN & DIP	Storm Events	No. of Samples in 2011
Murderkill River							
Murderkill River @ confluence of Black Swamp Creek at Rt. 13	206011	✓				3 storms	12
Browns Branch @ Milford - Harrington Hwy. (Rt. 14)	206041	✓					6
Murderkill River @ Bay Rd. (Rt. 1/113)	206091	✓					6
Murderkill River @ Bowers Beach Wharf (mouth)	206101	✓					12
Murderkill River near levee @ Milford Neck Wildlife Area (3.25 miles from mouth)	206141	✓					6
Murderkill River @ confluence of Kent County WWTF discharge ditch	206231	✓					6
McColley Pond @ Canterbury Rd. (Rt. 15)	206361	✓					6
Coursey Pond @ Canterbury Rd. (Rt. 15)	206451	✓					6
Double Run @ Barretts Chapel Rd. (rd. 371)	206561	✓					6
St. Jones River							
St. Jones River @ Barkers Landing	205041						12
St. Jones River @ Rt. 10	205091						12
Fork Branch @ State College Rd. (Rd. 69)	205151						12
Moores Lake @ S. State St.	205181						12
Silver Lake @ Spillway (Dover City Park)	205191					3 storms	12
St. Jones at Bowers Beach, mouth to Del.Bay.	205011						12
Derby Pond @ Rt. 13A	205211						12
INLAND BAYS DRAINAGE							
Tributary Stations							
Burton Pond @ Rt. 24	308031	✓	✓		✓		12
Millsboro Pond @ Rt. 24	308071	✓	✓		✓	3 storms	12
Pepper Creek @ Rt. 26 (Main St.)	308091	✓	✓		✓		12
Blackwater Creek @ Omar Rd. (Rd. 54)	308361	✓	✓		✓		12
Dirickson Creek @ Old Mill Bridge Rd. (Rd. 381)	310031	✓	✓		✓		12
Bunting Branch							
Buntings Branch @ Rt. 54 (Polly Branch Rd.)	311041	✓	✓		✓		12
Guinea Creek							
Guinea Creek @ Banks Rd. (Rd. 298)	308051	✓	✓		✓		12
Iron Branch							
Whartons Branch @ Rt. 20 (Dagsboro Rd.)	309041	✓	✓		✓		12
Lewes & Rehoboth Canal							
Lewes & Rehoboth Canal @ Rt. 9	305041	✓	✓		✓		12
Little Assawoman Canal							
Little Assawoman Bay @ Rt. 54 (The Ditch)	310011	✓	✓		✓		12
White Creek @ mouth of Assawoman Canal	312011	✓	✓		✓		12
Love Creek							
Bundicks Branch @ Rt. 23	308371	✓	✓		✓		12
Miller Creek							
Beaver Dam Ditch @ Beaver Dam Rd. (Rd. 368)	310121	✓	✓		✓		12
Stockley Branch/Cow Bridge							
Cow Bridge Branch @ Zoar Rd. (Rd. 48)	308281	✓	✓		✓		12
Swan Creek							
Swan Creek @ Mount Joy Rd. (Rd. 297)	308341	✓	✓		✓		12
Vines Creek							
Ocean Boundary Stations							

STATION INFORMATION - FY 2012	***STORET #***	***Cu, Pb & Zn***	***As***	***Fe***	***DIN & DIP***	***Storm Events***	***No. of Samples in 2011***
Lewes & Rehoboth Canal @ Rt. 1	305011	✓	✓		✓		12
Indian River Inlet @ Coast Guard Station	306321	✓	✓		✓		12
Boat Run Stations							
Rehoboth Bay @ Buoy 7	306091	✓	✓		✓		12
Masseys Ditch @ Buoy 17	306111	✓	✓		✓		12
Indian River Bay @ Buoy 20	306121	✓	✓		✓		12
Indian River @ Buoy 49 (Swan Creek)	306181	✓	✓		✓		12
Indian River @ Island Creek	306331	✓	✓		✓		12
Island Creek upper third	306341	✓	✓		✓		12
Little Assawoman Bay Mid-bay (Ocean Park Lane)	310071	✓	✓		✓		12

