Executive Summary

Economic Value of Stormwater in Delaware

Final Draft Report
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Executive Summary

The National Academy of Sciences (2009) has concluded: *"Stormwater runoff from the built environment remains one of the great challenges of modern water pollution control, as this source of contamination is a principal contributor to water quality impairment of waterbodies nationwide."*

Introduction

The Delaware DNREC proposes to submit legislation to the General Assembly during Spring 2011 to consider revisions to the Delaware Stormwater and Sediment Control Regulations. The objective of this regulatory review is to quantify the economic benefits and costs of the proposed revisions to the stormwater regulations according to Title 29, Ch. 104 of the Delaware Regulatory Flexibility Act.

Green Stormwater Management

After the 100-year floods of Tropical Storm Henri (Sep 2003) and Tropical Storm Jeanne (Sep 2004), the Governor's Task Force for Surface Water Management (2005) recommended revisions to the Delaware Stormwater & Sediment Control Regulations that call for innovative green stormwater practices such as:

Bioretention Systems	Infiltration Basins
Bio-Swales	Permeable Paving
Detentions Basins	Rain Gardens
Filter Strips	Stormwater Wetlands
Green Roofs	Wet Ponds

Green stormwater practices can provide the following benefits to Delaware communities (WERF 2009):

- Higher property values and increased tax revenue
- (higher sale/resale prices)
- Decreased flood damage
- Public infrastructure cost savings, reduced stormwater pipes and culverts
- Reduced water pollution and water treatment costs
- Improved water quality
- Increased tourism and recreation

Legislative Framework

The Delaware stormwater regulations evolved from the following legislative framework:

1987 - Congress revises Clean Water Act and charges EPA to control NPDES stormwater discharges.
1991 - Governor/General Assembly adopt Delaware Stormwater and Sediment Control Regulations.
1999 - EPA passes Phase II municipal separate storm sewer regulations, cities <100,000 in population.
2003 - Tropical Storm Henri (100- to 500-yr flood) causes $45 million in flood damage in Delaware.
2005 - Delaware Task Force for Surface Water Management issues report to Governor.
2006 - Governor /General Assembly amend Delaware Stormwater and Sediment Control Regulations
2009 - EPA issues Federal Register Notice seeking input on federal stormwater regulations.
2010 - DNREC releases Stormwater Runoff Reduction Guidance Document
Feb 2011 - DNREC issues timeline to promulgation/revisions to Delaware Stormwater Regulations
Jun 2011 - Public workshop on proposed revisions to Delaware Stormwater Regulations
Sep 2011 - Public Hearing/ Public Comment on proposed revisions
Jan 2012 - Effective date of proposed revisions to Delaware Stormwater Regulations

Delaware Regulatory Flexibility Act

Title 29, Chapter 104 requires that prior to any new regulation, an agency shall consider whether it is feasible to exempt individuals/small businesses or whether the agency may promulgate a regulation which sets less stringent standards for individuals and small businesses.

1. Estimated cost of preparation of reports by individuals/small business to comply with the new rule.
The estimated cost of retaining a consulting engineer to prepare a report utilizing green stormwater management techniques is approximately $_____ per acre.

2. Estimated costs of investments required by individuals/small businesses in complying with the rule.
Individuals and small businesses can save up to 50% of costs by implementing green stormwater management techniques ($1,200 per acre) compared to conventional practices ($2,500 per acre).

3. Estimated cost of legal, consulting, accounting services which individuals/businesses would incur.
The estimated cost of these services is estimated to be $ ______ per acre.

4. Ability of individuals/small businesses to absorb costs without suffering economic harm and without adversely affecting competition in the marketplace.
Indivudual and small businesses can save up to 50% of stormwater management costs using green techniques compared to conventional practices required under the current Delaware stormwater code.

5. Cost to agency of administering rule which sets lesser standards for individuals/small business.
The Delaware DNREC will save $ _______ per acre in administrative costs utilizing green stormwater techniques.

