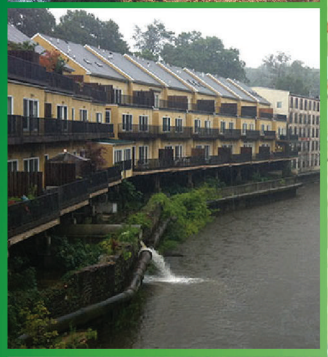
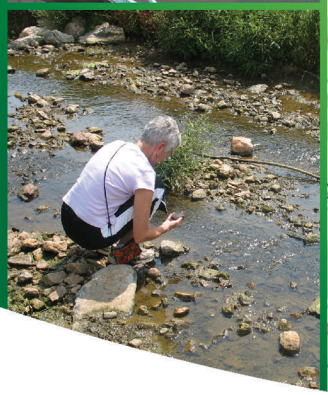
Brandywine-Christina Healthy Water Fund

Preliminary Feasibility Study
April 2015





The Nature Conservancy
Protecting nature. Preserving life.®

WILLIAM PENN FOUNDATION

UNIVERSITY OF DELAWARE

Brandywine-Christina Healthy Water Fund
Preliminary Feasibility Study

April 2015

prepared for the
William Penn Foundation
Philadelphia, Pa.

prepared by
The Nature Conservancy
Wilmington, Del.
and
University of Delaware
Newark, Del.

PREFACE

The Brandywine-Christina Healthy Water Fund (the Water Fund) is being developed under a grant from the William Penn Foundation (WPF/the Foundation) through a partnership between The Nature Conservancy in Delaware (TNC) and the University of Delaware's Water Resources Agency (WRA). The ultimate goal of the Water Fund is to restore the Brandywine-Christina watershed to fishable, swimmable, potable status on an expedited timeline. To meet this goal, the Water Fund will incentivize investments in water quality conservation by a variety of beneficiaries and leverage those investments with new and existing funding sources to dramatically increase the amount, pace, and coordination of overall conservation investments in the Brandywine-Christina watershed.

In addition to funding the development of the Water Fund, the Foundation awarded approximately $2.5 million in grants in 2014 to several nonprofits (including the Brandywine Conservancy, Brandywine Valley Association, Natural Lands Trust, and Stroud Water Research Center, which are collectively called the WPF Cluster Partners) to implement a variety of conservation strategies in the Brandywine-Christina watershed, including land protection and restoration, stream restoration, buffer plantings, and agricultural BMPs. This work is highly complementary of the Water Fund and is part of the Foundation's Delaware River Watershed Initiative—an unprecedented conservation effort to improve water quality in the entire Delaware River Basin.

February 16, 2015

Clare Billett
Program Officer, Watershed Protection
William Penn Foundation
Two Logan Square, 11th Floor
100 North 18th Street
Philadelphia, PA 19103

Re: Preliminary Feasibility Study for the Brandywine-Christina Healthy Water Fund

Dear Clare:

On behalf of our team at The Nature Conservancy and the University of Delaware, it is our pleasure to deliver the enclosed Preliminary Feasibility Study for the Brandywine-Christina Healthy Water Fund. Based on our research of case studies from around the world, interviews and audiences with watershed experts, stakeholders, and beneficiaries, and our economic analysis, we conclude on a preliminary basis that establishing the Water Fund is feasible. Additional work is needed in years two and three to lay the foundation for implementing the Water Fund. This study will help guide that work.

Thank you for the confidence you, your colleagues, and the William Penn Foundation Board of Directors have shown in supporting this initiative. By applying a healthy balance of science, policy, and economics (and a dash of diplomacy), the Brandywine-Christina Healthy Water Fund promises to bring a new business model to the way we protect and restore our nation's watersheds.

Sincerely,

Richard I. G. Jones, Jr., State Director
The Nature Conservancy in Delaware

Gerald J. Kauffman, Director
University of Delaware
Institute for Public Administration
Water Resources Agency

www.nature.org/Delaware • www.williampennfoundation.org • www.wra.udel.edu

ACKNOWLEDGEMENTS

The project team would like to acknowledge the William Penn Foundation for its support of the Brandywine-Christina Healthy Water Fund and all of the conservation measures they are funding throughout our watershed. The Foundation's commitment has strengthened coordination and collaboration and helped improve the overall health of the watershed. Special thanks to Andrew Johnson, Nathan Boon, and Clare Billett for their individual commitment to this project and the advice and guidance they have provided throughout this yearlong process.

We also would like to acknowledge all those who have served on the Regional Advisory Panel. Their names are listed in the appendices of this report. The panel members have committed numerous volunteer hours to participate in meetings and one-on-one communication that provided the project team with invaluable input and feedback. The panel has been extremely helpful in testing and strengthening our strategy for implementing the Brandywine-Christina Water Fund and making this study thorough and robust.

We would like to thank the key stakeholder representatives who were interviewed. They, too, gave generously of their time and advice. Their continuing commitment to the health of the watershed is critical to the success of this project.

Additionally, the team would like to acknowledge those who made time in their busy schedules to provide direct feedback on their organization's concerns and priorities, including staff from the Brandywine-Christina Cluster and those supporting the Foundation's Delaware River Watershed Initiative: the Brandywine Conservancy, the Brandywine Valley Association, the Natural Lands Trust, the Stroud Water Research Center, the University of Maryland Environmental Finance Center, the Academy of Natural Sciences, the Open Space Institute, and the Institute for Conservation Leadership.

Finally, we would like to acknowledge Nicole Minni, associate policy scientist with the University of Delaware's Water Resources Agency, who has provided technical and design support throughout this entire project as well as Policy Specialist Sarah Pragg and Policy Scientist Lisa Moreland with the University of Delaware's Institute for Public Administration (IPA) who have provided editing and formatting support.

Project Team

Brian Boutin, The Nature Conservancy in Delaware
Maria Dziembowska, The Nature Conservancy in Delaware
Andrew Homsey, University of Delaware, IPA, Water Resources Agency
Richard I. Jones, Jr., The Nature Conservancy in Delaware
Gerald J. Kauffman, University of Delaware, IPA, Water Resources Agency
Ellen Kohler, The Nature Conservancy in Delaware
Martha Narvaez, University of Delaware, IPA, Water Resources Agency
Kash Srinivasan, KS Group, LLC
Martin Wollaston, University of Delaware, IPA, Water Resources Agency

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

LIST OF TERMS

AVGWLF	ArcView Generalized Watershed Loading Function
B-C	Benefit Cost
BMP	Best Management Practice
BVA	Brandywine Valley Association
CAW	Central Arkansas Water
CBPRP	Chesapeake Bay Pollutant Reduction Plan
CCEDC	Chester County Economic Development Corporation
CCWRA	Chester County Water Resources Authority
CPI	Consumer Price Index
CRP	Conservation Reserve Program
CSO	Combined Sewer Outflow
CSS	Combined Sewer Systems
CTIP	Christina Basin TMDL Implementation Plan
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
CV	Contingent Value
CY	Cubic Yards
C2E	Conserve to Enhance (Tucson)
DelDOT	Delaware Department of Transportation
DMWA	Downingtown Municipal Water Authority
DNREC	Delaware Department of Natural Resources and Environmental Control
DO	Dissolved Oxygen
DRBC	Delaware River Basin Commission
EQIP	Environmental Quality Incentives Program
EWEB	Eugene Water and Electric Board
FAVS	Fondo Agua por la Vida y la Sostenibilidad (East Cauca Valley, Colombia)
FONAG	Fondo para la Protección del Agua (Quito, Ecuador)
GAMN	General Assessment Monitoring Network
GIS	Geographic Information Systems
GWLF-E	Generalized Watershed Loading Functions-Enhanced
InVEST	Integrated Valuation of Environmental Services and Tradeoffs
IWS	Investment in Watershed Services
LT2 Rule	Long Term 2 Enhanced Surface Water Treatment Rule
MAC	Marginal Abatement Costs
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
N	Nitrogen
NCC	New Castle County
NCCD	New Castle Conservation District
NCYCC	North Carolina Youth Conservation Corps
NE-PES	Northern Everglades-Payment for Environmental Services Program
NJWSA	New Jersey Water Supply Authority
NMP	Nutrient Management Plan
NPDES	National Pollutant Discharge Elimination System

NRCS	Natural Resources Conservation Service
NRDC	Natural Resource Defense Council
NTU	Nephelometric Turbidity Units
NYC DEP	New York City Department of Environmental Protection
O&M	Operations and Maintenance
P	Phosphorus
PADCNR	Pennsylvania Department of Conservation and Natural Resources
PADEP	Pennsylvania Department of the Environment
PCS	Pollution Control Strategy
PDE	Partnership for the Delaware Estuary
PES	Payment for Ecosystem Services
PRedICT	Pollution Reduction Impact Comparison Tool
RCPP	NRCS Regional Conservation Partnership Program
RCVA	Red Clay Valley Association
RIOS	Resource Investment Optimization System
SDWA	Safe Drinking Water Act
SWAT	Soil and Water Assessment Tool
TMDL	Total Maximum Daily Load
TMWA	Truckee Meadows Water Authority
TN	Total Nitrogen
TNC	The Nature Conservancy
TP	Total Phosphorus
TSS	Total Suspended Sediment
TWIG	Targeted Watershed Initiative Grant
UNCWI	Upper Neuse River Clean Water Initiative
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
WAC	Watershed Agricultural Council
WLA	Waste Load Allocation
WPF	William Penn Foundation
WQC	Water Quality Credit
WQIP	Water Quality Improvement Plan
WRA	Water Resources Agency
WRR	Watershed Resources Registry
WTP	Willingness to Pay
YCPC	York County Planning Commission

EXECUTIVE SUMMARY

E.S.1. Introduction

This document assesses on a preliminary basis the feasibility of establishing the Brandywine-Christina Healthy Water Fund. The Water Fund is a mechanism for engaging direct beneficiaries of freshwater and other stakeholders in making investments within the watershed to improve water quality on a least-cost basis, enhance environmental and social values, and achieve quantifiable economic benefits. This effort seeks to leverage The Nature Conservancy's global experience in developing and stewarding water funds with the quantitative expertise of the University of Delaware's Water Resources Agency in addressing water quality issues in the Brandywine-Christina watershed. To be successful, the Water Fund must creatively engage water withdrawers, stormwater managers, and agricultural stakeholders in the efficient deployment of pooled capital to achieve positive water treatment outcomes, risk mitigation, regulatory compliance, and preservation of farming as a long-term viable activity for the region.

This study consolidates research and analysis completed to date and finds sufficient preliminary evidence to conclude that a water fund offers a financially and politically viable approach to water quality (and perhaps quantity) improvement in the Brandywine-Christina watershed. This conclusion is based on the following factors (among others): (1) an opportunity exists to expand on and increase the efficiency of current conservation initiatives in the watershed, (2) regulators appear open to exploring more flexible regulatory approaches to achieving water quality (and possibly quantity) goals, and (3) water purveyors, stormwater managers, and potential public and private funders have expressed interest in exploring more cost-effective water quality (and possibly quantity) strategies, including nature-based solutions. This is a challenging and complex endeavor, but one that holds the promise of revolutionizing the way freshwater resources are managed to secure long-term benefits for people and nature.

E.S.2. Watershed Characterization

Chapter One provides an overview of the Brandywine-Christina watershed. The Brandywine-Christina is an emblematic eastern United States watershed. It covers more than 565 square miles and is home to more than 590,000 people (U.S. Census 2000–2010). The watershed includes four subwatersheds: the Brandywine, Red Clay Creek, White Clay Creek, and the Christina River. The watershed is also referred to as the Christina Basin. The majority of the land in the watershed is in Pennsylvania; however, the majority of the population is in Delaware. Approximately 39% of the watershed's land use is dedicated to agriculture, 33% is forest and wetlands, and 28% is suburban and urban (NOAA CSC 2005). The relative proportions of each land use are roughly similar in the White Clay, Red Clay, and Brandywine subwatersheds. The Christina River subwatershed, which lies almost completely in Delaware, is significantly more suburban/urban and less agricultural than the other subwatersheds (Figure ES.1).

Despite a long-standing and robust commitment to conservation in the watershed, much of the Brandywine-Christina remains impaired based on standards set by the Clean Water Act. This does not mean conservation interventions cannot restore watersheds to these standards. Indeed, conservation measures to date in the Brandywine-Christina have yielded significant water quality improvements, leading to the conclusion that increasing the pace, scale, and efficiency of conservation measures has the potential to restore the health of the watershed.

Restoration of the watershed requires removing impairments from the streams. One aspect of addressing stream health is meeting total daily maximum loads (TMDLs), which have been established for specific pollutants and apportioned among sections of the watershed, including those shown in Table ES.1. The achievement of these load limitations forms an important component of watershed restoration efforts.

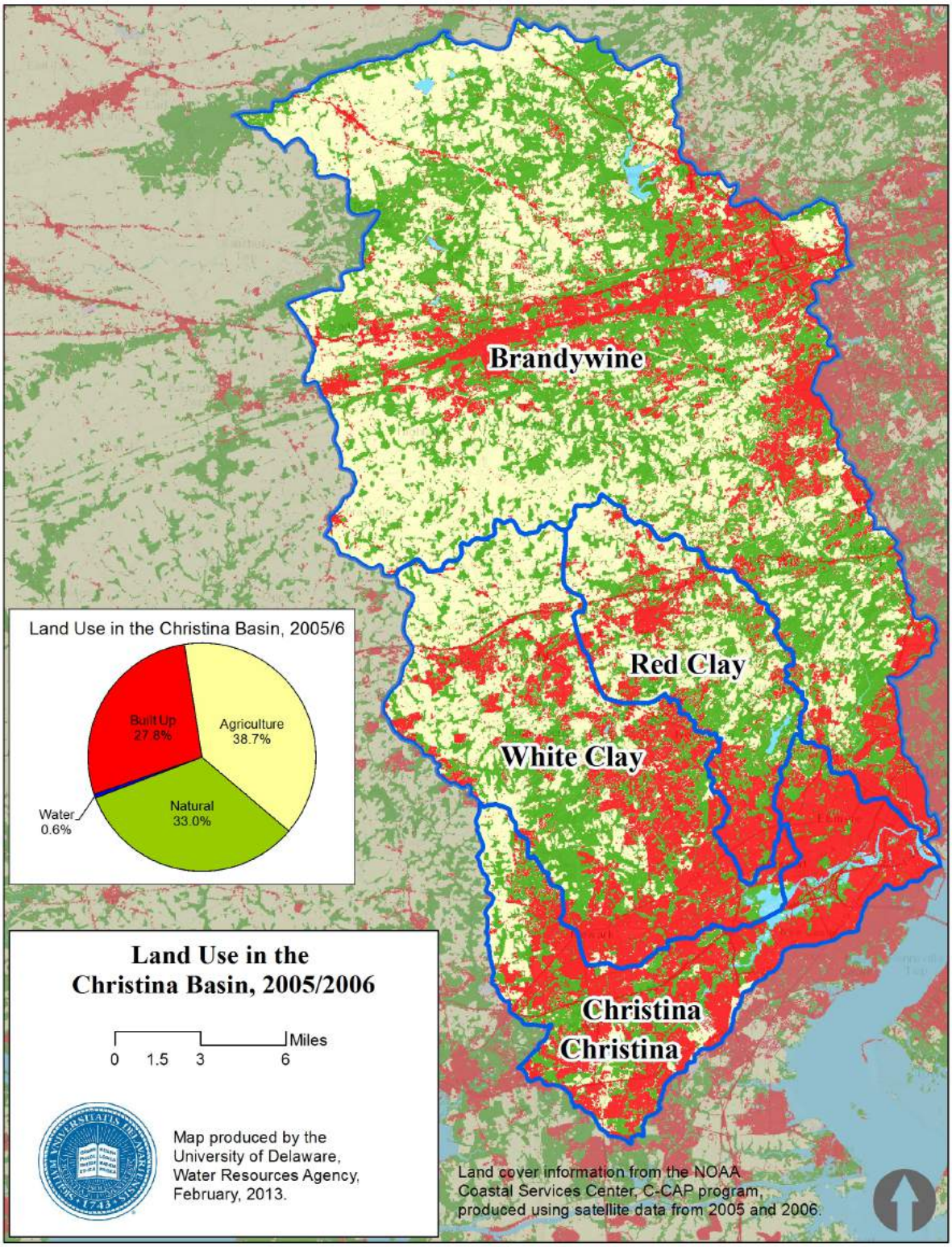


Figure ES.1. Land use in the Brandywine-Christina watershed

Table ES.1. High flow nonpoint source TMDL reductions in the Brandywine-Christina watershed (EPA, DNREC, and PADEP 2006)

Watershed	Percent Reduction (%)			
Pennsylvania–Delaware Line	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	93%	16 – 60%	46%	41%
Red Clay Creek	58%	45 – 52%	31%	40%
White Clay Creek	70%	26 – 70%	28%	73%
Christina River (at Md.–Del. line)	58%		73%	48%
In Delaware	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	88 – 94%		16%	36%
Red Clay Creek	29 – 89%		49%	54%
White Clay Creek	66 – 89%			
Christina River	61 – 91%		6%	9%
CSO Discharges, Wilmington, Del.	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	63%		64%	63%
Christina River	72%		72%	72%

E.S.2.1. Watershed Management Planning Documents

As discussed in Chapter One, numerous watershed management plans have been prepared for the Brandywine-Christina watershed. A review of the most recent of these plans resulted in a common set of recommended actions (Chapter 1, Table 1.6), including:

- Agricultural mitigation – nutrient management plans, cover crops, livestock fencing
- Riparian buffers – protection and restoration
- Forest preservation and reforestation
- Farmland preservation – fee and easements acquisition
- Open space preservation – fee and easements acquisition
- Headwater preservation – fee and easements acquisition
- Streambank restoration and stabilization
- Wetland/floodplain restoration and reconnection
- Stormwater retrofits in urban areas
- Stormwater runoff reduction to mitigate flooding, erosion, and sedimentation
- Increased tree canopy in urban/suburban areas

E.S.2.2. Existing Watershed Initiatives

Chapter One discusses the existing watershed initiatives in the watershed. Public and private drinking-water purveyors continue to support and contribute to watershed conservation and restoration projects throughout the watershed. Support generally goes to nonprofit conservation organizations in the watershed. The organizations have often leveraged these funds to garner additional state, federal, and private foundation contributions, resulting in a significantly larger impact on the watershed health than would have been possible with only local funding.

E.S.3. Regional Advisory Panel Process

In Chapter Two the Regional Advisory Panel process is summarized. An important component of this feasibility study was the empanelling of the Regional Advisory Panel composed of representatives with diverse water quality, conservation, and regulatory expertise throughout the watershed. Members of the Regional Advisory Panel include federal, state, and county government representatives, experts in the agriculture community, nonprofit representatives, and business leaders. The Regional Advisory Panel met three times and provided invaluable input and feedback on the project and this feasibility study.

E.S.4. Case Studies and Models

Chapter Three discusses the case studies and models. The project team conducted an extensive review of the literature and case studies from successful market-based funding approaches to watershed conservation around the globe (See Appendices B and C). From the case studies, the following six common principles emerged:

1. Develop strong public-private partnerships.
2. Leverage state, federal, and private funding.
3. Adopt science-based conservation and strategic plans.
4. Depend on local champions and stewards.
5. Start with seed money and develop a steady funding source.
6. Adapt to the setting.

The case studies demonstrated that water purveyors are typically the "first-round" investors in successful water funds. In the Brandywine-Christina watershed, municipalities and other stormwater-regulated entities are also significant stakeholders. Future partners could include philanthropic foundations, impact investors, and public-private partnerships.

As a result of the information gathered from the key stakeholders and feedback from the Regional Advisory Panel, the project team selected four case studies to highlight. Each has at least one component of its program that is particularly relevant to the Brandywine-Christina watershed:

- The City of New York case study demonstrates the power of working with the agricultural community to reach water quality goals (American Water Works Association et al. 2004, Majanen et al. 2011, New York City Department of Environmental Protection 2006, USEPA 2007, Hulle et al. 2013).
- The Upper Neuse River Clean Water Initiatives is an example of a multi-government project that includes dedicated funding sources (Triangle Land Conservancy et al. 2010, Hart 2006, Gartner et al. 2013, American Water Works Association et al. 2004, www.pinchot.org/doc/465).
- The York County case study illustrates a multi-government agreement reached to address stormwater permit requirements (Shellenberger 2014).