Table 2 Water Quality Parameters to be analyzed at all Stations in the Monitoring Network, FY 2012

Parameter	***Method Reference (EPA)***	***Reporting Level[1]***
Water Column Nutrients		
Total Phosphorus	EPA365.1 M	0.005 mg/l P
Soluble Ortho-phosphorus	EPA365.1	0.005 mg/l P
Ammonia Nitrogen	EPA350.1	0.005 mg/l N
Nitrite+Nitrate N	EPA353.2	0.005 mg/l N
Total N	SM 4500 NC	0.08 mg/l N
Carbon and Organics		
Total Organic Carbon	EPA415.1	1 mg/l
Dissolved Organic Carbon	EPA415.1	1 mg/l
Chlorophyll-a (Corr)	EPA 445.0	1 µg/l
Biochemical Oxygen Demand		
BOD_5, N-Inhib (CBOD)	SM20thed-5210B	2.4 mg/l
BOD_{20}, N-Inhib (CBOD)	SM20thed-5210B	2.4 mg/l
General		
Dissolved oxygen – Winkler[2]	EPA360.2	0.25 mg/l
Dissolved oxygen – Field	EPA360.1	0.1 mg/l
Total Suspended Solids	EPA160.2	2 mg/l
Alkalinity	EPA310.1	1 mg/l
Hardness	EPA130.2	5 mg/l
Field pH	EPA150.1	0.2 pH units
Conductivity – Field	EPA120.1	1 µS/cm
Salinity	SM20thed-2520B	1 ppt
Temperature	EPA170.1	^{o}C
Secchi Depth[3]	EPA/620/R-01/003	meters
Light Attenuation[4]	EPA/620/R-01/003	%
Turbidity	EPA180.1	1 NTU
Chloride	EPA325.2	1 mg/l
Bacteria		
Enterococcus	SM20thed-9230C	1 cfu/100 ml

[1] As documented in the ELS Quality Assurance Management Plan, the ELS defines the Limit of Quantitation (LOQ) as the lowest standard in the calibration curve or, in instances where a standard curve is not specified by the procedure, LOQ represents the limitations of the method. For those tests where reference spiking material exists, the ELS measures Method Detection Limit (MDL), as defined in the Federal Register 40 CFR Part 136 Appendix B. MDL values are generated or verified once per year. Results less than the MDL are considered to be not detected and "< MDL" is reported. Results greater than the MDL but less than the LOQ are qualified with a J to indicate a result that is extrapolated or estimated. For tests where MDL is not applicable, results less than the LOQ are reported as "< LOQ", ELS MDLs meet or exceed (i.e. are lower than) the reporting level requirements listed in Table 3.

[2] Secchi Depth to be measured at designated stations.

[3] Light attenuation to be conducted as practical to obtain correlation with Secchi disk readings

Table 3 Metals Parameters

Dissolved Metals (dissolved and total)	***Method Reference (EPA)***	***Reporting Level***
Copper	EPA 200.7 M	5.0 ug/l
Lead	EPA 200.7 M	3.0 ug/l
Zinc	EPA 200.7 M	10 ug/l
Iron	EPA 200.7 M	100 ug/l

Appendix A: FY 2012 Surface Water Monitoring Schedule & Cost Estimate

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Brandywine Creek	3		3		3		3		3		3							
	Christina River	6		6		6		6		6		6							
Northern Piedmont	Red Clay Creek	4		4		4		4		4		4		120	$36,480	$7,200	$300	$9,000	$52,980
	White Clay Creek	3		3		3		3		3		3							
	Duplicates + Field Blanks	4		4		4		4		4		4							
UD Farm	University of Delaware Farm	6	6		6	6		6	6		6	6		56	$8,176	$0	$0	$0	$8,176
	Duplicates + Field Blanks	1	1		1	1		1	1		1	1							
	Naaman's Creek	3		3		3		3		3		3							
Northeast Piedmont	Shellpot Creek	3		3		3		3		3		3		48	$14,592	$540	$300	$4,500	$19,932
	Duplicates + Field Blanks	2		2		2		2		2		2							