6. Impact on public interest of setting lesser standards of compliance for individuals/small businesses.
Adoption of green stormwater management code will provide the following public interest benefits:

7. Accommodations made in regulations to address individual/small business concerns identified above.
The Delaware DNREC has made the following accommodations to address individual/small business concerns…

Demographics

In 2010, 890,000 people lived in Delaware on 1,954 sq mi of land with a population density of 1,000 p./sq mi. From 2000 to 2010, the population grew by 100,000, an increase of 13%. By 2030, the population is projected to grow by 159,000 to just over a million people. Delaware is covered by 39% agriculture, 17% forest, 17% wetland, 15% urban, 8% marine, and 3% open freshwater.

Delaware is drained by the Piedmont, Delaware Estuary, and Inland Bays Basins that flow east and Chesapeake Bay Basin flows west. The Delaware DNREC (2010) characterizes Delaware waters as:

- Ocean coastline 25 mi
- Bay 841 sq mi
- Rivers and streams 2,509 mi
- Lakes and ponds 2,934 ac
- Rivers/streams impaired for swimming from bacteria 86%
- Rivers/streams not meeting fish/wildlife water quality standards 97%
- Ponds and lakes not meeting swimming uses 44%
- Ponds and lakes not supporting fish and wildlife uses 89%
- Fish consumption advisories from high PCBs, metals, pesticides >100 mi