- FONAG (Fondo para la Protección del Agua) is a mature water fund with multiple partners and a dedicated funding source (Arias et al. 2010, Calvache et al. 2012, The Nature Conservancy 2012).

Computer modeling has been an essential part of the planning and implementation of each of the case studies reviewed. These models are instrumental in generating information to answer questions essential to water fund design, including: what is the condition of hydrologic services in the watershed, how might the condition of those services change under various conservation schemes, and where should investments be made to maintain or improve key ecosystem services (including hydrologic services) and maximize return on investment? Four models should be considered in generating information for the Brandywine-Christina Health Water Fund: (1) Resource Investment Optimization System (RIOS), (2) Integrated Valuation of Environmental Services and Tradeoffs (InVEST), (3) Soil and Water Assessment Tool (SWAT), and (4) MapShed.

E.S.5. Economic Analysis

The economic analysis supporting this preliminary feasibility study, provided in Chapter Four, relies upon empirical data from the Brandywine-Christina and other watersheds to illustrate the economic benefits that could result from scaling-up water quality conservation. It concludes that conservation strategies often offer a lower-cost alternative to "gray infrastructure" investments. Targeting conservation interventions to specific locations within the watershed and prioritizing conservation strategies can result in significant efficiencies and cost savings. Similarly, conservation strategies help manage long-term risks.

For the purposes of the example analysis presented in the this study, nitrogen and sediment are selected as "currency" to derive pollutant reduction costs for the Brandywine-Christina watershed because: (1) water utilities are concerned about treatment costs and public-health risks from high nutrient and sediment loads, (2) the conservation strategies that reduce nitrogen and sediments reduce other pollutants such as phosphorus and bacteria, (3) good cost-reduction data is available for nitrogen and sediment, and (4) nitrogen levels continue to degrade in the watershed. Furthermore, there is significant overlap of the subwatersheds that require TMDLs for nitrogen and phosphorus, and most of those subwatersheds also require sediment reductions to meet TMDLs. While reducing the nitrogen and sediment loads to the TMDL levels will not by itself reach the goal of a swimmable, fishable, and potable watershed, it is a substantial first step toward that goal.

Pollutant load reduction costs are calculated based on 2006 TMDLs established by the United States Environmental Protection Agency (USEPA), the Delaware Department of Natural Resources and Environmental Control (DNREC), and the Pennsylvania Department of the Environment (PADEP), as listed on 2014 PADEP impaired streams maps for Chester County (Figures ES.2 and ES.3), and verified by water quality monitoring data. Agriculture, which represents a significant portion of land use in the Brandywine-Christina watershed, accounts for approximately 80% of the nutrient loads in the watershed (USGS SPARROW). Agricultural mitigation strategies, a best management practice (BMP), are by far the most

cost-effective means of achieving the water quality improvements necessary to restore the Brandywine-Christina to fishable, swimmable, and potable status (Jones et al. 2010).

The map below (Figure ES.4) shows the distribution of the nitrogen TMDL across the watershed. It illustrates that targeting conservation in specific areas of the watershed should result in significant water quality improvements. By implementing least-cost nitrogen-reducing strategies in high nitrogen load areas in the watershed, significant costs savings of up to $120 million can be achieved over a ten-year time horizon.

Similarly, targeted investments can also be used to address the sediment TMDL. Figure ES.5 shows the distribution of the sediment TMDL across the watershed. This map illustrates that conservation in these areas of the watershed should result in more effective water quality improvements. By using the least-cost strategies to reduce sediment, the cost to meet the sediment TMDL across the watershed is estimated to be $4.4 million per year for ten years. Studies in other watersheds would suggest that the cost of sediment removal by traditional sediment-removal processes would be significantly higher, although further analysis is needed to draw specific conclusions for the Brandywine-Christina watershed.

Based on work in the Chesapeake Bay watershed, buffers and restored wetlands achieve the same amount of nitrogen reduction as wastewater treatment plant upgrades and stormwater retrofits, but at a dramatically lower cost (Figure ES.6). The least-cost strategies in Figure ES.6 are comparable to agricultural mitigation or agricultural BMPs.

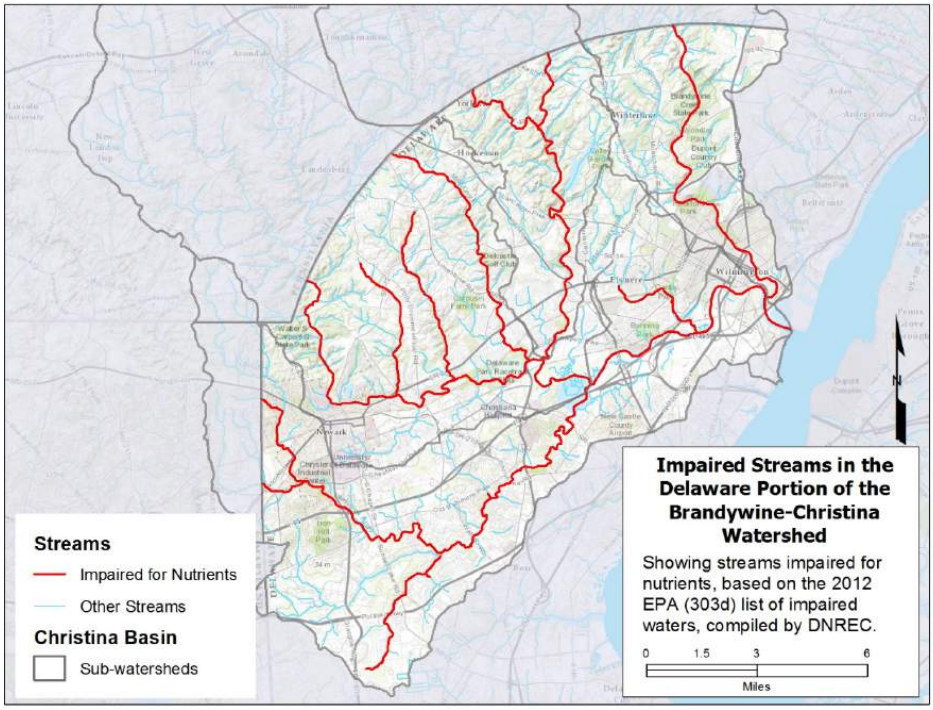


Figure ES.2. Streams impaired for nutrients in the Delaware portion of the Christina Basin, 2012 (DNREC and UDWRA)

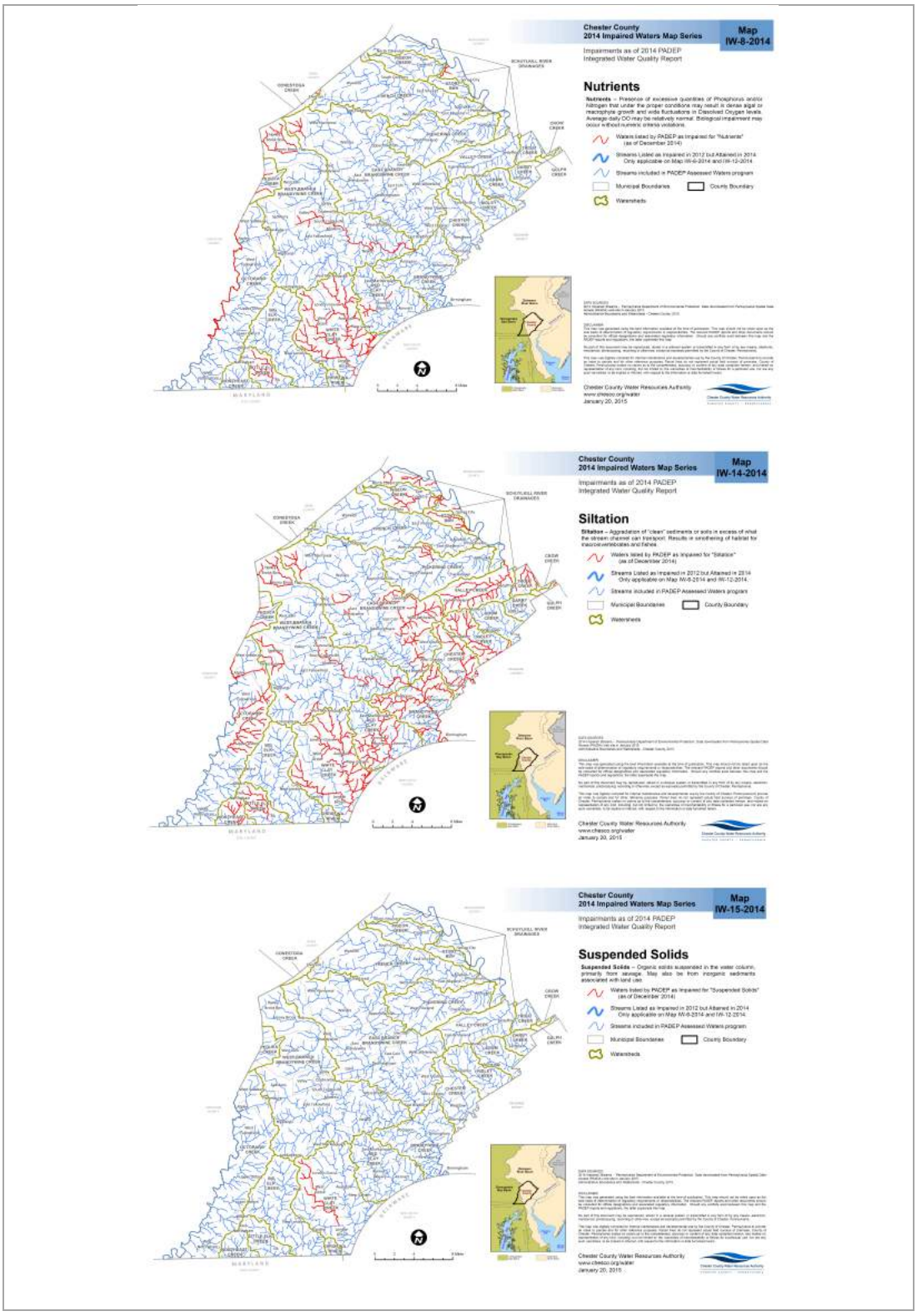


Figure ES.3. Streams impaired for nutrients, siltation, and suspended solids in Chester County, PA, 2014 (PADEP and CCWRA)

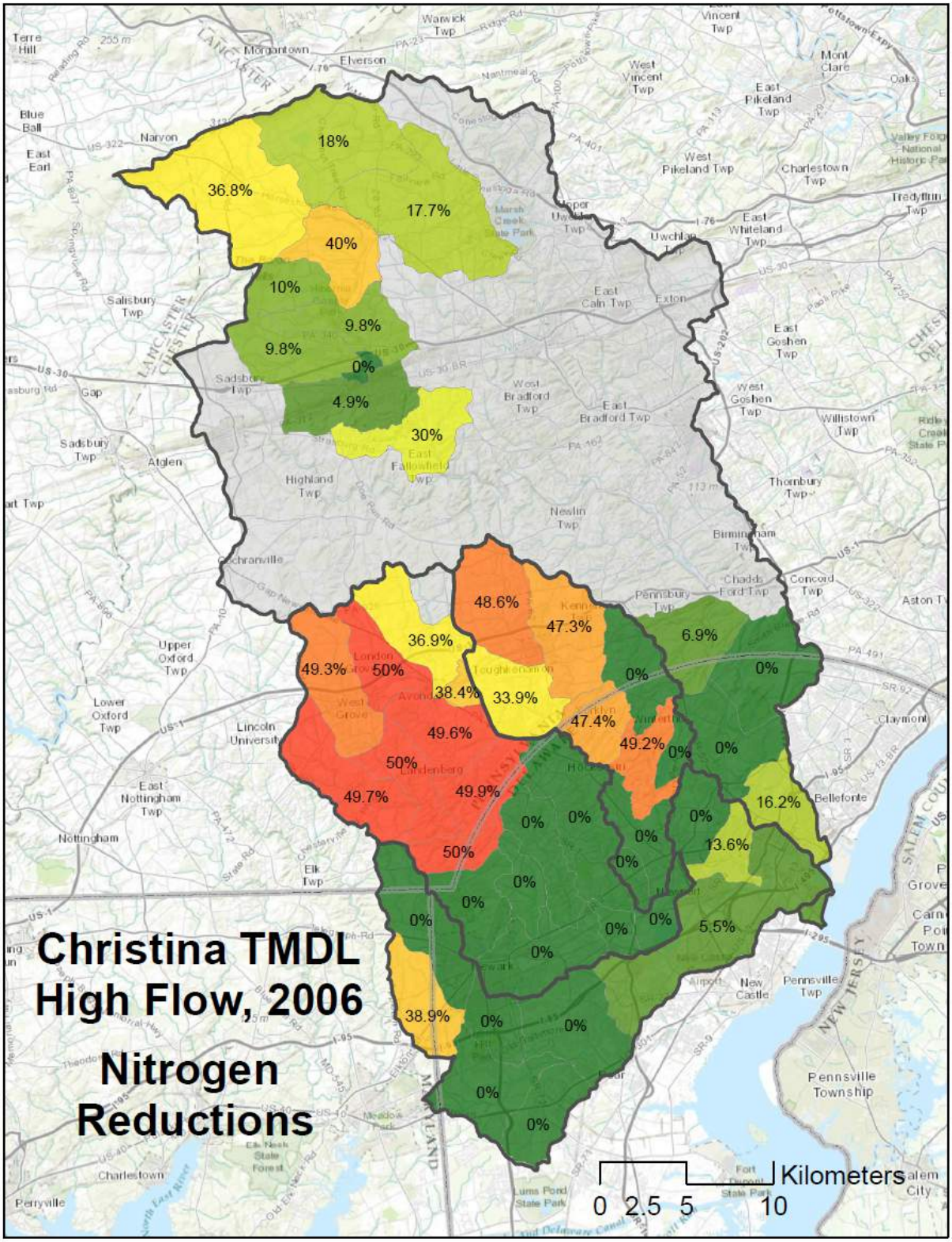


Figure ES.4. Nitrogen load TMDL reductions for Brandywine-Christina watershed (USEPA 2006)

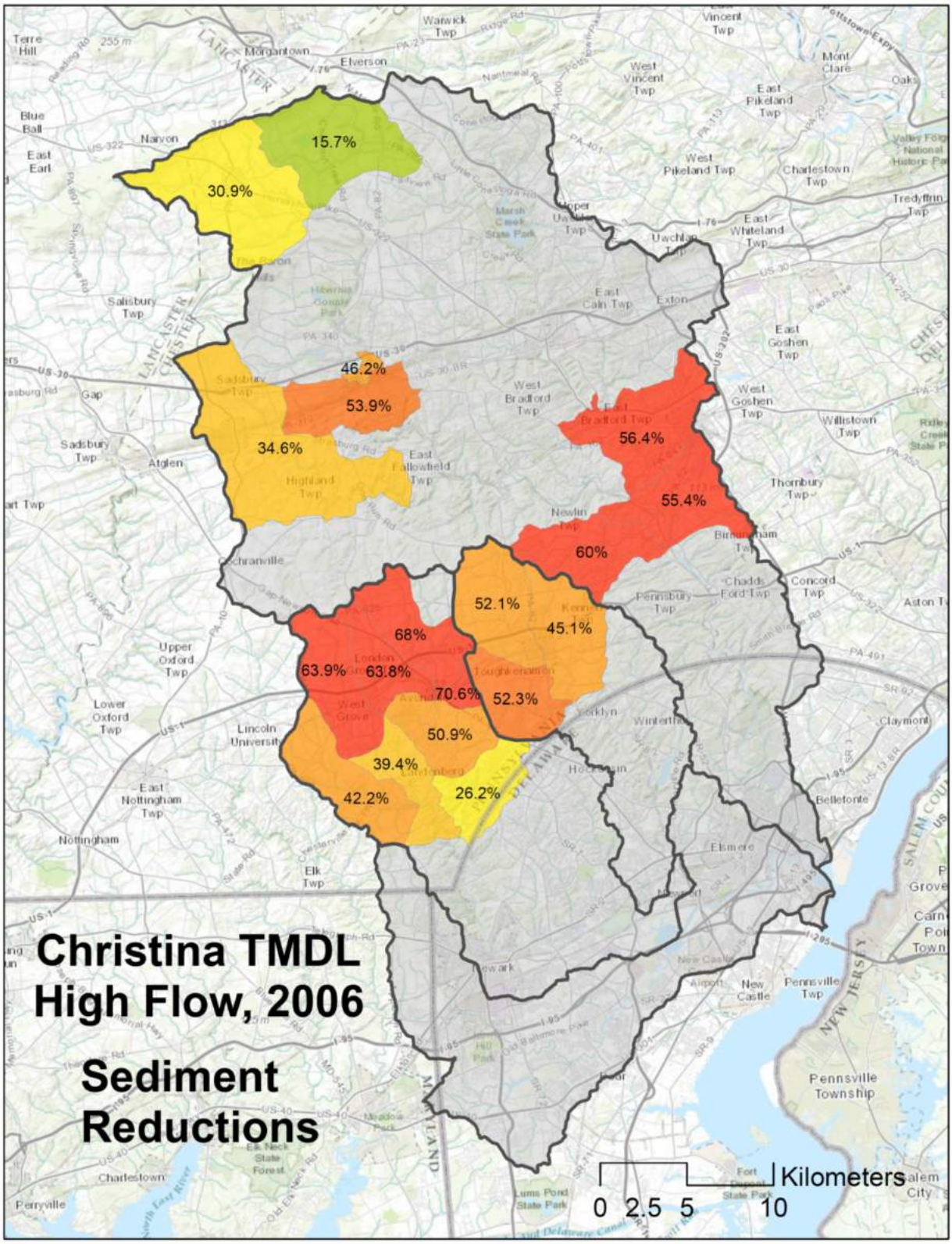


Figure ES.5. Sediment load TMDL reductions for Brandywine-Christina watershed (USEPA 2006)

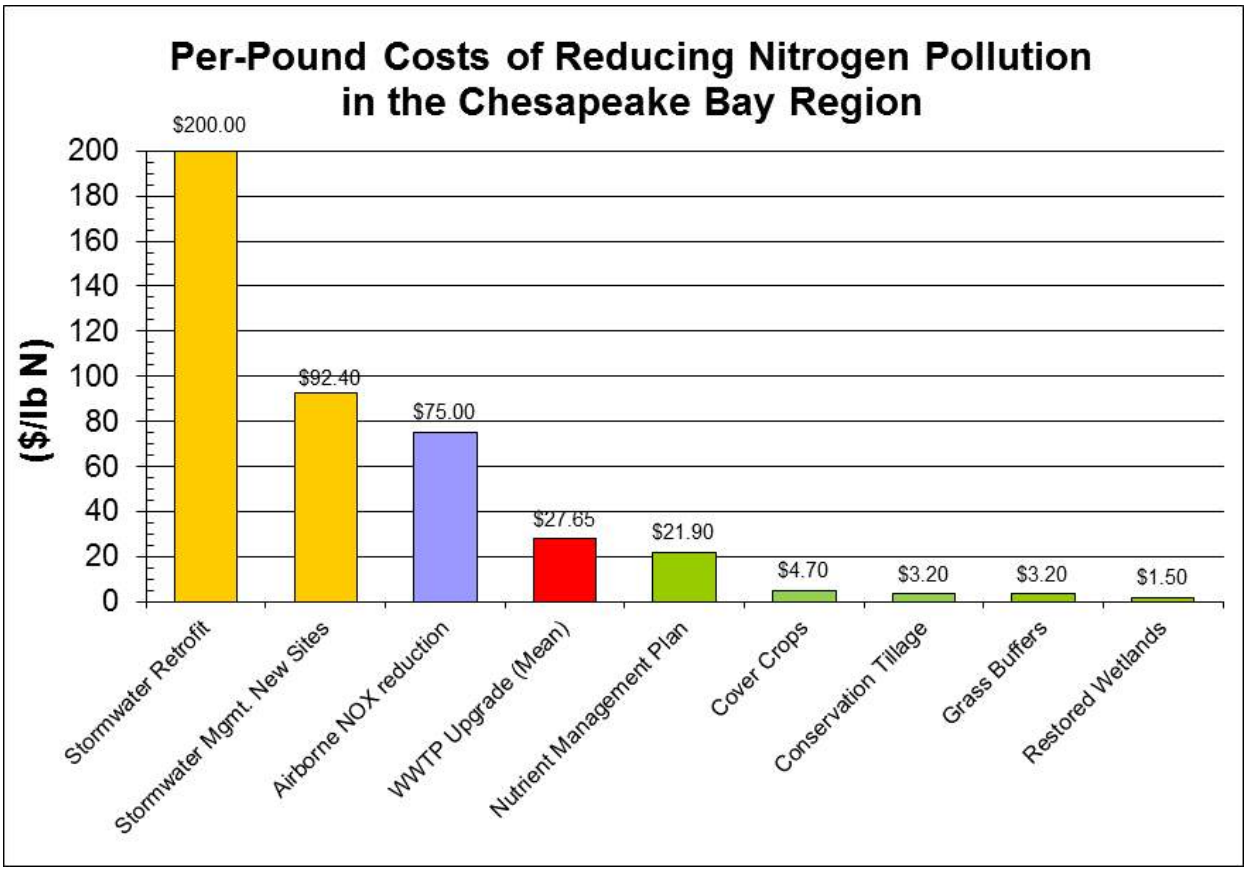


Figure ES.6. Per pound costs of nitrogen reduction for various strategies (Jones et al. 2010 and USEPA 1996)

Estimated annual costs to reduce pollutant loads in the Brandywine-Christina range from $5.5 million for nitrogen to $4.4 million for sediment over ten years between 2015 and 2025 (Table ES.2). Load reduction costs are complementary since agriculture conservation BMPs that reduce nitrogen and sediment also reduce phosphorus and bacteria.