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
Piedmont Monthly	Piedmont Monthly		6		6		6		6		6		6	48	$14,592	$2,520	$300	$4,500	$21,912
	Duplicates + Field Blanks		2		2		2		2		2		2						
North Delaware Bay Drainage	Army Creek	1	1	1	1	1	1	1	1	1	1	1	1	108	$32,832	$0	$600	$9,000	$42,432
	C & D Canal	2	2	2	2	2	2	2	2	2	2	2	2						
	Dragon Creek	2	2	2	2	2	2	2	2	2	2	2	2						
	Red Lion Creek	2	2	2	2	2	2	2	2	2	2	2	2						
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Appoquinimink River	Appoquinimink	8	8	8	8	8	8	7	7	8	8	8	8	118	$35,872	$7,080	$600	$12,375	$55,927
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Delaware Bay Drainage	Blackbird Creek	3	3	3	3	3	3	3	3	3	3	3	3	180	$54,720	$0	$600	$9,000	$64,320

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Leipsic River	3	3	3	3	3	3	3	3	3	3	3	3						
	Little River	2	2	2	2	2	2	2	2	2	2	2	2						
	Smyrna River	5	5	5	5	5	5	5	5	5	5	5	5						
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
St. Jones River	St. Jones River	7	7	7	7	7	7	7	7	7	7	7	7	108	$32,832	$0	$600	$9,000	$42,432
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Murderkill River	Murderkill								7		9		9	33	$10,032	$1,980	$150	$4,425	$16,587
	Duplicates + Field Blanks								2		3		3						
Murderkill River Profiles	Murderkill		17		17		17							63	$19,152	$3,780	$150	$5,513	$28,595
	Duplicates + Field Blanks		4		4		4												

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
Delaware Bay Monthly	Broadkill River Monthly	2		2		2		2		2		2		42	$12,768	$1,440	$300	$4,500	$19,008
	Mispillion River Monthly	1		1		1		1		1		1							
	Murderkill Monthly	2		2		2		2		2		2							
	Duplicates + Field Blanks	2		2		2		2		2		2							
South Delaware Bay Drainage	Cedar Creek		3		3		3		3		3		3	66	$20,064	$0	$300	$4,500	$24,864
	Mispillion River		6		6		6		6		6		6						
	Duplicates + Field Blanks		2		2		2		2		2		2						
Broadkill River	Broadkill River		11		11		11		11		11		11	78	$23,712	$0	$300	$4,500	$28,512
	Duplicates + Field Blanks		2		2		2		2		2		2						
Inland Bays	Inland Bays	24	24	24	24	24	24	19	19	24	24	24	24	362	$136,648	$26,250	$600	$34,875	$198,373

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Delaware Bay	1		1		1		1		1		1							
	Pocomoke River	1		1		1		1		1		1							
	Duplicates + Field Blanks	6	6	6	6	6	6	6	6	6	6	6	6						
Nanticoke River	Nanticoke River		15		15		15		13		15		15	112	$34,048	$6,720	$300	$10,688	$51,756
	Duplicates + Field Blanks		4		4		4		4		4		4						
Chesapeake Bay Nontidal	Chesapeake Bay Nontidal	2	2	2	2	2	2	2	2	2	2	2	2	48	$14,592	$0	$600	$9,000	$24,192
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Chesapeake Bay Drainage	Chester River		1		1		1		1		1		1	30	$9,120	$0	$300	$4,500	$13,920
	Choptank River		4		4		4		4		4		4						
Chesapeake Bay Nontidal Storm	Storm Sites	2		2	2		2	2		2	2		2	32	$12,256	$0	$400	$6,000	$18,656

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Duplicates + Field Blanks	2		2	2		2	2		2	2		2						
Statewide Storm	Storm Sites	11			11						11			45	$14,364	$1,980	$150	$4,500	$20,994
	Duplicates + Field Blanks	4			4						4								
TOTALS														1697	$536,852	$59,490	$6,850	$150,375	$753,567
Shellfish & Recreational Waters																			$21,000
Grand Total																			***$774,567***

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