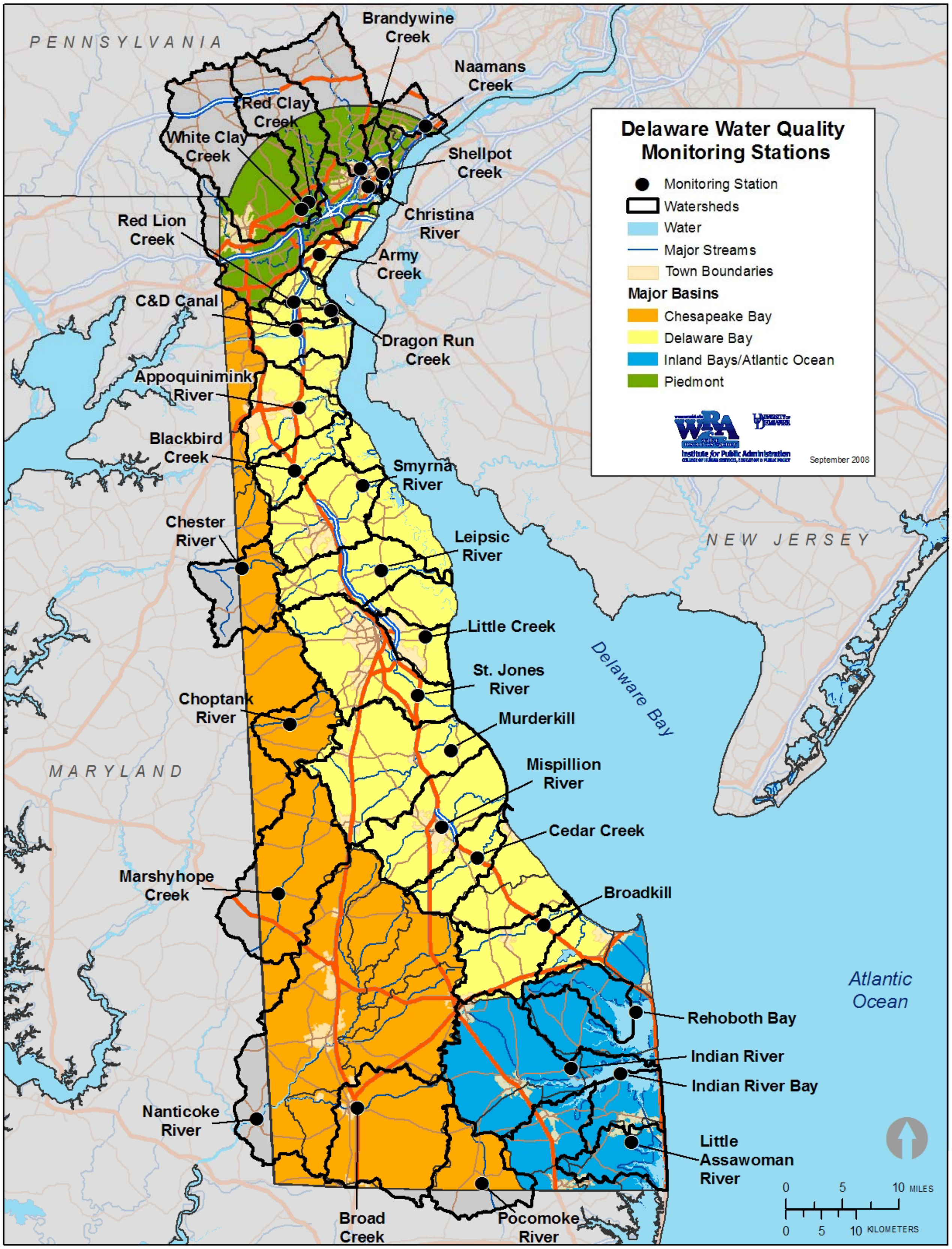

Figure ES1. Delaware watersheds

Flooding

In the last decade, 3 historic storms flooded Delaware causing $90 million in damages:

- Sep 15, 2003 Tropical Storm Henri, $46 million damages
- Sep 18, 2003 Tropical Storm Isabel, $40 million damages
- Sep 28, 2004 Tropical Storm Jeanne $ 4 million damages

The FEMA National Flood Insurance Program indicates New Castle County, Del. registered $12.9 million in repetitive flood damage losses at 51 properties between 1978 and 2008. New Castle County property owners filed the 5th highest flood damage claims of all counties in the 4-state Delaware Basin.

Situated on the Delmarva Peninsula between the Delaware and Chesapeake bays, Delaware is the lowest state in the U.S. with a mean elevation of 60 feet above sea level. Over 331 square miles or 17% of Delaware's land lie within the 100-year floodplain. Over 621 miles of roads run through the 100-yr floodplain. Over 18,000 structures lie in the 100-yr floodplain including:

- New Castle County 2,431 floodplain structures
- Kent County 1,853 floodplain structures
- Sussex County 13,760 floodplain structures

Watersheds with the highest flood flow are area include Shellpot Creek in New Castle County (1,161 cfs/sq mi), Duck Creek (Smyrna River) in Kent County (327 cfs/sq mi), and Indian River (52 cfs/sq mi). During the last quarter century, the largest floods in Delaware occurred on:

- Jul 8, 1989 (July 4th storm)
- Sep 16, 1999 (Hurricane Floyd)
- Sep 15, 2003 (Tropical Storm Henri)

Green Stormwater Benefits

Proposed revisions to the Delaware Stormwater & Sediment Control Regulations call for innovative green stormwater practices with tangible economic benefits according to North American watershed groups.

American Rivers reports:

- In California, 1,000 trees reduce stormwater runoff by 1 million gallons and saves $7,000.
- The Delaware Valley tree canopy saves $2 per cubic foot for stormwater volume control.
- Montgomery, Ala. forest has a stormwater infrastructure replacement value of $454 million.
- Albuquerque, NM tree canopy provides 150 MG of storm water services worth $123 million.
- In Denver, 0.1 ac bioretention pond cost $75,976, 17% less than traditional stormwater pond.
- New York City invested over $1.5 billion to protect and restore Catskill reservoir watersheds, rather than spending up to $9 billion on filtration plants, a benefit cost ratio of 6:1.

The City of Philadelphia (2009) reported the Green City - Clean Waters Program is designed to:

- Create 2 dollars in benefits for every dollar invested.
- Provide $500 million in economic benefits and employ 250 green jobs per year.
- Save $400 million from 1.5 million pounds of carbon dioxide emissions avoided or absorbed.
- Improve water quality from 5 - 8 billion gallons of CSO avoided per year.
- Restore 190 acres of wetlands and 11 miles of streams.
- Reduce 6 million Kw-hr of electricity and 8 million kBTU of fuel per year.

Earth Economics (2010) reported instead of constructing conventional curb/gutter and storm sewers:

- The Portland, Ore. Museum of Science Museum constructed vegetated swales and saved $78,000.
- Grayslake, Ill. Prairie Crossing saved $2.7 million using swales, native landscaping, and wetlands.