Table ES.2. Estimated annual costs to reduce nitrogen and sediment loads in the Brandywine-Christina watershed

Watershed	Nitrogen ($ mil/yr)	Sediment ($ mil/yr)
Brandywine	1.6	0.5
Red Clay	1.4	1.3
White Clay	2.0	2.6
Christina	0.5	No DE TMDL
Brandywine-Christina	5.5	4.4

A water fund can be designed to cover some but not all of the annual costs, since existing investments are being made by federal, state, local, and nonprofit sources. For instance, if the United States Department of Agriculture (USDA) Farm Bill provides 80% of agriculture

conservation costs, then the Water Fund could be utilized to provide the 20% local share to incentivize farmers. The Water Fund might also be used to provide low-cost loans to farmers to cover up-front costs for BMP implementation.

The benefits of water quality improvement extend beyond meeting regulatory requirements. For example, reductions in sediment decrease the cost of producing drinking water. A recent global study suggests that an annual reduction of sediment load by 4% can reduce water treatment by 1% (The Nature Conservancy and International Water Association 2014). Therefore, annual water treatment costs in the Brandywine-Christina watershed could potentially be reduced by $2.5 million.

Reduced nitrogen, sediment, and associated bacteria pollutant loads can provide annual benefits that range from a low-bound estimate of $5.9 million to a high-bound estimate of $20.2 million in the water supply ($2.5 million), forest ($0.3 million), agriculture ($0.7–$7.4 million), navigation ($0.8–$0.9 million), and nonuse swimming recreation ($1.6–$9.1 million) sectors in the Brandywine-Christina watershed (Table ES.3).

Table ES.3. Estimated potential benefits of improved water quality in the Brandywine-Christina watershed

Sector	Activity	2010 ($ mil)	
		Low Bound	*High Bound*
Water Supply	Reduced sediment load by 4% decreases surface water treatment costs by 1% for water supply withdrawals of 55 million gallons per day (mgd).	2.5	2.5
Forests	10% increase in 133,760 acres of forests reduces water treatment costs (55 mgd) by 20% ($33/mgd).	0.3	0.3
Agriculture	Reduced soil erosion and avoided loss of crop and agriculture sales from 135,000 acres of farmland.	0.7	7.4
Navigation	Reduce sediment loads by 48%–56% as per TMDL to avoid dredging costs for 200,000 cubic yards (CY) of sediment at $8.09/CY.	0.8	0.9
Nonuse	Willingness to pay ($10.62 to $60.00 per person) for swimmable water quality for adult population of 461,000 in the watershed.	1.6	9.1
Total		5.9	20.2

The City of Newark along White Clay Creek, the City of Wilmington along Brandywine Creek, and other water purveyors often curtail withdrawals and incur higher treatment costs when turbidity exceeds 20 nephelometric turbidity units (NTU) at United States Geological Survey (USGS) stream gaging stations. This suggests additional savings could be achieved through turbidity reductions. A real-time turbidity station is needed along the Red Clay Creek at the state line.

Clean drinking water also provides human-health benefits through reduced mortality, cancer, illness, and neurological/reproductive risks. In the summer of 2014, nutrient-induced algal blooms along Lake Erie caused outbreaks in Milwaukee, Wisconsin, and Walkerton, Ontario, and the shutdown of Toledo, Ohio, intakes. The risk of waterborne disease should be considered in the economics of source water protection and public drinking water safety.

A recent study evidenced strong public support in Delaware for public funding of water quality improvements. The Delaware Nature Society, with support from The Nature Conservancy, commissioned a survey of 400 Delaware residents (OpinionWorks LLC 2015). The poll found that the public (without knowledge of details) profoundly supported the concept of a clean water fee by a nearly 2-to-1 margin (57% in favor, 32% opposed). Support for the fee crosses party and county lines: 66% of Democrats and 52% of Republicans support a clean water fee, and the measure enjoys support from 57%, 53%, and 58% of the residents of New Castle, Kent, and Sussex Counties, respectively.

The ultimate success of the Water Fund will also depend upon a strong working relationship with the agricultural community. Fortunately, the members of the Regional Advisory Panel and the WPF Cluster Partners already have strong relationships with the agricultural communities in the watershed. These pre-existing relationships will prove invaluable in implementing the Water Fund.

E.S.6. Stakeholder Interview Process

Chapter Five summarizes the stakeholder interview process. Stakeholders interviewed for this preliminary feasibility study included water purveyors, municipalities, and other stormwater-regulated entities in the Brandywine-Christina watershed. Appendix D includes detailed notes from each interview. After initial engagement, the following stakeholders expressed an interest in continuing a dialogue about how to work collaboratively in the watershed to achieve water quality improvements:

- City of Wilmington
- City of Newark
- New Castle County
- Delaware Department of Transportation
- Christina TMDL Implementation Plan representatives
- Aqua Pennsylvania
- Pennsylvania American
- United Water Delaware

The primary water quality stressors consistently identified in stakeholder interviews were sediments, nutrients, and stormwater volume. There was also interest in developing a more robust emergency response/early warning system with respect to water quality threats throughout the watershed.

Stakeholders expressed a general appreciation for the leverage achievable through pooling investments throughout the watershed and saw the value in taking a whole-watershed approach. At this phase of the project, there is no indication that the geographic scope of the Water Fund should be narrowed or limited to any particular portion of the watershed; though, as the development of the Water Fund progresses the issue of equitable investments across subwatersheds may need to be addressed.

For some stakeholders, regulatory drivers can provide an important incentive to increase water quality investments. The current regulatory environment offers encouraging opportunities for implementation of market-based approaches to achieving regulatory compliance in the watershed. Indeed, USEPA, PADEP, and DNREC have all expressed an interest in further exploring this collaborative effort.

Both stakeholders and the Regional Advisory Panel emphasized the importance of a robust communications and outreach plan to engage key constituencies throughout the watershed. Such communication and outreach can be targeted to specific interest groups, including ratepayers, regulators, legislators, municipalities, corporations, and members of the agricultural community.

E.S.7. Communications

Chapter Six summarizes the communications approach. As evidenced by the evaluation of case studies and feedback from stakeholders and the Regional Advisory Panel, communication and outreach are important components of a successful water fund. The project team has developed and conducted targeted communications with stakeholders and the Regional Advisory Panel. This outreach employed a variety of engagement methods, including Regional Advisory Panel meetings, development of a project website, written communication, stakeholder interviews, presentations, and informal meetings and discussions. As the project progresses, additional forms of communication and outreach will be developed and employed.

E.S.8. Conclusions

In Chapter Seven the conclusions are presented. This report reflects findings from the initial phase of analysis for a water fund to support water quality (and perhaps quantity) improvements in the Brandywine-Christina watershed. Based on the case study research, economic analysis, feedback received from the Regional Advisory Panel, and the stakeholders interviewed, the project team concludes that a water fund offers a financially and politically viable approach to water quality (and perhaps quantity) improvement in the Brandywine-Christina watershed. This conclusion is based on the following factors (among others): (1) an opportunity exists to expand on and increase the efficiency of current conservation initiatives in the watershed, (2) regulators appear open to exploring more flexible regulatory approaches to achieving water quality (and possibly quantity) goals, (3) water purveyors, stormwater managers, and potential public and private funders have expressed interest in exploring more cost-effective water quality (and possibly quantity) strategies, including nature-based solutions. The initial analysis has not indicated any

insurmountable barriers to design and implementation for a water fund and a set of key stakeholders interested in continuing discussions has been identified.

This preliminary feasibility study reaches the following conclusions:

Regulatory Structure: Based on feedback from the Regional Advisory Panel and key stakeholders, a water fund for the Brandywine-Christina watershed will have the greatest chance to accelerate the pace and increase the scale of pollution reduction if:

- The Water Fund can finance projects that are identified and prioritized based on their demonstrated ability to improve water quality (rather than on the basis of regulatory jurisdiction or other regulatory requirements).
- The Water Fund can ultimately scale up conservation finance in the watershed (e.g., through low-interest loans, grants, or matching funds).
- A regulatory structure is in place that allows municipalities that contribute to the fund to receive offsets/credits to meet their Municipal Separate Storm Sewer System (MS4) permit pollutant reduction requirements (even if implementation of those projects occurs outside of the contributing municipality's jurisdiction).

To be successful, the Water Fund must:

- Add value to conservation of the watershed and not duplicate or diminish the overall impact of preexisting initiatives.
- Measure water quality improvements in the watershed against the goals of swimmable, fishable, and potable waters, which will require removing impairments from the watershed's streams.
- Must be able to demonstrate a favorable economic return on investment.

Water Purveyors and Stormwater Managers: Water purveyors and stormwater managers in the watershed must drive the next phase of analysis, design, and implementation. These key stakeholders are making or may be making the largest local investments to protect and restore water quality. Their involvement in the design and implementation phase is essential for success.

This watershed presents the opportunity to design a program with water purveyors and stormwater managers. The case study research shows that most existing programs involve water purveyors as the main stakeholders. However, given the overlap between the areas that provide the drinking water supply for purveyors and the jurisdictions subject to MS4 permits, there is an opportunity for collaboration between these two groups in this watershed, and this opportunity should be further explored. Meeting the goals of the Water Fund will require determining the broad areas of consensus among these groups and focusing efforts there (Figure ES.7). This area of overlap includes, among other things, identifying pollutants of concern and developing strategies for watershed protection (BMPs, prioritization of landscape position and land use type, etc.).

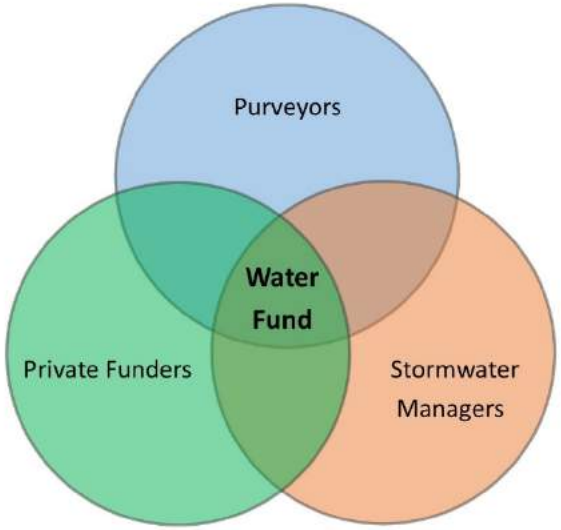


Figure ES.7. Areas of consensus for a multi-stakeholder water fund

Water Fund Structure: As demonstrated by the case studies, the financial structure for a water fund in the Brandywine-Christina watershed could be relatively simple—either one fund for the entire watershed or a fund for each of the four subwatersheds accompanied by an umbrella fund for the entire watershed. The revenue sources for contributions to the fund would be at the discretion of each contributor.

The governance structure would likely reflect the financial structure (i.e., one board for the entire watershed or a separate board for each of the four watersheds with an umbrella board). As the key stakeholders, water purveyors and stormwater managers would decide who sits on the board, how decisions are made about project selection, and whether there is a need for a technical advisory board to assist with project review. These decisions would be part of the design and implementation phases.

Given the level of existing expertise in the watershed with the design and implementation of conservation strategies, it seems unlikely that the administrative structure would include project design and implementation. Case studies demonstrated that programs such as the Quito Water Fund, which has an administrative structure that includes project design and implementation, are found in watersheds where there is no existing expertise.

Jurisdiction: As demonstrated by the case studies, these programs can cross jurisdictional lines. State lines should not prohibit the adoption of a watershed-wide fund. If a state line restricts some funding, both restricted and unrestricted funds can be managed within the same financial structure. The case studies include examples of programs that include multiple jurisdictions, including the Upper Neuse Clean Water Initiative and the Intergovernmental Cooperation Agreement for Implementation of the York County Regional Chesapeake Bay Pollutant Plan.

Economic Analysis: The economic analysis provides an example of how selecting an interim water quality goal (meeting TMDLs) can help shape implementation of conservation strategies by helping to target the location of implementation (subwatersheds providing the largest pollutant loads) and how maximizing the least-cost approaches can reduce the costs of achieving significant water quality improvements. This conclusion is supported by the experience of New York City's source water protection program and its success working with farmers to implement whole-farm plans as a cost-effective way to reduce pollutant loads.

Estimated annual costs to reduce pollutant loads in the Brandywine-Christina range from $5.5 million for nitrogen to $4.4 million for sediment over a ten-year period between 2015 and 2025 (Table ES.4). Load reduction costs are complementary since agriculture conservation BMPs that reduce nitrogen also reduce sediment and phosphorus and bacteria.

Risk Avoidance and Other Benefits: Clean drinking water provides human-health benefits through reduced mortality, cancer risk, illness, and neurological/reproductive risks. Improving water quality could provide estimated annual benefits that range from a low-bound estimate of $5.9 million to a high-bound estimate of $20.2 million in the water supply ($2.5 million), forest ($0.3 million), agriculture ($0.7–$7.4 million), navigation ($0.8–$0.9 million), and nonuse swimming recreation ($1.6–$9.1 million) sectors in the Brandywine-Christina watershed.

Table ES.4. Estimated benefits and costs of improved water quality in the Brandywine-Christina watershed

Parameter	Low Bound ($ mil/yr)	High Bound ($ mil/yr)
Benefits (B)	5.9	20.2
Costs (C)	4.4	5.5

Agricultural Incentives: Because of the amount of agricultural land in the watershed, maximizing the benefits to be achieved through implementation of agricultural BMPs should be part of the strategic plan to improve water quality in the watershed. Given the recent announcement of new regional and state funding through the Natural Resource Conservation Service's Regional Conservation Partnership Program (RCPP), there is an important opportunity to maximize the impacts of these federal investments in the Brandywine-Christina watershed to achieve the greatest improvements in water quality possible.

Communication: As recommended by both the Regional Advisory Panel and stakeholders interviewed, there is a need for effective communication throughout the watershed as well as communications targeting key constituencies.

E.S.9. Recommendations

The conclusions lead to the following recommendations for the next phase in the design and implementation of the Water Fund:

1. Continue to draw upon the expertise, connections, and wisdom of the Regional Advisory Panel as necessary to further develop the Water Fund. Expand the panel to include additional experts in the field and managers from existing programs.
2. Encourage regulators to consider alternative and additional approaches to achieving regulatory compliance.
3. Advance the dialogue with the water purveyors and stormwater managers who have expressed interest in remaining involved in this process, focusing in particular on (1) understanding the costs stakeholders currently are facing to address water quality and quantity issues, (2) quantifying the alternative costs associated with equivalent conservation strategies, and (3) modeling the effectiveness of such conservation strategies. Build on the information gained in the above dialogue to develop a refined benefit–cost analysis and assessment of conservation strategies that will result in a comprehensive and strategic business plan for the entire Brandywine-Christina watershed. Essential components of this analysis should include:
    - Work with partners and stakeholders to consolidate the recommendations from existing watershed management plans for the Brandywine-Christina watershed and confirm their continued validity.
    - Work with partners in the watershed to evaluate the opportunities, relative implementation costs, and water quality improvements associated with three conservation strategies: land acquisition, conservation easements, and implementation of agricultural BMPs. Costs should include technical assistance and maintenance over the expected life of the projects.
    - Work with the agricultural community and partners in the watershed to conduct a subwatershed-scale analysis of existing agricultural BMPs and opportunities for implementation of additional agricultural BMPs.
    - Conduct an analysis of the most effective conservation strategies to reduce the volume of urban stormwater and identify where those strategies should be implemented.
    - Implement real-time monitoring of turbidity, nutrients, and volume at locations strategically selected to determine the sources of pollutants on a subwatershed basis.
    - Develop a decision-making process for prioritizing implementation of the strategic business plan and leveraging local investments with state, federal, and private foundation investments based on experience within the watershed.
4. Recognize that water purveyors and stormwater managers will have different motivations for participating and structure the Water Fund to ensure that the needs of both stakeholder groups are met.

5. Work with the agricultural community to develop a firm understanding of its business realities, needs, and concerns and structure the Water Fund to addresses them.
6. Work with partners in the watershed who have experience implementing conservation strategies to ensure that the Water Fund adds value and momentum to these efforts as opposed to detracting from them.

CHAPTER ONE—WATERSHED CHARACTERIZATION

1.1. Introduction

The Brandywine-Christina watershed is a valuable multi-use watershed (Figure 1.1). It is a major source of drinking water, recreation, biological diversity, and agricultural production. Moreover, it's an economic engine worth $1.6 billion in annual economic activity, $900 million in annual ecosystem goods and services (2010 dollars), and $4.9 billion in annual wages (from 125,000 direct and indirect jobs). Preserving and enhancing these values is of great interest to the region.

Water quality in the watershed is of great interest to water purveyors from treatment and risk-management perspectives. In addition, under the federal Clean Water Act, the 60 local governments in the Brandywine-Christina watershed are required to restore streams to fishable and swimmable goals through watershed-based Total Maximum Daily Loads (TMDLs) set by the United States Environmental Protection Agency (USEPA), Delaware Department of Natural Resources and Environmental Control (DNREC), Pennsylvania Department of Environmental Protection (DEP), and municipal-based National Pollutant Discharge Elimination (NPDES) Municipal Separate Storm Sewer System (MS4) permits.

Funding water quality restoration throughout the watershed presents many challenges. Meeting all of the applicable regulatory standards using traditional gray infrastructure to manage stormwater, filter drinking water at filtration plants, and treat wastewater at treatment plants is becoming cost prohibitive especially in the face of declining federal and state water resources revenues and investments. Natural infrastructure solutions are cost-effective, but more funding is needed to implement them at scale. Many nonprofit organizations in the watershed have been implementing natural infrastructure solutions to improve the health of the watershed, but funding constraints limit the capacity to put a sufficient number of projects in the ground. The Brandywine-Christina watershed lacks a coordinated and sustainable financing mechanism, which hampers progress in restoring the watershed.

Under a grant from the William Penn Foundation, the University of Delaware's Water Resources Agency and The Nature Conservancy in Delaware have been working for the past year with partners in the watershed to conduct an initial feasibility study for a new business model to restore the health of the Brandywine-Christina watershed. The overarching vision for the Brandywine-Christina Healthy Water Fund is to leverage and maximize financial resources to improve the health of the Brandywine-Christina watershed for the benefit of people and nature. This vision will be achieved through a funding mechanism and science-based investment protocol that creates a dependable funding stream for strategic investments in conservation-based restoration projects to meet the watershed's water quality goals by 2025.

The one-year preliminary feasibility study process concluded in February 2015. The information collected and research conducted over this one-year period is provided in detail in this report. Chapter One characterizes the Brandywine-Christina watershed,

including its multi-use function; the bi-state complexity of the watershed; land use; population; and water quality impairments. Chapter Two explains the establishment and important role of the Regional Advisory Panel. Chapter Three provides an in-depth summary of the literature review and case studies of payment for watershed services. Chapter Four provides a detailed economic analysis conducted for the watershed. The stakeholder process, identification, interview protocol, and outcomes are discussed in Chapter Five. Chapter Six summarizes the communications conducted in year one of this project. The final chapter presents the project team's conclusions and recommendations regarding the feasibility of a water fund in the Brandywine-Christina watershed, finding that it is feasible to continue with the design and development of a water fund.

Figure 1.1. The Brandywine-Christina watershed

1.2. The Brandywine-Christina Watershed

Spanning 565 square miles, the Brandywine-Christina watershed, also referred to as the Christina Basin, is an integral part of the larger Delaware River Basin. Its headwaters and two-thirds of the watershed are in Pennsylvania. The Brandywine-Christina is only one of two interstate watersheds in the entire basin, adding complexity to the management of the watershed; it is also the second-largest watershed draining to the Delaware Estuary (after the Schuylkill). The watershed includes the following governing entities:

- Three states: Delaware, Pennsylvania, and Maryland.
- Five counties: Chester, Lancaster, and Delaware counties in Pennsylvania; New Castle County in Delaware; and Cecil County in Maryland.
- Over 60 townships, boroughs, and cities such as Elsmere, Newark, Newport, and Wilmington in Delaware and Avondale, Coatesville, Downingtown, Kennett Square, West Chester, and West Grove in Pennsylvania.

The watershed includes the Brandywine, Red Clay Creek, White Clay Creek, and the Christina River subwatersheds (Table 1.1).

Table 1.1. Subwatersheds of the Brandywine-Christina watershed

State	Tributary	Square Miles	% In State	% of Total
PA	Brandywine Creek	301	93%	
DE	Brandywine Creek	23	7%	
		324		**58%**
MD	Christina River	8	10%	
DE	Christina River	67	86%	
PA	Christina River	2	3%	
		78		**14%**
PA	Red Clay Creek	33	61%	
DE	Red Clay Creek	21	39%	
		54		**10%**
PA	White Clay Creek	61	57%	
DE	White Clay Creek	46	43%	
MD	White Clay Creek	0	0%	
		107		19%
	TOTAL	**564**		**100%**

The Brandywine-Christina watershed is divided into 28% urban/suburban, 39% agriculture, and 33% forest/wetlands/open-water land uses (Table 1.2 and Figure 1.2). The Pennsylvania portion of the watershed is characterized by open space, including agricultural land and forests, while the southern portion in Delaware tends to have more developed land. Only a very small piece of the watershed lies in Maryland.

Table 1.2. Brandywine-Christina watershed land use, 2005 (NOAA CSC)

Watershed	Urban/ Suburb. (mi^2)	Agric. (mi^2)	Forest/ Wetland (mi^2)	Total	Urban/ Suburb. (%)	Agric. (%)	Forest/ Wetland (%)
Brandywine	60.1	147.7	117.5	325.4	18%	45%	37%
Red Clay	14.7	20.9	18.4	54.1	27%	39%	34%
White Clay	36.8	38.1	32.3	107.3	34%	36%	30%
Christina	45.2	11.2	20.7	77.1	59%	15%	26%
Brandywine-Christina	156.8	218.0	189.0	563.8	28%	39%	33%

The Brandywine-Christina watershed serves an essential role in meeting the drinking water needs of the residents and industries in Delaware and Pennsylvania. The Brandywine-Christina can supply up to 100 million gallons per day of drinking water from surface and groundwater sources for close to 600,000 people in both states. The watershed supplies over 60% of the drinking water to Delaware residents.

The Brandywine-Christina watershed provides numerous ecological and natural functions while also serving as a recreation destination. The White Clay Creek is designated by the U.S. Congress as a National Wild and Scenic River and is one of only two wild and scenic rivers in the United States designated on a watershed basis. The Brandywine-Christina watershed includes many miles of high-quality, cold-water trout streams in Pennsylvania and is home to the only six trout streams in Delaware. The watershed functions as protected-species habitat for the bald eagle, brook trout (the state fish of Pennsylvania), cerulean warbler, and bog turtle. The watershed has a growing ecotourism industry with canoe and kayak liveries along the Brandywine River. The watershed is an important attraction for a variety of popular recreational activities in the mid-Atlantic region, such as hiking, biking, and bird watching.

Population

The population in the watershed increased by 42,000 people from 2000 to 2010 with population numbers at 549,000 and 591,000 respectively (Table 1.3). The Brandywine Creek is home to 42% of the watershed's population (Figure 1.3). Nearly 60% of the watershed residents live in Delaware and 40% live upstream in Pennsylvania (Figure 1.4).

Table 1.3. Brandywine-Christina watershed population change, 2000–2010 (U.S. Census)

Watershed	Area (mi2)	2000 pop.	2010 pop.	Change	2000 (p/mi2)	2010 (p/mi2)
Brandywine Creek	326	221,413	246,702	25,289	679	757
Red Clay Creek	54	42,630	46,893	4,263	789	868
White Clay Creek	107	118,579	123,506	4,927	1,109	1,155
Christina River	78	166,435	174,196	7,761	2,134	2,233
Brandywine-Christina	564	549,057	591,297	42,240	972	1,047

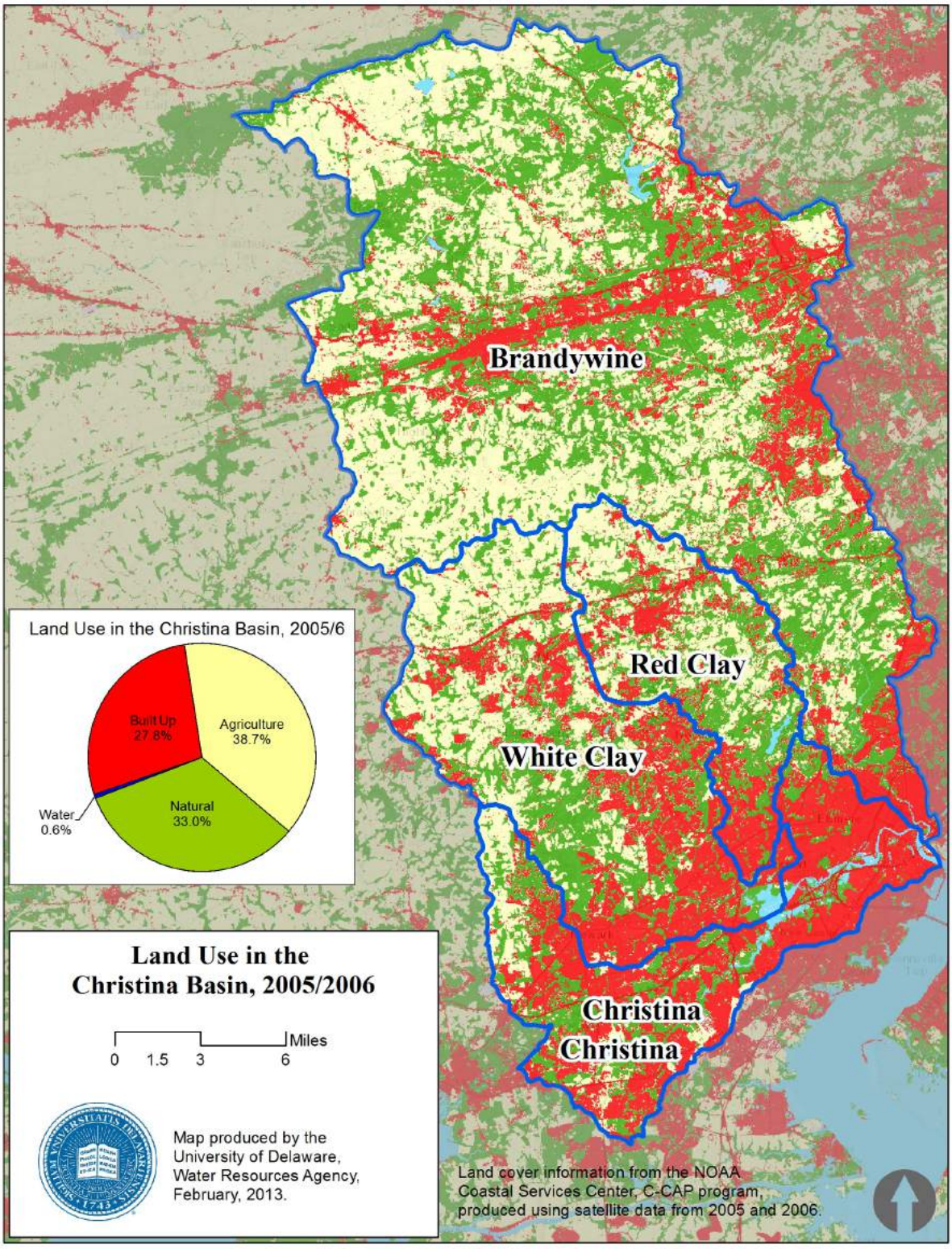


Figure 1.2 Land use in the Brandywine-Christina watershed (NOAA CSC, 2005)

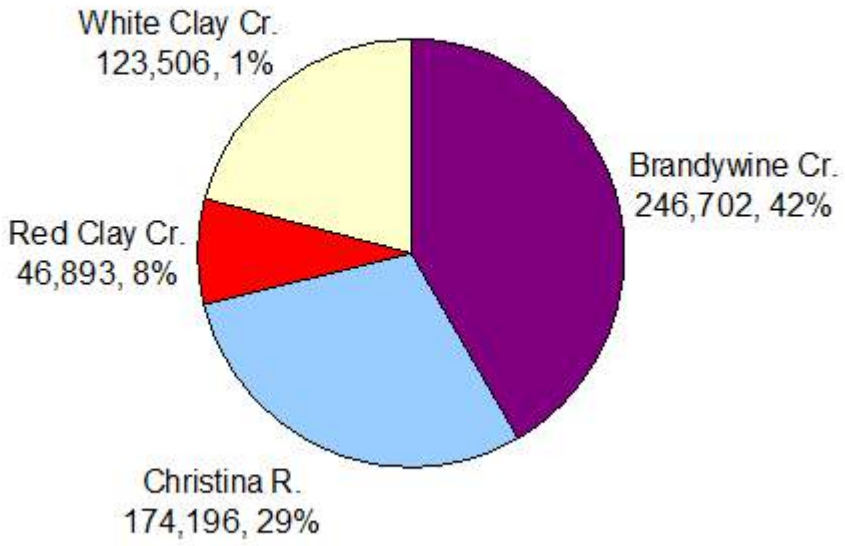


Figure 1.3. Population in the Brandywine-Christina watershed, 2010

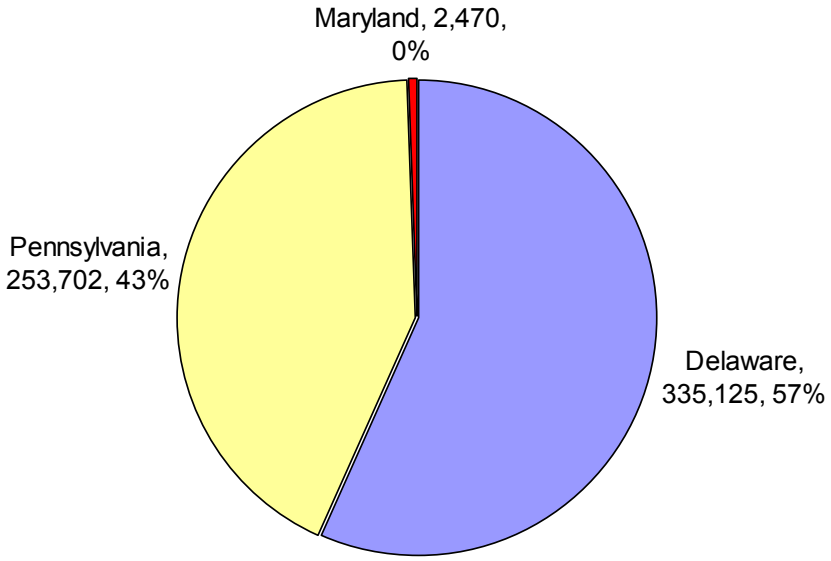


Figure 1.4. Population by state in the Brandywine-Christina watershed, 2010

Impairments and Water Quality Regulations in the Watershed

Many threats impact water quality in streams throughout the watershed, including toxic legacy pollutants, nutrient overloads, failing septic systems, and urban runoff that have rendered the great majority of the streams, rivers, and lakes in this watershed unsafe for swimming and fishing, let alone drinking without treatment.

Municipalities and private water purveyors in Pennsylvania and Delaware draw 55 million gallons per day (mgd) of drinking water for over a half million people in the watershed and

must meet federal standards under the Safe Drinking Water Act. The Clean Water Act (CWA) requires assessment of water resources and improvements in water quality where needed. Streams in the Brandywine-Christina watershed are impaired by many pollutants, including nutrients (such as nitrogen and phosphorus), bacteria, and sediment (Figures 1.5 and 1.6). Section 303 of the CWA requires the adoption of watershed-based Total Maximum Daily Loads (TMDLs) to remedy these impairments. The 2006 Brandywine-Christina high flow TMDL mandates reductions in bacteria ranging from 29% to 93%, sediment by over 50% and nitrogen and phosphorus reductions up to 75% (Table 1.4).

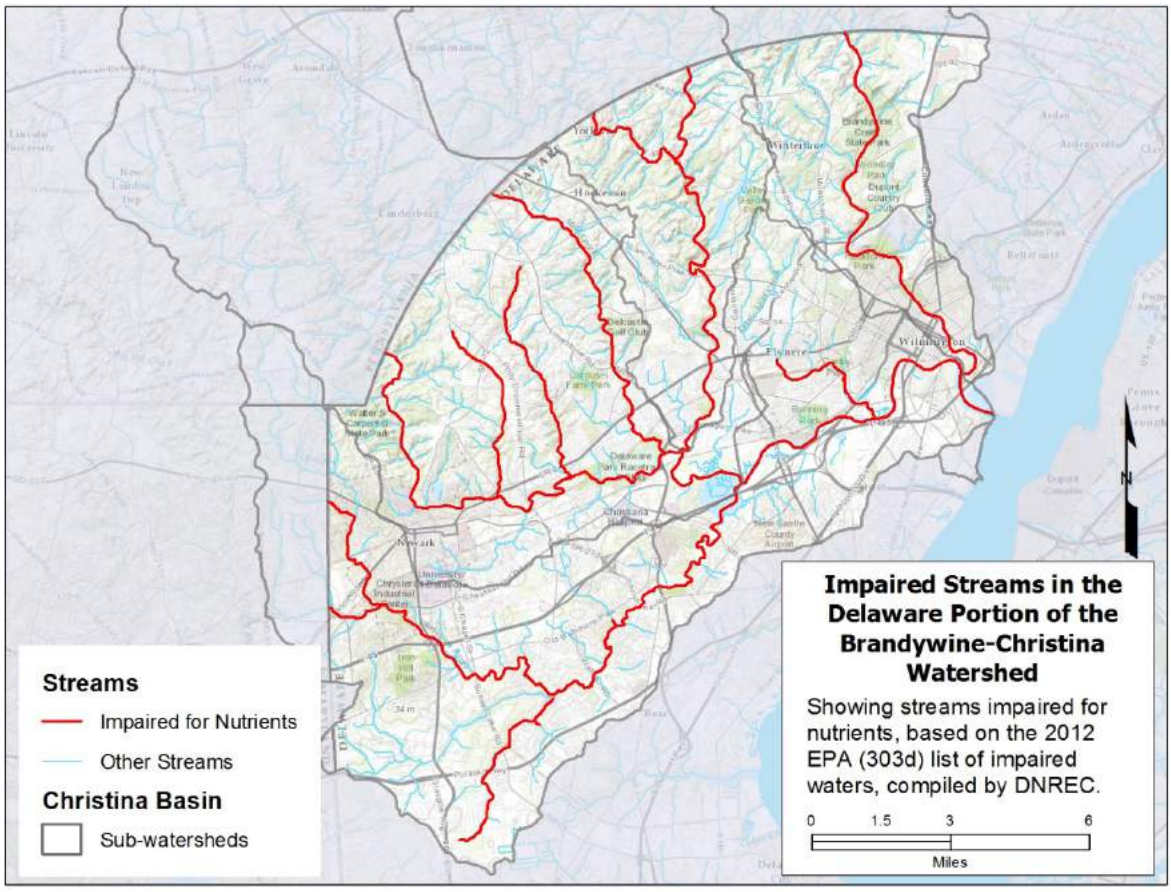


Figure 1.5. Streams impaired for nutrients in the Delaware portion of the Christina Basin, 2012 (DNREC and UDWRA)

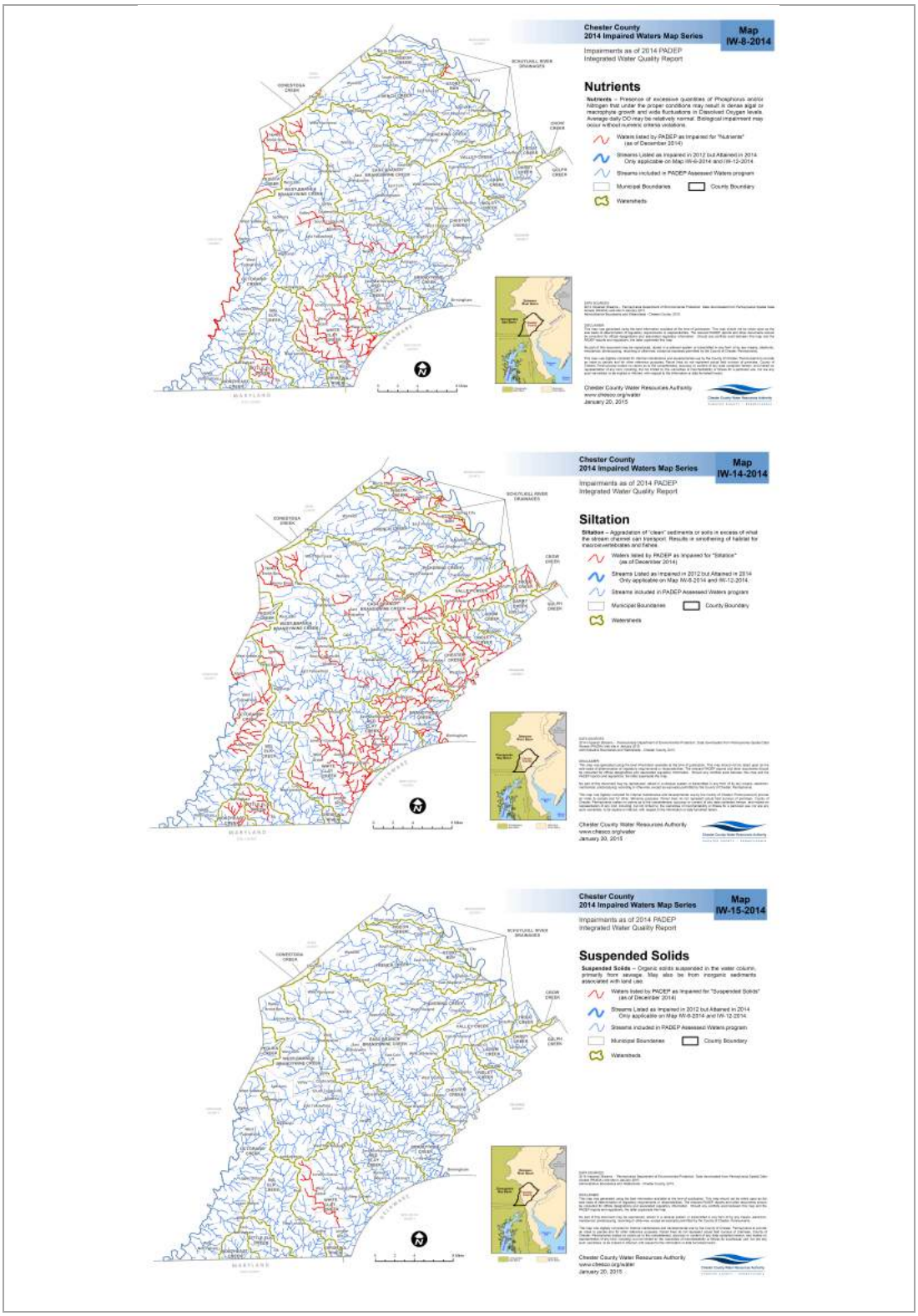


Figure 1.6. Streams impaired for nutrients, siltation, and suspended solids in Chester County, PA, 2014 (PADEP and CCWRA)

Table 1.4. High flow nonpoint source TMDL reductions in the Christina Basin (EPA, DNREC, and PADEP 2006)

Watershed	Percent Reduction (%)			
Pennsylvania–Delaware Line	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	93%	16 – 60%	46%	41%
Red Clay Creek	58%	45 – 52%	31%	40%
White Clay Creek	70%	26 – 70%	28%	73%
Christina River (at MD–DE line)	58%		73%	48%
In Delaware	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	88 – 94%		16%	36%
Red Clay Creek	29 – 89%		49%	54%
White Clay Creek	66 – 89%			
Christina River	61 – 91%		6%	9%
CSO Discharges, Wilmington, DE	**Bacteria**	**Sediment**	**Total N**	**Total P**
Brandywine Creek	63%		64%	63%
Christina River	72%		72%	72%

As part of their political-boundary-based NPDES MS4 permits under Section 402, the 60 local governments in Pennsylvania and Delaware, as well as New Castle County and the Delaware Department of Transportation (DelDOT), are required to meet water quality standards and reductions in the watershed.