The USEPA (2010) in a guidance document for the Chesapeake Bay watershed found:

- Middlesound, N.C., low impact development stormwater design gained 4 lots worth over $1 million in new home yield, reduced storm pipe costs by 89%, avoided $1.5 million in fill material.
- State of Washington, low impact development storm water design reduced site construction costs $22,000 to $761,000 or by 15% to 80% compared to conventional stormwater design.
- St. Paul, Minn. Watershed District constructed infiltration facilities/rain gardens saving $0.5 million capital costs on $2.5 million project infiltrating 2 million cf of runoff at $0.03/cf.
- Portland, Oregon conducted an analysis that indicates a 40,000 sf green roof would provide a net benefit of $404,000 ($2008) over a 40-year life when compared to a conventional building roof.
- In Seattle, green grid streets cost $280,000 per block compared to traditional local street stormwater management at $425,000 per block, a savings of $145,000 per block.

The Wisconsin Dept. of Natural Resources estimated the mean cost of implementing municipal stormwater programs to comply with Clean Water Act provisions is $162,900 or per capita cost of $9.00.

Belanger (2009) conducted a cost-benefit study of urban stormwater economics in Toronto and found:

- A 12,300 acre green roof saved $313 million initially and $37 million annually.
- Concrete pavement cost $11.50/sf vs. permeable pavement at $6.50/sf, saving $4.50/sf.
- A concrete stormwater pipe costs $24/ft versus $5/ft for a green grass swale.

The Center for Watershed Protection (2000) summarized the economics of watershed protection:

- In the Chesapeake Bay watershed, a 12.2 acre commercial office park saved $160,469 when an innovative stormwater design was used instead of a conventional storm sewer design.
- Replacing conventional curb & gutter and storm sewers with conservation BMPs like natural bioswales saved $4,000 per 0.2 acre residential site and $78,000 on a 6-acre commercial parking lot.
- Narrow streets, bioswales, rain gardens, forest buffers, and filter strips instead of conventional curb & gutter & storm sewers saved $1.4 million per residential subdivision, $7,458 per lot.
- LID narrow streets, bioswales, rain gardens, natural buffers, filter strips, and forested depressions instead of curb & gutter and storm sewers saved $564,000 per commercial site, or $13,000 per ac.
- From 1856 to 1873, Frederick Law Olmsted measured a $209 million increase in property value on land adjacent to Central Park in New York City.
- Open space stormwater design at Remlik Hall Farm cost $594,000 or $600,000 (50%) less than a conventional stormwater design approach for this 490-acre cluster development (Table ES1).

The American Planning Association (2002) found green stormwater management saves:

- $1,100 for each commercial parking space eliminated or $7,000 per space over life time.
- $150 for each foot of road shortened with reduced pavement, curb/gutter, storm sewer needs.
- $25 to $50 for each foot of roadway narrowed.
- $10 for each foot of sidewalk eliminated.

Table ES1. Conventional versus cluster stormwater design approach for Remlik Hall Farm

Parameter	Scenario A Conventional Plan	Scenario B Cluster Plan
Engineering Costs	$79,600	$39,800
Road Construction Costs	$1,012,500	$487,500
Sewage and Water	$25,200	$13,200
Contingencies	$111,730	$54,050
Total	**$1,229,030**	**$594,550**
Total Developed Land	287.4 ac	69.4 ac
Roads/Driveway	19.7 ac	11.7 ac
Turf	261.1 ac	54.0 ac
Buildings	6.6 ac	3.9 ac
Total Undeveloped Land	202.7 ac	420.6 ac
Forest	117.6 ac	133.0 ac
Wetlands	11.5 ac	11.5 ac
Total Site Area	**490.2 ac**	**490.2 ac**
Impervious Cover	5.4%	3.7%
Nitrogen	2,534 lb/yr	1,482 lb/yr
Phosphorus	329 lb/yr	192 lb/yr

The Ontario MOE (2003) found the following benefits from green stormwater management:

- Reduced downstream flooding that can increase floodplain property values by up to 5%.
- Reduced energy cooling costs by 33%-50% from increased natural vegetation in Davis, Cal.
- Retrofitting of Seattle's greenstreets BMPs added 6% to the neighborhood value of properties.
- Improved water quality can increase property value by 15% along the water body.
- Bioretention instead of storm sewers saved $250,000 along Anacostia River in Washington, DC.
- Replacing curb & gutter & storm sewers with roadside swales saved $70,000/mile or $800/lot..
- Lots in LID neighborhoods sold for $3,000 more than lots in competing areas.

American Forests (2006) calculated billions of dollars of stormwater infrastructure would have to be built to replace lost water quality/quantity benefits of urban forests in the U.S. and Canada (Table ES2).