The interstate nature of the watershed and the numerous governing bodies and regulations create a complex operating environment. Although the interstate nature of the watershed creates complexities, water quality improvements are occurring due to the efforts of private and nonprofit groups, the regulatory actions of states, and the efforts of local governments. These efforts include, but are not limited to, the Christina Basin TMDL Implementation Plan (CTIP) led by the Brandywine Valley Association, Chester County Water Resources Authority, and Chester County Conservation District; the Christina Basin Pollution Control Strategy (PCS) led by the Delaware DNREC and University of Delaware; private efforts of conservation groups; and the Christina Basin Clean Water Partnership, a unique interstate partnership.

Interstate Watershed Partnership

Since 1994, an interstate partnership effort between the USEPA, Delaware River Basin Commission, Commonwealth of Pennsylvania, and State of Delaware has been working to restore the Brandywine, Red Clay Creek, White Clay Creek, and Christina River to fishable, swimmable, and potable status (Figure 1.7). The Brandywine-Christina is the second-largest watershed draining to the Delaware Estuary (after the Schuylkill) and is one of only two watersheds in the entire 13,000 square-mile Delaware Basin that cross state boundaries, a complex interstate policy challenge.

For close to 20 years, through the Christina Basin Clean Water Partnership, the organizations participating in this voluntary alliance have been communicating, meeting regularly, and coordinating water quality improvement projects such as reforestation,

stream restoration, urban/suburban stormwater retrofitting, and agricultural conservation. The group's goal is to be one of the first watersheds in the Delaware Valley to be restored to Clean Water Act fishable, swimmable, and potable goals and serve as an example of what can be achieved when governments in two states cooperate with progressive policies to restore the environment. The partnership focuses on five key areas of action including: (1) stormwater, (2) open space, (3) wastewater, (4) agriculture, and (5) education.

Figure 1.7. Christina Basin Clean Water Partnership

Economic Values

The water, natural resources, and ecosystems in the Brandywine-Christina watershed contribute an estimated economic value of $900 million to $4.9 billion annually to the Delaware and Pennsylvania economies. This value range is calculated through three different examinations, discussed below (Table 1.5) (Narvaez and Kauffman 2012).

1. **Economic value directly related to the Brandywine-Christina watershed's water resources and habitat.** The Brandywine-Christina watershed contributes $1.6 billion in annual economic activity from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and parks benefits. When accounting for navigation benefits at the Port of Wilmington, the watershed contributes $4.5 billion annually.

2. **Value of goods and services provided by the Brandywine-Christina watershed's ecosystems.** Using natural capital as a measure of value, habitat in the Brandywine-Christina watershed provides $900 million annually in ecosystem goods and services in 2010 dollars, with a net present value (NPV) of $29 billion calculated over a 100-year period.
3. **Employment related to the Brandywine-Christina watershed's resources and habitats.** Using employment as a measure of value, natural resources within the Brandywine-Christina watershed directly and indirectly support 125,000 jobs with $4.9 billion in annual wages.

The Brandywine-Christina watershed provides real and significant economic benefits to Delaware and Pennsylvania—benefits that are worthy of investment to keep these natural resources healthy and productive. Estimates were made by taking values from existing literature and studies and applying them to the Brandywine-Christina watershed using ecological economics and benefits-transfer techniques described later in this report. Values are converted to 2010 dollars based on the change in the Northeast Region Consumer Price Index except where noted.

Table 1.5. Annual economic value of the Brandywine-Christina watershed (Narvaez and Kauffman 2012)

Watershed	Economic Activity[1] ($ million)	Ecosystems Services ($ million)	Jobs	Wages ($ million)
Brandywine Creek	890	560	50,000	2,000
Red Clay Creek	145	84	10,000	425
White Clay Creek	420	165	25,000	1,000
Christina River[1]	190	99	40,000	1,500
Brandywine-Christina[1]	1,645	908	125,000	4,925

[1] Excludes navigation benefits from Port of Wilmington.

1.3. Watershed Management Planning Documents

Several watershed management plans have been developed for parts of the Brandywine-Christina watershed. The plans listed below are the most recent studies and were reviewed for this feasibility study.

- White Clay Creek Watershed Management Plan (2001)
- White Clay Creek, Red Clay Creek, Brandywine Creek Watershed Action Plans (2002)
- Brandywine Creek Watershed Conservation Plan (2002)
- Upper East Branch Brandywine Creek Conservation Plan (2004)
- Honey Brook Authority Wellhead Protection and Management Plan (2008)
- City of Wilmington Source Water Protection Plan (2010)
- Christina Basin Pollution Control Strategy (2011)
- PA American Water—Coatesville Source Water Protection Plan (2013)

Each plan was developed for a specific purpose. Some were designed to assist with countywide planning processes and others were completed to qualify for grant funding. Each plan addresses different geographic areas in the watershed. While none of the plans addresses the entire Brandywine-Christina watershed, consolidation of the plans would accomplish much of the work needed to create a watershed-wide plan.

A review of the plans demonstrates agreement across the entire watershed about the priority actions needed to address water quality concerns (Table 1.6). The recommended actions common across the plans include:

- Agricultural mitigation – nutrient management plans, cover crops, livestock fencing
- Riparian buffers – protection and restoration
- Forest preservation and reforestation
- Farmland preservation – fee and easements acquisition
- Open space preservation – fee and easements acquisition
- Headwater preservation – fee and easements acquisition
- Streambank restoration and stabilization
- Wetland/floodplain restoration and reconnection
- Stormwater retrofits in urban areas
- Reducing stormwater runoff to mitigate flooding, erosion, and sedimentation
- Increased tree canopy in urban/suburban areas

Two additional initiatives seek to assist local governments and organizations in prioritizing actions and locations to maximize the effectiveness of water quality projects:

- In 2011, the U.S. Army Corps of Engineers in partnership with the Pennsylvania Department of Environmental Protection initiated a project called the Chester, Delaware, and Montgomery Counties Regional Watershed Improvement Project. The goal of the project is "to improve and protect surface water resources and environmental infrastructure in portions of Chester, Delaware, and Montgomery Counties through regional coordination and collaboration" (ACOE 2011). This project

collected GIS layers relating the flooding, watershed health, and water quality for the Pennsylvania part of the Brandywine Creek watershed as well as other watersheds in the project area (Figure 1.8). The information was used to develop an online tool to prioritize these watersheds (the Decision Support Tool).

- The U.S. Environmental Protection Agency has been working in partnership with federal, state, and local partners to develop the Watershed Resources Registry (WRR). This resource is currently available only for Maryland, but it is being developed for Delaware and Pennsylvania. The registry is a compilation of GIS layers and is designed to be a mapping tool that:
    - Integrates regulatory and non-regulatory programs.
    - Guides resource planners.
    - Conserves program resources.
    - Highlights multiple environmental benefits.
    - Maximizes watershed benefits.

The objective of the WRR is to map natural resource areas that are a priority for preservation and identify sites that are best suited for ecosystem preservation and restoration. The WRR process aims to create a set of suitability analyses developed with sound science and the best professional judgment of regional experts. These analyses will be used as a screening tool to target opportunity sites for the protection of high-quality resources, restoration of impaired resources, and improvement of water resources. The analyses will specifically identify areas for upland preservation, upland restoration, wetland preservation, wetland restoration, riparian preservation, riparian restoration, natural-stormwater infrastructure preservation, and compromised-stormwater infrastructure restoration. By having both regulatory and non-regulatory agencies base decisions from a WRR, the integration and use of the watershed approach will become implicit, and "stovepipe" processes in decision-making will become obsolete. The results will streamline the regulatory and non-regulatory processes and ensure maximum environmental results.

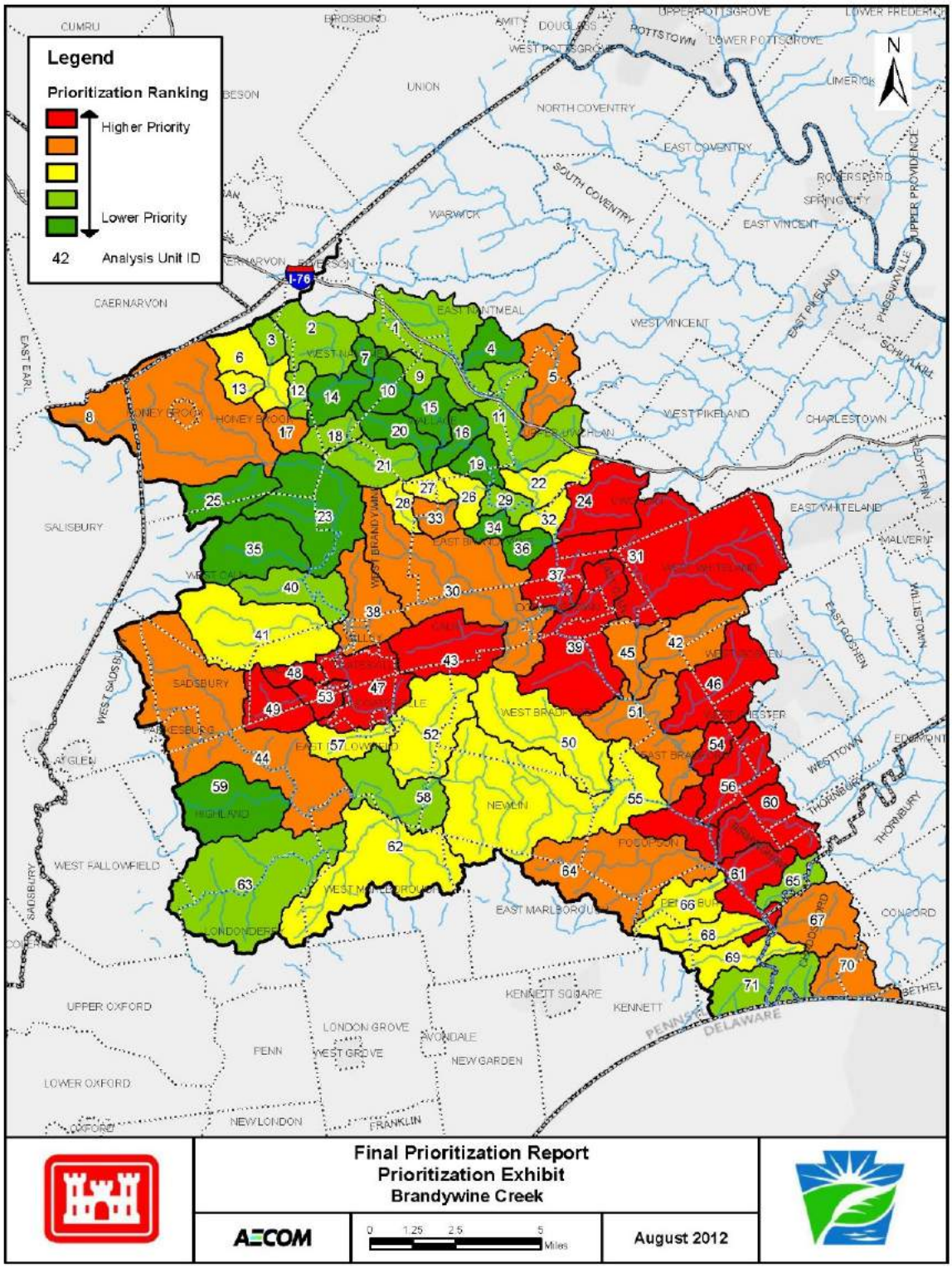


Figure 1.8. Pennsylvania portion of the Brandywine Creek watershed prioritization map (USACOE, PADE, AECOM, 2012)

Table 1.6. Priority actions from Brandywine-Christina watershed plans

Report	Watershed	Priority Actions
White Clay Creek Watershed Management Plan (2001)[1]	White Clay watershed, PA and DE	• Improve and conserve water quality and water quantity. • Conserve open space, woodlands, wetlands, and geologic features. • Protect native plant and animal species. • Preserve cultural, historical, and archaeological sites. • Enhance outdoor recreation opportunities. • Encourage environmental education and watershed awareness. • Protect and improve water quality and stream habitat through floodplain and wetland protection, riparian forest buffer enhancement, sediment and stormwater management, and slope protection. • Sustain biodiversity through habitat linkage and management. • Encourage dedication, purchase, and stewardship of open space. • Address stream bank stabilization, water quality enhancement, and restoration of fish and wildlife habitat on an integrated, comprehensive watershed-wide basis.
White Clay Creek, Red Clay Creek, Brandywine Creek Watershed Action Plans and Brandywine Creek Watershed Conservation Plan (2002)[2]	White Clay, Red Clay, Brandywine watersheds, PA and DE	• Reduce stormwater runoff to mitigate flooding, erosion, and sedimentation to restore water quality and riparian habitats (manure management, fencing, conservation plans, stormwater improvement projects and retrofits, stream restorations, and monitoring). • Protect and expand forested riparian buffer networks, particularly for first-order streams (protect existing buffers and establish new buffers). • Protect and enhance cultural, recreational, and historic resources (including open space preservation).
Upper East Branch Brandywine Creek Watershed Conservation Plan (2004)[3]	Brandywine watershed, PA	• Protect and maintain high-quality streams and improve conditions as necessary. • Preserve priority tributary watersheds. • Protect and restore degraded and threatened streams. • Further analyze significantly degraded streams for appropriate site-specific restoration activities. • Protect high quality of priority watershed reserve areas. • Protect priority wetland preserve areas. • Protect the Downingtown drinking water supply. • Address flooding hot-spots in Downingtown and identify stormwater retrofit needs. • Reforest most riparian areas within 100 feet of streams. • Preserve priority agricultural lands. • Protect an integrated system of forest and riparian hubs and corridors.
Honey Brook Borough Authority Wellhead Protection and Management Plan (2008)[4]	Brandywine watershed, PA	Recommended actions for agricultural lands in wellhead protection zone: • Encourage farmers to implement nutrient management plans. • Create and maintain current inventory of conservation and nutrient management plans. • Ensure availability of skilled technical assistant to assist landowners in implementation. • Offer financial incentives for construction of buffers within wellhead protection zone. • Encourage integrated crop management planning and planting that lessen the use of fertilizer and minimize soil disruption (no-till).

Report	Watershed	Priority Actions
Wilmington Source Water Protection Plan (2010)[5]	Brandywine watershed, PA	• Agricultural mitigation (stream bank fencing, conservation and nutrient management plans). • Agricultural preservation. • Forest preservation. • Open space preservation. • Riparian buffer and forest reforestation. • Stormwater runoff mitigation.
Christina Basin Pollution Control Strategy (2011) [6]	Christina, White Clay, Red Clay, Brandywine watersheds, DE	Stormwater management • Increase urban tree canopy. • Identify areas where stormwater retrofits will effectively reduce sediment and nutrients. Open space preservation and protection • Protect existing wooded/vegetated open space areas. • Require management plans for community open space areas that are designed for water quality protection, including reduced nutrient loading. • Require forested riparian buffers of adequate and proper widths sufficient to reduce or eliminate nonpoint source pollution for all new development. • Implement stream restoration projects. • Acquire/conserve additional open space and retain conservation easements. • Reforest watersheds and headwaters. Agriculture • Develop and implement nutrient management plans. • Plant cover crops. • Construct pasture stream fencing. • Install grassed filter strips. • Establish grassed waterways. • Install forested riparian buffers. • Establish pasture and hay planting.
PA American–Coatesville Source Water Protection Plan (2013)[7]	Brandywine watershed, PA	• Work with the William Penn Foundation Christina Team, the Partnership for the Delaware Estuary, the Brandywine Valley Association, the Coatesville Area Arts Alliance, the Brandywine Conservancy, and other environmental organizations on watershed-wide source water protection events and activities. To assist in planning, provide the GIS shapefiles for protection zones. • Work with the Conservation District to ensure that farms near the Rock Run Reservoir and Honey Brook have current and implemented conservation and nutrient management plans. • Work with the Conservation District to encourage farmers within the protection zones to implement agricultural BMPs. • Work with the Coatesville Country Club on suggestions for BMPs on the golf course.

[1] White Clay Wild and Scenic Study Task Force and National Park Service Northeast Region

[2] BVA, CCWRA, RCVA, Chester County Planning Commission, Camp Dresser and McKee, Gaadt Perspectives, LLC

[3] Brandywine Conservancy and Upper East Branch Steering Committee

[4] Honey Brook Borough Authority Wellhead Protection and Management Plan, March 2005, Spotts, Stevens, McCoy

[5] City of Wilmington, Delaware and Crockett Consulting

[6] Delaware Tributary Action Teams, DNREC and University of Delaware, Water Resources Agency

[7] PA American–Coatesville Source Water Protection Plan, October 2013, West Branch Brandywine Creek Rock Run Reservoir

1.4. Existing Watershed Restoration Initiatives

There are several local governments and organizations making investments in watershed restoration in the Brandywine-Christina watershed. The examples included in this study demonstrate activities already taking place and the range of organizations involved.

- In 2010, the City of Wilmington adopted its Source Water Protection Plan. The city has committed $279, 850 for source water protection projects since its adoption (Miller 2014).
- United Water Delaware, a private water purveyor in the White Clay Creek watershed, is committing $700,000 from 2012 through 2017 to watershed restoration projects as part of its LT2 permit (Hubbard 2014).
- The State of Delaware implemented a voluntary tax check-off for the benefit of the White Clay Creek. It has generated $11,000 in revenue since 2011. The White Clay Creek Wild and Scenic Management Committee decides how the funds are used.
- Christina TMDL Implementation Plan (CTIP) is a partnership of local organizations and 33 local governments. It has leveraged approximately $150,000 from the City of Wilmington and Pennsylvania local governments to bring in an additional $3 million, mostly from Pennsylvania's Growing Greener program, for seven restoration projects in the Brandywine-Christina watershed (Struble 2014).
- Victory Brewing founded the Headwaters Grant Program, under which one cent from every Headwaters Pale Ale sold goes into the grants awarded nationwide.
- DuPont's Clear into the Future initiative works with the community to preserve the Delaware Estuary by providing grants for research and restoration projects in the estuary, including the Brandywine-Christina basin.
- Chester County began the Brandywine Headwaters Preservation Program in 2010. The County describes the program as an effort "to increase the number of partners, further leverage limited public funds, and promote water quality improvements and permanently preserve land." The program uses the agricultural priority areas set out in Wilmington's Source Water Protection Plan to determine eligibility for the funding.
- In October 2014, the Chester County Economic Development Corporation (CCEDC) published "Vista 2025: Progress and Preservation." It is a strategic economic development plan for the next ten years. The first goal of the plan includes maintaining Chester County's quality of place. The plan calls for supporting natural land preservation because of the economic benefits of natural lands to the county and the role of natural lands in improving water quality (Vista 2025 at 7). The plan also emphasizes the importance of the agricultural sector to the county and the opportunities for growth in this sector (Vista 2025 at 16-17).

CHAPTER TWO—ADVISORY PANEL PROCESS

2.1. Stakeholder Engagement Process

Stakeholder consultation is a critical component of the feasibility analysis. It provides substantive information and contributes significantly to the credibility of the process and outcome. Each stakeholder consultation process will vary according to the unique circumstances and context of the watershed being considered (Schmeer 1999, Calvache & Ramos, 2012).

The primary goals of any stakeholder consultation process are:

- To ensure a well-informed and balanced assessment.
- To instill confidence in the assessment through an accessible and equitable process.
- To optimize the durability of the recommendations.
- To build and strengthen credibility.
- To strengthen overall stakeholder support.

The stakeholder consultation process is about identifying the full range of relevant information and issues (Schmeer 1999, Calvache and Ramos 2012). For this project, we employed two stakeholder engagement processes: convening a regional advisory panel, which will be discussed in this chapter, and interviewing key stakeholders, which will be discussed in Chapter Five.

2.2. Purpose and Composition of the Regional Advisory Panel

The Brandywine-Christina Water Fund Regional Advisory Panel is essential to this project to ensure that this is a transparent process with a feasible outcome. The panel members were invited by the project team to provide feedback and review in the development of the Water Fund. The role of the panel includes the following:

- Vet the approach of the feasibility study to ensure the process is well-informed, transparent, and representative of diverse interests in the watershed.
- Provide the project team with frank feedback and opinions both during and outside of advisory panel meetings.
- Point the team toward critical pieces of information where necessary.

The Regional Advisory Panel is composed of federal, state, and county government representatives, experts in the agriculture community, nonprofit representatives, and business leaders (Table 2.1). Generally, the members have a more regional perspective. Individual farmers or representatives of specific sectors or companies were not chosen for the Regional Advisory Panel. Instead, the panel is composed of individuals who already represent these diverse interests in the watershed. The panelists with expertise in these distinct areas, such as farming and industry, understand that they represent these perspectives, and their feedback to the project team reflects the varying interests and needs in the watershed. The composition of the group is deliberately diverse and

representative of the diversity of uses in the watershed as well as the considerations that are required to develop a successful water fund.

Once contacted and briefed on the project, potential panelists were requested to attend the following three meetings (a summary of each meeting is provided in Appendix A):

- Meeting 1: May 30, 2014 (Longwood Gardens, Kennett Square, Pa.)
- Meeting 2: September 18, 2014 (Mount Cuba, Hockessin, Del.)
- Meeting 3: January 14, 2015 (Stroud Water Research Center, Avondale, Pa.)

These meetings served to update the group on the Brandywine-Christina Water Fund project, the analysis and research conducted, the findings, and the overall progress of the project. The meetings were critical to get feedback and expertise from the panelists. The project team discussed and addressed all feedback provided by the advisory panel. This preliminary feasibility study incorporates the feedback and comments provided by the advisory panel members.

Table 2.1. Regional Advisory Panel Members

Regional Advisory Panel Members[1]	
Jennifer Adkins	Partnership for the Delaware Estuary
Janet Bowers, Alternate: Barbara D'Angelo	Chester County Water Resources Authority
Jon Capacasa	USEPA, Region 3
Kevin Donnelly	New Castle Conservation District
John Goodall	Brandywine Conservancy
Kenneth Najjar	Delaware River Basin Commission
Michael Leff, Alternate: Sarah Low	USDA/Urban Waters Federal Partnership
Robert Molzahn	Water Resources Association of the Delaware River Basin
Sec. David Small, Alternate: Frank Piorko	Delaware DNREC
Blaine Phillips	The Conservation Fund
Dawn Rittenhouse	DuPont
Domenic Rocco, Alternate: Rhonda Manning	Pennsylvania DEP, Southeast Regional Office
Donna Siter	Western Chester County Chamber of Commerce
Christian Strohmaier, Alternate: Adam Mowrey	Chester County Conservation District
Bernard Sweeney	Stroud Water Research Center

[1]Two large private companies in the watershed, Victory Brewing Company and ArcelorMittal, were invited to participate in this process but were not able to attend the advisory panel meetings.

CHAPTER THREE—CASE STUDIES AND MODELS

3.1. Water Fund Case Study Reviews

A recent overview of programs that invest in watershed services, sometimes called water funds, documents growing momentum. In the last two years, the number of established programs tripled globally. These 345 programs supported sustainable land management, restoration and preservation, and urban green infrastructure on more than 1.4 million square miles of land. Currently, public subsidies provide the largest share of financing, though national subsidies are decreasing in the United States. Private businesses in the United States invested $17.9 million in 2013 (Bennett and Carroll 2014).

After reviewing reports on these programs and researching individual case studies, the project team selected 16 representative programs to analyze more fully (Table 3.1). The analysis focused on watershed-based programs with diverse revenue streams that demonstrated a variety of elements and approaches.

The financial structures of these programs varied from establishing a bank account to setting up a fund with a community foundation to forming a private trust fund with a designated manager. Each program had more than one revenue source supporting project implementation. Several utilities dedicate a percentage of their utility rates for the fund; other utilities designate part of the water rate for the fund. Several programs rely on regular budget allocations from participants or regulator voluntary contributions. One program collects voluntary donations through a check-off on the water bill; another is supported by a voter-approved sales tax. As discussed below, all of the programs leverage their base funding to bring in government and private foundation grants.

Program administration varied more widely. Some programs functioned through bilateral agreements between a water utility and a land manager. Other programs relied on recommendations from an advisory panel to the water utility board that holds decision-making authority. Some multi-partner programs adopted an administration structure that includes a board of directors with representation from the largest investors and a technical secretariat that designs and implements projects.

In the review of these 16 programs and other case studies, the team identified six themes that include:

1. Developing strong public-private partnerships.
2. Leveraging state, federal, and private foundation funding.
3. Adopting a conservation or strategic plan.
4. Depending on champions and stewards.
5. Starting with seed money and maturing into identification of a steady funding source.
6. Adapting to the setting.

Several of these themes reflect similar conclusions found in the literature (e.g., Bennett et al. 2013; Majanen 2011; American Water Works Association and Trust for Public Land,

Protecting the Source 2004; American Water Works Association and Trust for Public Land, Source Protection Handbook 2004; Ernst 2004; Gartner et al. 2013; Calvache et al. 2012).

Theme 1: Developing Strong Public-Private Partnerships

Programs designed to address water quality concerns across a watershed are, by their nature, complex. They impact and benefit a large group of interested parties, address a large landscape, and require multiple kinds of expertise to develop. It is rare that one entity—whether a governmental body or private utility—has the capacity to develop and implement a watershed-wide program on its own, particularly because it is rare for one entity to own the majority of land in a watershed. To design a program that is effective, efficient, and collaborative, developing strong partnerships is essential. In all of the case studies we examined, these partnerships included both public and private partners (AWWA et al, Protecting the Source 2004; Gartner et al 2013).

The New York City Source Water Projection Program provides an excellent example of why public-private partnerships are essential to designing a program that works on the ground. More than a decade ago, the city developed a multi-pronged approach to preserving the quality of its drinking supply to avoid filtration. One part of this strategy was implementation of new nonpoint source regulations in the Catskills and Delaware watersheds. The land in these areas is agricultural and the farmers in the watershed did not like the proposed regulations. Some representatives from the agricultural community proposed to meet the water quality goals by working with farmers on whole farm plans. This group later formed what is now the Watershed Agricultural Council (WAC). State and federal regulators agreed to give the approach a chance.

Whole farm plans address environmental concerns to protect water resources without negatively impacting the farm business objectives. Farmers receive payments to implement projects required in the plans. Where possible, Natural Resource Conservation Service (NRCS) programs provide cost-share funding; the remainder of the funding for implementation of the plans comes from the city.

Initially, WAC was able to achieve an 85% enrollment rate of farmers who would adopt whole farm plans. Currently, they have 93% enrolled in this program. The acreage enlisted in whole farm plans is in addition to the 156,690 acres acquired or under easement through the city's land preservation strategy. NYC's 2002 renewal of the filtration avoidance determination was contingent in part on its strong relationship with WAC and other partners (NYC DEP 2006, USEPA 2007, Hulle et al. 2013). Without this public-private partnership, the city would likely have faced years of opposition by the agricultural community to the imposition of regulations.

Theme 2: Leveraging State, Federal, and Private Foundation Funding

Successful programs are able to leverage local investments to bring in additional state, federal, and private funding to vastly expand the area of impact.

The Truckee River Fund demonstrates the power of leveraging funds. It was established in 2004 by the Truckee Meadows Water Authority (TMWA). It is a regional water authority

that operates in a watershed that crosses the Nevada–California border. Because the watershed includes multiple jurisdictions, it is difficult for one entity to implement improvement projects.

The TMWA started the fund explicitly to enable local organizations and agencies to be in a better position to receive matching funds and develop partnerships with other public agencies. The utility asserts that the fund makes good business sense because leveraging funds means that the utility's customers spend less money to protect the Truckee River and its watershed. The fund has a simple structure. The utility commits 2% of its annual budget to the fund. It is managed by a community foundation, and the fund advisors are separate from the TWMA. Over ten years, 130 projects have been funded (www.truckeeriverfund.org).

Several case studies involved programs that were able to leverage dedicated state watershed protection funding. The availability of this state funding has expanded the impact of watershed protection in those states. Examples of state programs include the Rhode Island Water Resources Board, the North Carolina Clean Water Management Trust Fund, the Minnesota Clean Water Fund, the Oregon Water Enhancement Board grant program, and the Pennsylvania Growing Greener grant program (www.wrb.ri.gov; www.cwmtf.net; www.legacy.leg.mn/funds/clean-water-fund; www.oregon.gov/OWEB/GRANTS/pages/index.aspx; www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958).

Theme 3: Adopting a Conservation or Strategic Plan

At its core, a conservation plan or strategic plan represents the agreement among the project partners about the work to be done as part of the program. Development of the plan provides an opportunity to review the technical information available about the watershed, from its hydrology to its natural communities to the water quality threats. Perhaps more importantly, development of the plan strengthens partnerships among interested parties that will be the program's foundation as it moves into implementation (AWWA et al., Protecting the Source 2004; AWWA et al., Source Protection Handbook 2004).

One of the first tasks the Upper Neuse River Clean Water Initiative tackled was the adoption of a conservation plan. It was developed with the help of a technical team and stakeholder input. The plan prioritizes parcels for acquisition based on their ability to help protect water quality. The plan helped demonstrate to residents the connection between upstream and downstream communities (Triangle Land Conservancy and Tar River Land Conservancy for the Healthy Forest Initiative 2010, Hart 2006). The initiative's program activities now include adoption of BMPs on private forestlands in addition to land acquisition. Steady funding comes from a watershed protection fee added to water bills for Raleigh and Durham residents (www.pinchot.org/doc/465).

Theme 4: Champions and Stewards

As with any project, these water fund programs need champions and stewards. A "champion" is a local leader who was a robust supporter of the proposed program with key

stakeholders. "Stewards" are those government or organizational staff members who helped put all the pieces of the program together and shepherded it through the design, development, adoption, and implementation phases. These key players have also been referred to as local conveners and advocates (Gartner et al. 2013).

The mayor of Raleigh, Charles Meeker, was a champion of the Upper Neuse River Clean Water Initiative in the Raleigh–Durham area of North Carolina. He founded the initiative in response to increasing development and resulting threats to water quality in his community. Because of these threats, Raleigh was considering building a new water filtration system, estimated at $150 million. He convened a group of local government officials to discuss a partnership approach, and he worked with his council to get the initial $500,000 seed money approved for the initiative (U.S. Endowment for Forestry and Communities, Source Water Case Study; www.pinchot.org/doc/465; www.ctnc.org/land-trusts/statewide-land-protection-programs/upper-neuse-clean-water-initiative/).

Theme 5: Starting with Seed Money and Maturing into Identification of Steady Funding Sources

In general, the younger programs reviewed were funded through seed money, while the mature programs often have developed a dedicated source for local funds. This transition likely reflects a changing political landscape that can occur between initial implementation and wide acceptance across the watershed. As mentioned in several sources, the financing challenge for the project partners is to identify a politically viable selection of local funding sources to generate sufficient funds to support implementation of the conservation plan over the long term (Gartner et al 2013; AWWA, Protecting the Source 2004).

It is essential that communities understand that these investments reach beyond the individual conservation projects. The Freshwater Trust in Oregon has found that approximately 80% of funds invested in watershed restoration remain in the watershed—providing economic benefits to local business and organizations (e.g., earth-moving contractors and nurseries) and jobs for local workers (every $1 million spent on restoration creates up to 20 jobs) (www.thefreshwatertrust.org/main/wp-content/uploads/2013/09/WQT_Program-Overview_WEB_General_updated-10-2014.pdf).

The Conserve to Enhance program in Tucson, Arizona, has an innovative approach to developing seed money. The University of Arizona's Water Resources Research Center developed the model for the program. Tucson Water, the city utility, has set up a donation structure such that money saved by customers through water conservation is donated to the Conserve to Enhance program. The utility's monthly bill also includes a voluntary check-off for the program. It started in 2011 and has generated $40,000. The funds have been used to support local watershed restoration projects (http://conserve2enhance.org/Tucson; Bennett et al 2013). The Conserve to Enhance approach is one potential funding option that may not present significant political hurdles, though it is not likely to generate sufficient funds to meet program goals.

The development of Water Quality Credits (WQCs) could support conservation impact investments on a larger scale. This approach is being piloted in several watersheds across the nation, wherein:

- Capital would be raised for the water fund to finance conservation interventions designed to improve water quality (e.g., riparian buffer or agricultural cover crop planting, stream bank fencing, floodplain restoration).
- Such conservation interventions would be scientifically modeled or monitored to achieve demonstrable outcomes (e.g., nutrient and sediment removal at specific loads or flood storage at specific volumes).
- A third-party would certify the conservation value of each intervention and assign an "equivalency" to a corresponding gray infrastructure solution (e.g., sediment filtration or stormwater retention), thereby establishing the WQC.
- The applicable regulatory agency would recognize the validity, value, and equivalency of the WQCs and sanction their use by municipalities and other regulated entities (e.g., developers, wastewater treatment providers) to meet all or part of the entity's requirements under the Clean Water Act or state stormwater laws and regulations.
- Municipalities would purchase WQCs from the water fund at a significantly lower cost than that associated with implementation of an equivalent gray infrastructure solution.
- The water fund would generate a return on investment through the sale of WQCs by arbitraging the spread between the cost of implementing the conservation measure and the cost of an equivalent gray solution (www.thefreshwatertrust.org/fixing-rivers/water-quality-trading/).

Theme 6: Adapting to the Setting

Each watershed is different, so the program for each water fund is dependent on an understanding of the setting (AWWA 2004). FONAG in Quito, Ecuador, is a mature watershed protection program with an established governance structure, multiple partners, and mature funding structure with the dedicated revenue stream from the utility and contributions from water users such as the electric company and Andean Ecuador Brewery. The fund uses interest from its endowment of $8 million to pay for projects.

Perhaps most importantly, the program design shows a deep understanding of the setting. The fund was developed to help address land conversion in and near the protected areas of the upper watersheds that provide Quito's drinking water. As a result of diminishing soil productivity, local people were starting to move into these areas and convert forested or natural grasslands to agricultural uses. The land conversion resulted in sediment and flow issues. In response, one of the recognized goals of the fund is to improve or maintain human well-being and quality of life for upstream communities. The main beneficiaries of program activities are local communities close to the water resources. At the same time, the program helps link the citizens of Quito to their water supply (Calvache et al, 2012).

Adapting to the setting can take several forms. Some programs have developed in response to a triggering event—like forest fires in western states that leave watersheds vulnerable

to heavy sedimentation after storms. Others have developed in response to a regulatory driver such as the Safe Drinking Water Act that includes maintaining a filtration avoidance determination and complying with Long-Term 2 Enhanced Surface Water Treatment Rule (LT2) and under the Clean Water Act, complying with permit requirements for point and non-point sources and meeting total maximum daily load (TMDL) allocations.

3.2. In-Depth Case Study Summary

A table of case studies and summary of 12 selected case studies can be found in Appendices B and C. With information gathered from key stakeholder interviews and feedback from the Regional Advisory Panel, the project team selected four case studies to highlight project development. Each of the following case studies has at least one component of its program that appears particularly relevant to the Brandywine-Christina watershed. These include:

- The New York City case study demonstrates the power of working with the agricultural community to reach water quality goals.
- The Upper Neuse River Clean Water Initiatives is an example of a multi-government project that includes dedicated funding sources.
- The York County case study is a multi-government agreement with a funding mechanism to address stormwater permit requirements.
- FONAG is a mature water fund with multiple partners and a dedicated funding source.

Table 3.1. Summary of select case studies

Program Name	Location	Enrolled/Protected Acres	Funding Source	Revenue
N. Everglades & Estuaries PES Program	Lake Okeechobee watershed, FL	171,000 acre-feet of storage created	Water Management District budget allocation	$46 million committed through 2016
San Antonio Water Fund	San Antonio, TX	116,683 acres	1/8 cent sales tax approved	$225 million since 2000
Upper Neuse Clean Water Initiative	Raleigh and Durham, NC	6,170 acres, 63 miles of stream	Raleigh: 1 cent/100 gallons/month in water rate; Durham: 1 cent/cubic foot in water rate	$17.7 million since 2005
New York City Source Water Protection Program	Catskill, NY (East Branch/West Branch Delaware River)	156,690 acres acquired or under easement; 93% of farms with Whole Farm Plans	NYC DEP budget allocation	$186 million to date; $300 million committed 2007–2017
Eugene Water and Electric Board	Eugene, OR (Mackenzie River)	N/A	1% utility rate increase to fund initial program	$200,000 to $250,000 annually anticipated
Denver Water From Forests to Faucets Partnership	Denver, CO (South Platte River)	4,700 acres treated	14 cents per household per month or 4 cents per 1,000 gallons of water withdrawn	$16.5 million from USFS; $16.5 million from Denver Water
Truckee River Fund	Lake Tahoe, CA Reno, NV	101 watershed projects completed	2% of utility annual budget	$9,200,000 since 2004

Program Name	Location	Enrolled/Protected Acres	Funding Source	Revenue
Central Arkansas Water	Near Little Rock, AR	1,800 acres	Utility rate includes watershed protection fee based on meter size; averages 45 cents/ month	Fee raises approximately $1 million/year
Saugatuck River Watershed Compact	Fairfield County, CT	Opened up 7 miles of river to fish passage	Annual contributions of $5000 from larger municipalities; $1000 from smaller municipalities	$306,624 in contributions (municipal, private individual and foundation); $243,849 in federal grants
Rhode Island Water Board	Providence, RI (Narragansett Bay)	2,410 acres protected	Initial state budget allocation; 10 cents per 1,000 gallons surcharge	$18,343,382 allocated for source water protection since 1991
New Jersey Water Supply Authority	Raritan and Manasquan River basins; Delaware & Raritan Canal basin, NJ	4,000 acres protected	Source water protection component to water rate; $24 per million gallons	$112,536 for 2014
Crooked River Initiative	Portland, ME	1,500 acres	Budget allocation	$175,000 annual allocation; $500,000 in NRCS grant, $500,000 in-kind match
Fondo para la Protección del Agua (FONAG)	Quito, Ecuador	1.2 million acres	Voluntary; 2 % of Quito water utility revenue	$8 million in fund
Agua por la Vida y la Sostenibilidad	East Cauca Valley, Colombia	19,000 acres	Voluntary contributions from water users	$3,891,340 through Dec 2013; $4,700,000 with matching funds through Dec. 2010
Conserve to Enhance (C2E)	Tucson, AZ	N/A	Donation of water conserve savings and voluntary check-off on utility bill	$40,000 since 2011
Intergovernmental Cooperation Agreement for the Implementation of the York County Regional Chesapeake Bay Pollutant Plan	York County, PA Susquehanna River	N/A	Budget allocations	$200,000 per year over 5 years

New York City Source Water Protection Program

Location: Catskills/Delaware Watershed, NY
Population: 90% of water supply for 9 million people
Partners: City of New York, NYC DEP, USEPA, USDA, NRCS, NRDC, WAC
Revenue/Rate: $186 million in 20 years; NYC DEP committed $300 million (2007–2017)
Acres Enrolled/Protected: 156,690 acres acquired or under easement as of 2011

The program focuses on acquiring land and conservation easements, upgrading wastewater treatment plants and water supply facilities, and working with landowners to adopt BMPs that reduce pollutants in runoff. The city is also erecting screens, building baffles, and using technology to help settle sediments to reduce turbidity in its reservoirs.