Table ES2. Avoided stormwater construction costs due to tree canopy (American Forests)

Urban Area	Avoided Costs ($ billion)
Vancouver, Can.-Portland, Ore.	$20.2
Metro Puget Sound, Wa.	$5.9
Washington, D.C.-Metro	$4.7
Atlanta, Ga.	$2.4
San Antonio, Tex.	$1.3
Houston, Tex.	$1.3
Chesapeake Bay Region	$1.1
New Orleans, La.	$0.7
Detroit, Mi.	$0.4
San Diego, Cal.	$0.2

Value of Stormwater Management in Delaware

The annual economic value of green stormwater management in Delaware exceeds $200 million if innovative practices are implemented based on benefits from:

- Increased Property Value
- Water Treatment
- Stormwater Detention
- Stormwater Runoff
- Improved Water Quality
- Small Property Owner Benefits

Table ES3. Annual economic value of stormwater management in Delaware

Activity	Value ($2010/year)	Source
Water Quality Benefits		
Improved water quality increases stream-side property value by 8%.	$39,200,000	Leggett, et al. (2000), EPA (1973), Brookings Institute (2007)
Water treatment by forests @ $41/mgd	$1,496,000	Trust for Public Land and AWWA (2004)
Benefits of stormwater management to achieve Delaware water quality standards.	$153,000,000	Carson and Mitchell (1993).
Small property owner (1 acre site) benefits of green stormwater management	$8,600/ac	National Green Values™ Calculator at http://greenvalues.cnt.org/national/calculator.php
Flood Control Benefits		
Stormwater detention improves downstream floodplain property value by 2% to 5%.	$42,000,000 - $105,000,000	Braden and Johnston (2004), University of Illinois
Green stormwater mgmt. in Del. can save $17 billion (42.6 billion gal runoff @ $0.35 gal).	$17,000,000	Bélanger (2009), City of Toronto
Total	**>$200 million**	

The annual benefits from stormwater management to meet improved boating, fishing, and swimmable water quality standards in Delaware is $141 million with a 2010 willingness to pay of $438 per household (Table ES1 and Fig. ES2).

Table ES4. Annual benefits from stormwater management and improved water quality in Delaware

Water Quality Use Support	2010 Population[1]	2010 Households[1]	2010 WTP[2] ($/hh)	WQ Benefits ($)
Boating	868,000	322,232	$168	$54,134,976
Fishing	868,000	322,232	$127	$40,923,464
Swimming	868,000	322,232	$141	$45,434,712
Total	**868,000**	**322,232**	**$438**	**$141,137,616**

1. Population impacted by impaired streams = 890,000(0.97) = 868,000

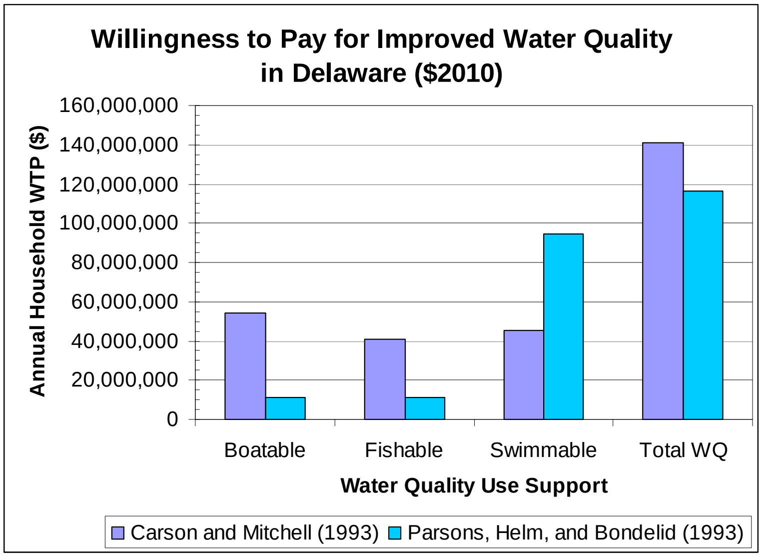

Figure ES2. Willingness to pay for improved water quality in Delaware

Total benefits of municipal ($141 million) and construction site ($11 million) stormwater management to achieve boatable, fishable, and swimmable water quality standards in Delaware are $153 million per year. Annual costs to implement municipal stormwater programs and construction site erosion and sediment controls in Delaware is $11 million. The benefit -cost ratio of innovative green stormwater management to achieve water quality standards in Delaware is 14:1.