The agricultural land management aspects of the program are administered by the Watershed Agricultural Council (WAC). The WAC applies strategic watershed management approaches that benefit the general public through incentivized, on-site practices performed on private lands. As of 2014, it has enrolled 93% of the farmers in whole farm plans. The WAC credits its success to voluntary participation, local control of the program, and farm plans implemented with funding from the New York City Department of Environmental Protection (NYC DEP), USDA, U.S. Forest Service and other funding sources. These management plans cover land in addition to that acquired and under easement.

In January 1997, New York City, through the NYC DEP, entered into a Watershed Memorandum of Agreement with some 76 signatories, including the USEPA, the state of New York, many local governments in its watersheds, and a number of environmental and public interest groups. This agreement established a program to protect water quality in the Catskill, Delaware, and Croton watersheds, including adoption of new watershed regulations, environmental and economic partnerships with watershed communities, and a watershed land-acquisition program. Funding for these programs was expected to come from utility user fees, bonding, and state and federal funding sources. The city chose to pursue this approach in lieu of building an $8–$10 billion filtration plant, which would also cost millions of dollars each year to operate.

Over the last 15 years, NYC DEP and its partner agencies and organizations have developed and implemented an aggressive and comprehensive watershed monitoring and protection program that has not only maintained but enhanced the high quality of Catskill/Delaware water. The program has enabled the city to secure a series of waivers from filtration requirements under the Safe Drinking Water Act from 1993 through 2017.

In addition to its source water protection plan, the city has embarked on other initiatives to address water quality issues. Last year, the city deferred a $3.4 billion dollar mandate for handling CSOs by replacing costly gray infrastructure projects with green infrastructure projects. These initiatives have helped protect more than 1.2 million acres of land with total investments estimated at $1.5 billion (AWWA et al, Protecting the Source, 2004; Majanen et al, 2011; NYC DEP, 2006; USEPA, 2007; Hulle et al., 2013).

Upper Neuse River Clean Water Initiative (UNCWI)

Location: Raleigh and Durham, NC
Population: 700,000 people
Partners: Conservation Trust for North Carolina, Ellerbe Creek Watershed Association, Eno River Association, Tar River Land Conservancy, Triangle Greenways Council, Triangle Land Conservancy, Trust for Public Land, City of Raleigh, City of Durham, Wake County, Orange County, Granville County, Franklin County, and Person County
Revenue and Rate: $1 per 100 gallons "watershed protection fee" in Raleigh resulting in $1.8 million a year; 1 cent per cubic foot in Durham
Acres Enrolled/Protected: 6,170 acres, 63 miles of stream protected through April 2012

The program conserves priority forests, wetlands, floodplains, and other vegetated areas that serve as natural "water treatment facilities." The partners adopted the approach as a

cost-effective way to preserve the high quality drinking water supply. Identified secondary benefits include flood prevention and habitat protection. The state-funded North Carolina Clean Water Management Trust Fund has provided significant support, committing more than $11 million in grants to UNCWI projects to purchase land and conservation easements worth more than $59 million. A three-year U.S. Endowment for Forestry and Communities grant is being used to help UNCWI partners promote and maintain sustainable forest practices on strategically located lands in the basin to reduce pollutants in stormwater runoff. The project will help landowners continue generating timber revenue, even as they help to ensure downstream water supplies are protected.

Pepsi Bottling Venture's partnership with UNCWI supports the emerging North Carolina Youth Conservation Corps (NCYCC) program in the Upper Neuse basin. The NCYCC will provide paid summer jobs for 16–24 year olds, with the aim of teaching youth valuable work and life development skills through hands-on outdoor work on high-priority conservation projects. Raleigh received estimates of up to $150 million to install a new water filtration system if impairment in the water supply exceeded certain levels. In 2005, Raleigh Mayor Charles Meeker, with city council support, established the Upper Neuse Clean Water Initiative. The council made financial commitments to drinking water protection with annual allocations of $500,000 to $1.5 million for watershed conservation.

In 2011, Raleigh established a "watershed protection fee" of 1 cent per 100 gallons, included in customers' monthly water bills. The fee costs homeowners an average of 40 cents per month and generates about $1.8 million annually for land protection to protect drinking water quality. Since 2005, Raleigh has allocated on average more than $1 million per year for land conservation in the Upper Neuse. Nearby Durham instituted a fee for the same purpose (1 cent per cubic foot) (Triangle Land Conservancy and Tar River Land Conservancy for the Healthy Forest Initiative, 2010; Hart, 2006; Gartner et al, 2013; AWWA et al, Protecting the Source 2004, http://www.pinchot.org/doc/465).

York County Regional Chesapeake Bay Pollutant Reduction Plan

Location: Susquehanna River watershed, York County, Pennsylvania
Population: 434,000 people in the county
Partners: 44 municipal governments
Revenue/Rate: $200,000 per year over 5 years, totaling $1 million
Acres Enrolled/Protected: Not determined at this time

This case studies looks at a collaborative approach to stormwater management that includes a financing formula. York County sits in the middle of the Susquehanna River watershed, the largest drainage within the Chesapeake Bay watershed. In December 2010, the USEPA issued the Chesapeake Bay TMDL for major sources of nitrogen, phosphorus, and sediment across the entire 64,000-square-mile watershed. The TMDL was then allocated to major river basins within the watershed and to jurisdictions. As part of its obligations to help achieve the necessary reductions to reach the TMDL, each state developed watershed implementation plans in 2012. One of the key aspects of the Pennsylvania plan was the allocation of the TMDL to the counties within the state.

The staff of the York County Planning Commission (YCPC) prepared a draft outline for the Intergovernmental Agreement for Implementation of the York County Regional Chesapeake Bay Pollutant Reduction Plan (CBPRP) and shared it with the Regional CBPRP Steering Committee for feedback. The Steering Committee consisted of representatives of 46 municipalities. The final draft of the outline was then given to the YCPC Solicitor who prepared the initial draft of the agreement.

The draft agreement was distributed to all the participating municipalities who were encouraged to share it with their solicitors for review and comment. A meeting with the municipal solicitors was then held to address remaining issues in the agreement and arrive at a final draft that was acceptable to all. All but two of the municipalities decided to participate in the agreement.

The municipalities that are part of the agreement are now in the process of adopting the agreement by ordinance. A Regional Committee and a Management Committee will be formed to guide the implementation process. A YCPC staff person will serve as administrator.

Part 8 or "Financing" of the agreement describes the formula that was used to determine the municipal contributions and the cost-share schedule is included as Attachment A to the agreement. A variety of cost-share formulas were developed by the YCPC staff, but the Regional CBPRP Steering Committee ultimately selected the "weighted cost" scenario (i.e., 20% impaired streams, 30% population, and 50% impervious coverage). The percentages were applied to the entirety of each municipality as opposed to the 2000 Census Urbanized Area, as some of the participants do not have an MS4 Permit.

Fondo para la Protección del Agua (FONAG)

Location: Quito, Ecuador
Population: Over 2 million people
Partners: City of Quito, Quito water utility, TNC, Fundación Antisana, other water users
Revenue/Rate: $8,000,000 in 2010 (voluntary donations and 2% of water utility revenue)
Acres Enrolled/Protected: 1.2 million acres

FONAG is an endowment fund that receives money from the government, public utilities, electric companies, private companies, and nongovernment organizations. An independent financial manager invests the money, and the interest is used to fund activities for watershed protection. FONAG is governed by a board of directors comprising water users who have contributed to the fund. The board approves the annual operational plan of FONAG and approves reports, conducts audits, and makes reforms to bylaws. FONAG also has a technical secretariat who acts as the executive director of the fund.

The goals of FONAG are to improve and maintain water quality and quantity for downstream users; maintain regular flows of water throughout the year; maintain and enhance natural ecosystem biodiversity; and maintain and improve human well-being and quality of life for upstream human communities.

Almost 80% of Quito's water comes from three protected areas upstream. The major threat to this regular, clean water supply, is land conversion in and around the protected areas. People living in the watershed depend on natural resources and water from the region for their livelihoods. Available productive land is diminishing as soils lose nutrients, forcing families to move up in the watershed toward the natural ecosystems. These ecosystems are the key hydrologic regulators of the system. Conversion means diminishing water services to people downstream, but keeping watershed communities out is unjust and unsustainable. This complex management problem required time and money that municipal authorities of Quito did not have.

About 20 years ago, TNC and a local partner, Fundación Antisana, approached the mayor of Quito with water flow studies. They wanted to demonstrate to the mayor that protecting the watersheds that supply water to Quito was crucial if citizens were to continue to enjoy the same water quality and quantity in the future. The mayor asked TNC to design a mechanism to link the citizens of Quito to their water source. The mayor's support helped the partners obtain the support of the Quito municipality and the Quito water company.

FONAG was created with an initial investment of $1,000 from TNC and $20,000 from the Quito water company. Other water users have since joined. Since 2000, FONAG has leveraged its assets to generate an additional $7 million for conservation work. Before 2010, all contributions were voluntary. In 2010, the Quito water utility passed a bylaw committing to pay 2% of revenue into the fund. The main beneficiaries of the activities are the local communities close to the water sources. They receive permanent support from FONAG through different programs, from environmental education to community-based projects that invest in rural livelihoods.

3.3. Watershed Modeling Tools

The design and operation of a water fund is highly dependent on a science-based understanding of current hydrology and stream flows in the watershed as well as the impact of conservation practices, land use alterations, and climate change on those services. It is necessary to clearly demonstrate sources of hydrologic stressors, core areas for ecosystem service protection, and interventions that yield the greatest return and incentivize end-user (e.g., water utilities) investment. Models and tools can be employed to generate this information and answer questions including: what is the condition of hydrologic services in the watershed, how might the condition of those services change under various conservation schemes, and where should investments be made to maintain or improve key ecosystem services (and hydrologic services) and maximize return on investment? The discussion examines several models and tools that have been successfully used in design of water funds and conservation-focused water management plans.

Resource Investment Optimization System (RIOS) and Integrated Valuation of Environmental Services and Tradeoffs (InVEST)

The Resource Investment Optimization System (RIOS) and Integrated Valuation of Environmental Services and Tradeoffs (InVEST) are two interrelated, open-source software tools developed by the Natural Capital Project, a partnership among Stanford University,

the University of Minnesota, The Nature Conservancy, and World Wildlife Fund. The tools combine to use biophysical, social, and economic data to prioritize watershed investments by identifying the best locations for protection or restoration to achieve conservation objectives at the lowest cost. Stakeholder input is paramount to these tools as many of the model inputs are defined by stakeholders. They are also able to incorporate climate change into the long-term vision of conservation investment, ensuring the maintenance of ecosystem services over time. These tools require mapping software, such as ArcGIS, to adequately view and manipulate model results.
The RIOS tool is the primary scenario-generating platform and consists of three modules:

1. Investment Portfolio Advisor
2. Portfolio Translator
3. Benefits Estimator

The tool uses a stepwise approach to inform watershed service investment via these modules by guiding the user through a series of decision points. Objectives (e.g., erosion control, nutrient retention, flood mitigation, biodiversity, etc.), activities (e.g., protection, assisted re-vegetation, fertilizer management, etc.), and a budget allocation scheme are first specified, allowing for the tool to select an investment portfolio of priority areas within the watershed based upon existing social, economic, and biophysical conditions. Users can weight objectives, geographies, and activities for investment to further customize the investment portfolio. Several scenarios, including restoration of services in degraded areas and protection of existing service-generating resources, are then produced for further analysis. Ecosystem service and economic benefits related to implementation of the RIOS-designed portfolio and user-specified investment scenarios are estimated using various InVEST models (e.g., sediment retention, water purification, etc.) found within the Benefits Estimator module. These models quantify where/how ecosystem services are generated within a watershed and what tradeoffs may exist under various investment schemes. The analytical process provides a foundation to assess whether watershed conservation objectives are achievable given financial, social, and environmental constraints.

RIOS and InVEST have been successfully employed as part of numerous existing water funds, particularly those in Latin America. For example, the Agua por la Vida y la Sostenibilidad water fund in the East Cauca Valley of Colombia used the RIOS tool as one of three models to identify areas with high potential to retain sediment and maintain regular water flows, providing benefits to biodiversity, residents, and sugar cane producers. The Water Producer Program in Brazil applied the InVEST sediment retention model to identify priority erosion areas and estimate the benefit that could be achieved through the program's activities in areas at high risk of erosion. Domestically, InVEST has been used in the emerging Cape Fear River water fund to visualize nutrient flows into the watershed and identify significant sources of pollution (www.naturalcapitalproject.org).

Soil and Water Assessment Tool (SWAT)

The Soil and Water Assessment Tool (SWAT) is a semi-distributed, physically based, hydrologic model designed by the U.S. Department of Agriculture and Texas A&M University to evaluate the effects of watershed management decisions, land use, and

climate change on surface and groundwater quality and quantity. The model generates a watershed baseline of ecosystem service flows, including sediments, nutrients, and pathogens, from which to assess the impacts of multiple land use/management scenarios. These scenarios aim to address the pollutant(s) of interest and incorporate the range of intervention techniques feasible in the watershed. The model is capable of long-term simulations, allowing for the assessment of impacts from climate change, and combines social aspirations with ecosystem goals. The model is public domain software and requires the ArcGIS platform to analyze geographic data.

SWAT processes data using a hydrologic balance model as this balance drives both plant growth and the flow of sediments, nutrients, and other pollutants through ecosystems. The model uses weather, hydrology, soil properties, plant growth, nutrients, pesticides, pathogens, and land management as inputs to simulate the movement and transformation of pollutants in the watershed. These data can be observed measurements or simulated based upon monthly statistics. Prior to analysis, a watershed is divided into smaller units that consist of homogeneous land use, land management, and soil characteristics. Within each unit, a user can specify land management practices either currently being employed or for future consideration. The output can then be used to examine the impact of specific BMPs and other conservation practices on future pollutant loads at the field or basin level.

SWAT has been successfully used for watershed conservation planning in a variety of settings. This model is generally employed as a second corroborating model in the development of water funds. The Agua por la Vida y la Sostenibilidad water fund in the East Cauca Valley of Colombia used SWAT to determine critical areas for conservation and specific interventions that achieve the watershed conservation objective. SWAT is an internationally accepted hydrologic modeling tool, spurring international SWAT conferences and over 250 peer-reviewed publications (http://swat.tamu.edu/).

MapShed

MapShed uses free mapping software (MapWindow) as a free, open-source watershed modeling tool developed by Pennsylvania State University's Institutes of Energy and the Environment to simulate the effects of conservation practices on sediment and nutrient transport within a watershed. The tool estimates current watershed loads by source and evaluates the impact of rural and urban BMP implementation on those loads. The model is capable of running multiple BMP implementation scenarios and generates implementation costs for comparison of return on investment, as well as to gauge the feasibility of reaching the conservation objective given financial constraints. The flexibility of the model allows for tracking of progress towards load reduction goals (e.g., TMDL), as well as for analyzing load distribution for regulatory requirements (e.g., MS4).

MapShed relies upon the Generalized Watershed Loading Functions-Enhanced (GWLF-E) watershed model originally developed by Cornell University to estimate loadings. Input data for the model, including hydrology, land cover, soils, topography, animal operations, and pollutant discharges, is derived from GIS layers and weather data entered by the user. Once derived, the input data can be edited by the user to better reflect local conditions. The impacts of alternative BMP scenarios are evaluated either using the Pollution Reduction

Impact Comparison Tool (PRedICT) or via manipulation of BMP data in the GWLF-E model. PRedICT generates easily interpretable "before" and "after" BMP implementation charts for load reduction comparisons as well as the total cost of the scenario. BMP implementation over time can be evaluated using PRedICT by progressively adding BMPs, allowing the user to estimate load reductions and costs associated with staging implementation.

Manipulating BMPs in GWLF-E generates similar load reduction information as PRedICT but allows for more BMP options and better simulates changes associated with urban BMPs. Generally both options are employed to give a comprehensive view of load reduction potential and associated implementation costs.

MapShed, and more specifically the original modeling application developed using ArcView (AVGWLF), has been widely used for watershed conservation planning. The Pennsylvania Department of Environmental Protection has used the model for TMDL studies for over 15 years. The MapShed tool has also been used by the Chester County Water Resources Authority, Pennsylvania State University, and Stroud Water Research to assess needed load reductions for the Christina River Basin (i.e., Brandywine-Christina subwatershed) and track progress toward meeting the Christina River TMDL. Recently, regional versions of the software have been developed to allow for a broader view of water quality impacts beyond the watershed scale (www.mapshed.psu.edu).

CHAPTER FOUR—ECONOMIC ANALYSIS

4.1. Objectives

This chapter outlines a watershed-based economic analysis to define revenue and investment needs for a Brandywine-Christina Healthy Water Fund. The objective of the Water Fund is to finance and incentivize protection/restoration of the watershed to meet Clean Water Act fishable/swimmable and Safe Drinking Water Act potable goals by 2025.

4.2. The Economic Approach

Water is one of the few substances in nature without an economic substitute. Traditionally, economics has not accounted for negative externalities in the environment such as water pollution that can harm people who are both living downstream and do not receive compensation (Daily and Allison 2002).

This economic analysis provides an example of how selecting an interim water quality goal (meeting TMDLs) can shape implementation of conservation strategies by helping to target the location of implementation (i.e., subwatersheds providing the largest loads of a pollutant) and how maximizing the least-cost approaches can reduce the costs of achieving significant water quality goals. It also addresses long-term risk management and potential benefits of water quality improvements.

Science-based methods such as stream buffers and reforestation that restore watersheds are becoming increasingly successful, however they are hamstrung by diminishing government appropriations. Federal infrastructure funding has dwindled even though 87% of the U.S. public believes the government should invest in clean water (ITT Corporation 2010). Data from the Congressional Budget Office determined public investment in water infrastructure as a percentage of the GDP fell from 0.35% during the 1970s Clean Water Act years to 0.25% by 2006. Annual budgets announced by the Office of Management and Budget (OMB) report that two popular federal programs have been cut—the Clean Water State Revolving Fund (CWSRF) and CWA Section 319 Nonpoint Source Pollution Grants (Figure 4.1). In 2012, the Corps of Engineers Institute for Water Resources reiterated the call for a new national water policy initiative to maximize net benefits through water charges as first set forth by the Harvard Water Program (Dorfman et al. 1972) almost a half century ago (Stakhiv 2012).

These public water-resource funding gaps have reignited interest in a movement to adopt progressive economic policies to fund water quality control programs. Every $1 billion invested yields at least 10,000 jobs in water supply, 5,000 jobs in stormwater management, and 12,000 jobs in urban conservation (Pacific Institute 2013). The Water Puts America to Work campaign asserts that every billion dollars invested in water and wastewater infrastructure funds 2,000 jobs and generates $1.4 billion in economic activity (Green For All 2011). At these ratios, a $1 million/yr investment to improve water quality in the Brandywine-Christina would boost GDP by $1.4 million and yield 20 direct water jobs.