According to the National Green Values™ Calculator, a one acre property proposed for development in Delaware will generate 94,160 cf of runoff for predevelopment conditions, 88,307 cf for conventional stormwater design, and 85,067 cf for green stormwater design. Compared to conventional stormwater design, green stormwater design reduces runoff from a one acre site by 3,240 cf or $74,520 using the Center for Watershed Protection value of $23/cf for stormwater treatment. The CWP recommends the DNREC adopt an in-lieu fee of $23/cf of stormwater treatment volume not managed on-site.

Watershed Ecosystem Services

The estimated value of natural goods and services provided by ecosystems in Delaware watersheds is $6.7 billion ($2010) with a net present value (NPV) of $216.6 billion (Table ES4). Freshwater wetlands, farms, marine habitat, forests, and saltwater wetlands provide the highest ecosystems goods and services values.

Table ES4. Value of ecosystem good and services in Delaware watersheds

Ecosystem	Area (ac)	$/ac/yr	PV $	NPV $
Freshwater wetlands	178,632	13,621	2,433,081,000	79,075,132,489
Marine	124,879	10,006	1,249,541,955	40,610,113,531
Farmland	590,150	2,949	1,740,640,688	56,570,822,374
Forest land	265,476	1,978	525,143,567	17,067,165,922
Saltwater wetland	71,001	7,235	513,691,702	16,694,980,313
Urban	229,827	342	78,511,742	2,551,631,623
Beach/dune	588	48,644	28,579,665	928,839,116
Open water	48,253	1,946	93,891,133	3,051,461,812
Delaware	**1,515,263**		**6,663,081,452**	**216,550,147,179**

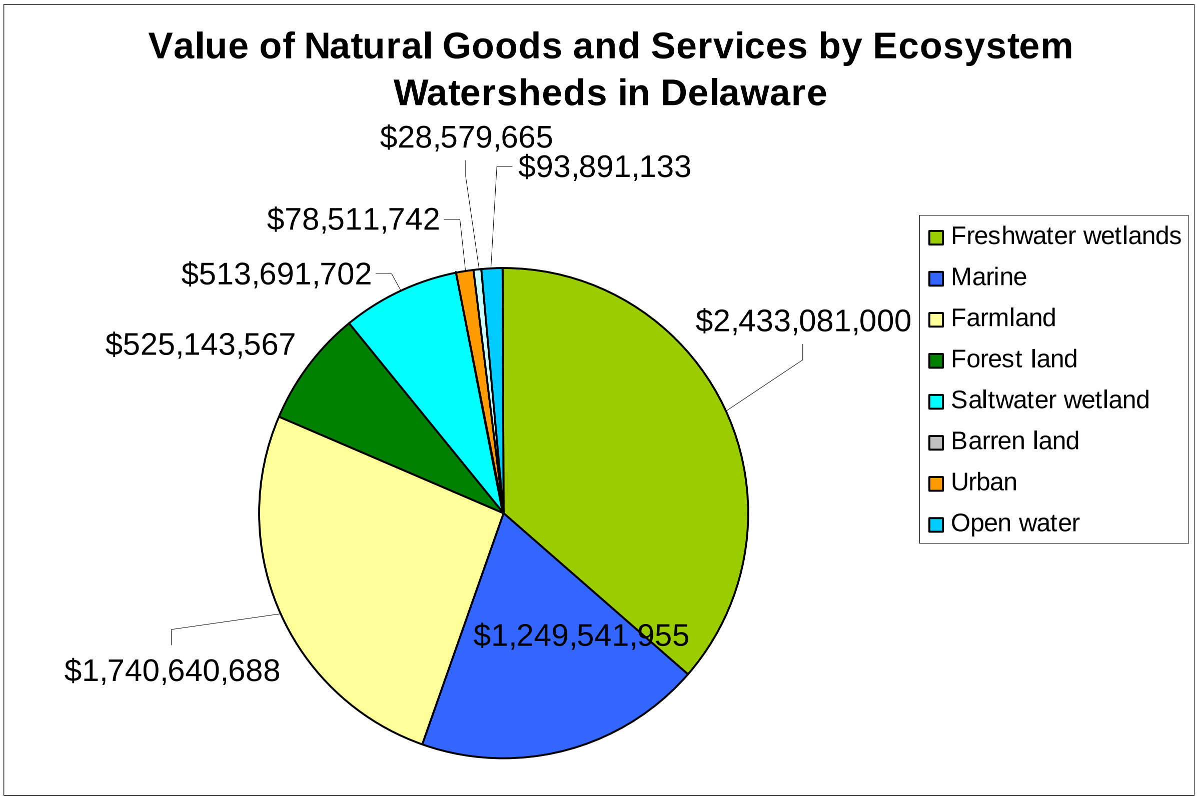

Figure ES3. Value of natural goods and services by ecosystem within Delaware watersheds

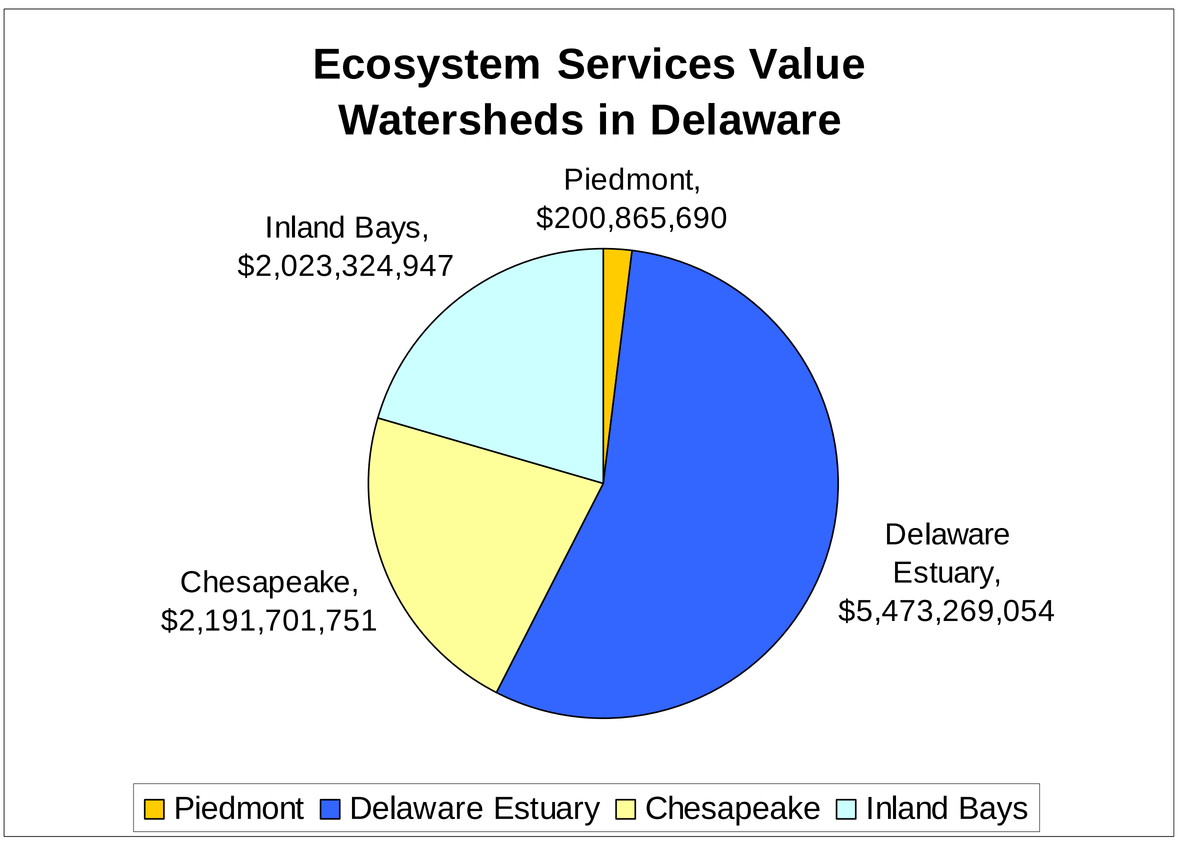

Figure ES4. Value of natural goods and services by watershed within Delaware

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