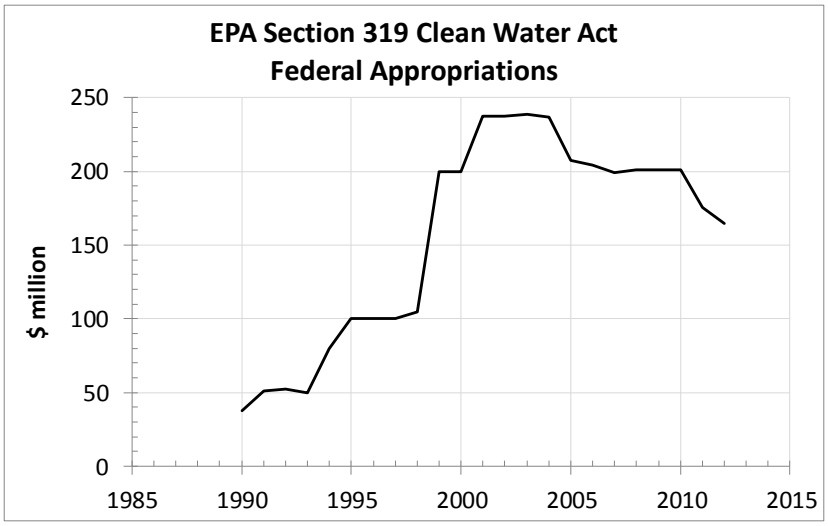


Figure 4.1. USEPA Section 319 nonpoint source appropriations (Federal budget appropriations announced by OMB from 1990 to 2012)

With declining government funding, watershed managers have trained renewed interest on market-based funding models such as water use charges as more efficient options that would supplement traditional command/control regulatory approaches that rely on subsidies and grants. New York City utilized investments in watershed services (IWS) to negotiate with USEPA in 1997 to invest $1.5 billion and restore forested watersheds in the Catskills instead of building a $10 billion microfiltration plant in the Bronx, a 6.5 to1 benefit-cost ratio (Thacher et al., 2011). In the Chesapeake Bay watershed, forest buffers reduce nitrogen at half the wastewater treatment cost as shown in Figure 4.2 (Thacher et al. 2011).

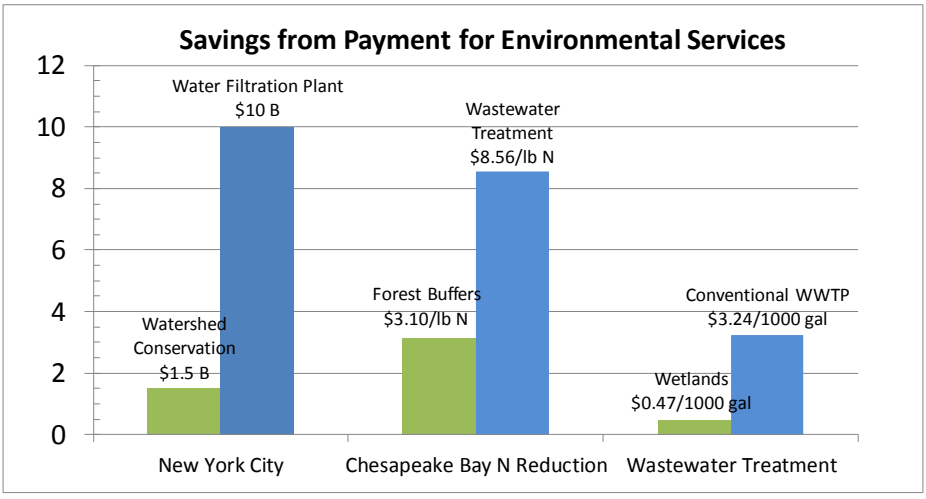


Figure 4.2. Investment in watershed services (Thacher et al. 2011)

Water funds have been established through public-private partnerships as long-term, sustainable financing sources for conservation (Majanen et al. 2011). Water users voluntarily invest in a trust fund and the revenue (interest and part of the principal) is used to implement conservation projects in the watershed. Water users (beneficiaries) include water utilities, hydropower companies, bottling plants, breweries, and vegetable farmers. These key stakeholders and local watershed community representatives are appointed to the board of the fund. Goldman Sachs (2014) at a February 2014 Environmental Finance Innovation Summit reported that private-sector investment in nature's services and associated cash-flow streams can provide appreciable capital. The Water Environment Research Foundation (Quinn et al. 2014) reported that every $1 million in direct spending by water utilities supports 16 jobs in the economy, and over the next decade the 30 largest drinking water utilities in America will contribute $524 billion in economic output to the national economy supporting 289,000 permanent jobs.

The USEPA surveyed six communities and found improved source water quality resulted in lower water treatment/chemical costs and that every dollar invested in source water protection resulted in $27 in water treatment savings (Gartner et al. 2014). The survey concluded that natural infrastructure such as reforestation in source watersheds costs 2 to 30 times less than built water treatment infrastructure in Oregon, New Mexico, Maine, and New York (Figure 4.3).

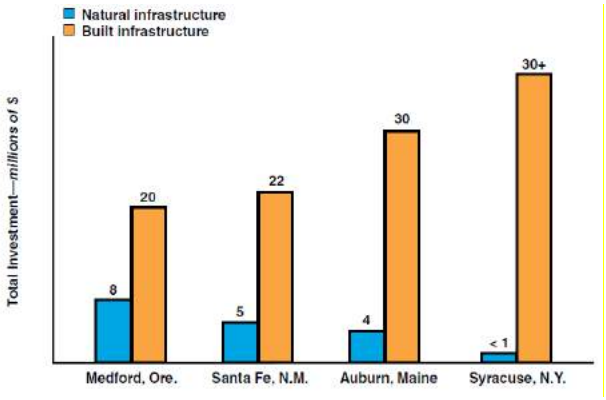


Figure 4.3. Financial merits of natural compared to built water supply infrastructure (Gartner et al. 2014)

Economic benefits are the maximum dollar value of goods and services that individuals are willing to pay (WTP) for improved water quality (Cech 2005). In environmental economics, WTP measures how much people are willing to pay for a given good or service regardless of whether they actually pay or not (Goulder and Kennedy 1997). Consumer surplus is the area under the demand (marginal benefit) curve above its price (or value) measured by the difference between the amount individuals actually pay and the amount they are willing to pay for a benefit such as clean drinking water or enhanced fishing due to improved water quality (Figure 4.4). In other words, consumer surplus is the amount people are willing to pay above the price they pay for it (Thurston et al. 2009). If an individual is willing to pay

$6.00 per 1000 gallons for drinking water and the price is $5.00, then the consumer surplus is $1.00.

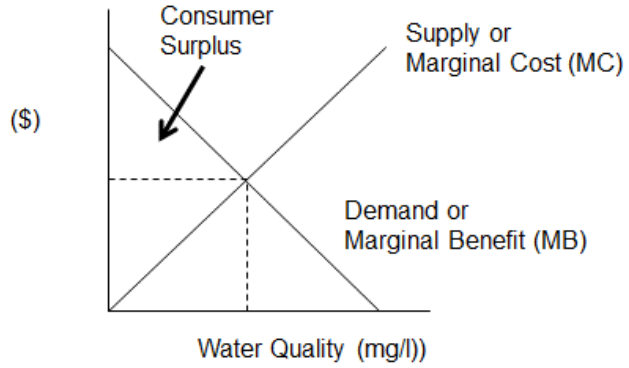


Figure 4.4. Consumer surplus as willingness to pay for improved water quality (adapted from [Thurston et al. 2009])

The dilemma inherent in defining the economic value of water goes back two and a half centuries to the 1776 *Wealth of Nations* when Adam Smith, who described the "invisible hand of economics," first defined the diamond-water paradox (USEPA 2012). If water is so valuable to society, then why is the price of diamonds so high and the price of water so low? The answer was later found to lie in the supply and demand curve or the costs of producing a good and the benefits that the good provides. Since diamonds are rare, their price is correspondingly high. When water is plentiful and pure, the cost of delivering a million gallons of water and the benefits derived from using that million gallons are low, therefore the price of water is low. When water is less abundant such as during drought or in a polluted river, individual willingness to pay for each additional million gallons will increase and the price of water rises. In other words, the opportunity cost of water is low when supply is plentiful, but significantly rises when the supply or quality dwindles.

The diamond-water paradox points out a significant challenge in water resources management that the value of water and the prices charged to utilize this resource do not reflect the full opportunity cost at its highest use. In the public policy realm, consumers pay for the right to use the water at its average cost when water is abundant and not at its highest value for all uses (not just drinking water) based on its scarcity value. Since water is undervalued compared to its highest and best opportunity cost, federal, state, and local governments are inclined to underinvest in water resources and watershed programs.

To define this consumer surplus or what the public is willing to pay, the Delaware Nature Society (OpinionWorks LLC 2015) polled 400 Delaware residents and found that the public (without knowing the amount) profoundly supported the concept of a clean water fee by nearly a 2 to 1 margin (57% in favor, 32% opposed). When the residents were informed the fee would be $3.75/month, the support increased to a 3 to 1 margin (74% in favor, 21% opposed). Support for the fee crosses party and county lines as 57%, 53%, and 58% of the people supported the clean water fee in New Castle, Kent, and Sussex Counties, respectively, and 66% of Democrats and 52% of Republicans support the measure.

4.3. Methods

The economic analysis was performed according to the following methods:

7. **Water Quality Monitoring:** Review water quality monitoring programs along the Brandywine, Red Clay, White Clay, and Christina Creeks to measure watershed pollutant load reductions.
8. **Hydrodynamic Modeling:** Utilize hydrodynamic models such as USGS SPARROW and HSPF to estimate nutrient/sediment loads and reductions needed to meet stream water quality standards, Clean Water Act TMDLs, and fishable, swimmable, potable goals.
9. **Analysis of Example Conservation Strategy:** Analyze one approach to implementation of conservation strategies that would use reductions in pollutant loads for nitrogen and sediments to TMDL levels as an initial water quality target. This approach is being presented as an example, not as a recommendation.
    - Tabulate pollutant load reductions (lb/yr) by subwatershed for nutrients/sediment.
    - Estimate unit costs ($/lb/yr) to reduce nutrient/sediment loads by 2025.
    - Calculate annual costs of pollutant load reductions based on two scenarios:
        a. Load reduction costs spread evenly across all sources (atmospheric, wastewater, urban/suburban, agriculture).
        b. Invest in least-cost practices that have the lowest per pound unit costs based on marginal abatement cost (MAC) principles.
10. **Evaluation of Risk Reduction and Other Benefits:** Consider the risks of inaction and estimate benefits of reduced nutrient and sediment loads to improve water quality in the Brandywine-Christina watershed in the drinking water, forest, agriculture, navigation (avoided dredging), and nonuse swimming recreation sectors. The economic value or benefits of improved water quality in the Brandywine-Christina watershed are determined by calculating use and nonuse value (Figure 4.5). Use value includes the market price established by revealed preferences where goods and services are bought and sold such as the sale of drinking water or purchase of equipment and travel accomodations for receational fishing. Nonuse value is established by what individuals state they are willing to pay for clean water with the knowledge that a river is preserved now and for future generations.
11. **Key Findings:** Based on the economic analysis, provide key findings to further evaluate the feasibility of the Brandywine-Christina Healthy Water Fund.

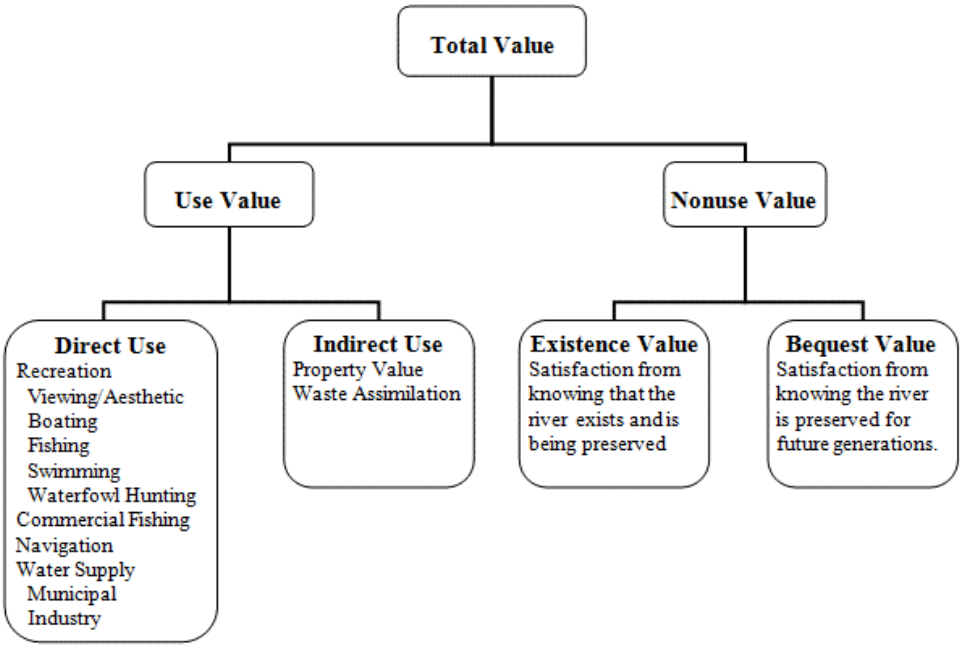


Figure 4.5. Benefits of improved water quality in the Brandywine-Christina watershed

4.4. Water Quality Monitoring

Water quality monitoring stations operated by DNREC and USGS currently provide historic water quality data and measure pollutant load reductions and monitor performance of BMPs (Figure 4.6). Along the Brandywine Creek at Smith Bridge, dissolved oxygen, bacteria, phosphorus, and sediment have improved, while nitrogen continues to degrade (Figure 4.7). The fishable DO standard is 4.0-5.0 mg/l while the swimmable bacteria standard is 100 #/100 ml. DNREC set targets for P and N at 0.05 mg/l and 1.0 mg/l (DNREC 2012). Watershed monitoring can be improved by installing relatively inexpensive real-time nitrogen sensors ($25,000/yr) at USGS gages along the Brandywine, Red Clay, and White Clay Creeks near the state line.

According to the USGS SPARROW model, nitrogen loads in the Brandywine-Christina watershed are among the highest on the East Coast (Figure 4.8). Close to 40% of the watershed is utilized for agriculture, and about 80% of the nitrogen loads in the watershed emanate from agriculture with the balance from wastewater, urban/suburban, and atmospheric sources (Table 4.1). The USGS SPARROW model further indicates that the Brandywine-Christina watershed delivers 8% of the nitrogen load to the Delaware Estuary, the third-highest tributary yield after the Delaware River at Trenton and the Schuylkill.

Table 4.1. Nitrogen loads in the Brandywine-Christina watershed (USGS SPARROW)

Watershed	Area (mi^2)	N Load (ton/yr)	Atmospheric (ton/yr)	Wastewater (ton/yr)	Urban/Sub. (ton/yr)	Agriculture (ton/yr)
Brandywine	328	2,516	165	162	197	1,995
Red Clay	54	331	23	11	37	260
White Clay	106	670	45	0	89	535
Brandywine		100%	7%	6%	8%	79%
Red Clay		100%	7%	3%	11%	79%
White Clay		100%	7%	0%	13%	80%

Figure 4.6. DNREC water quality monitoring stations in Brandywine-Christina watershed

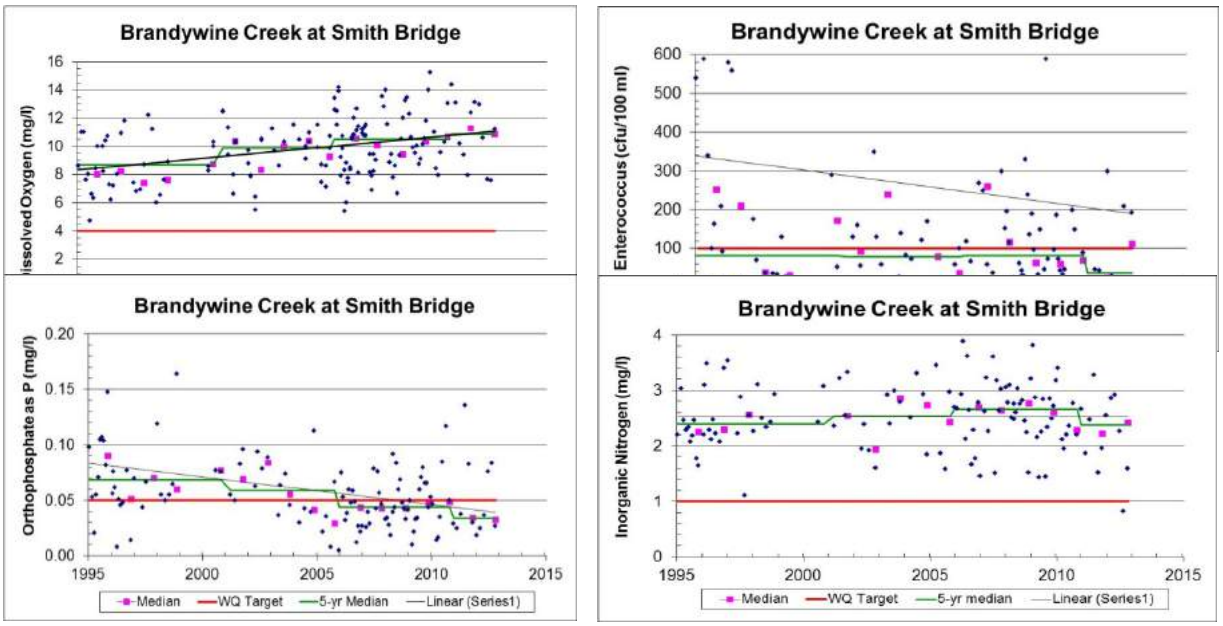


Figure 4.7. Water quality trends along Brandywine Creek at Smith's Bridge from DNREC STORET data

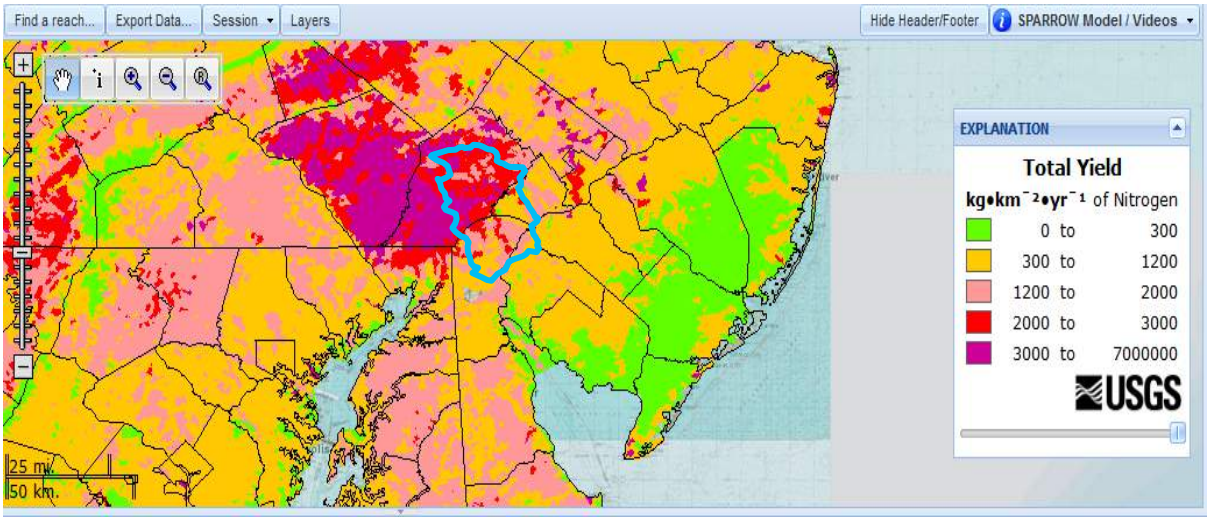


Figure 4.8. The Brandywine-Christina watershed has the highest N loads on the East Coast (USGS SPARROW)

High turbidity and sediment loads lead to higher water treatment costs. The City of Newark along the White Clay Creek and City of Wilmington along Brandywine Creek (Figure 4.9) often curtail withdrawals and incur higher treatment costs when turbidity exceeds 20 NTU at USGS stream gaging stations. Real-time turbidity monitoring stations may be used to estimate sediment loads since the two parameters are highly correlated ($R^2 = 0.82$) where 82% of the variance is explained (Figure 4.10). A real-time turbidity station is needed along

the Red Clay Creek at the state line to supplement the existing real-time USGS sensors along the Brandywine Creek and White Clay Creek.

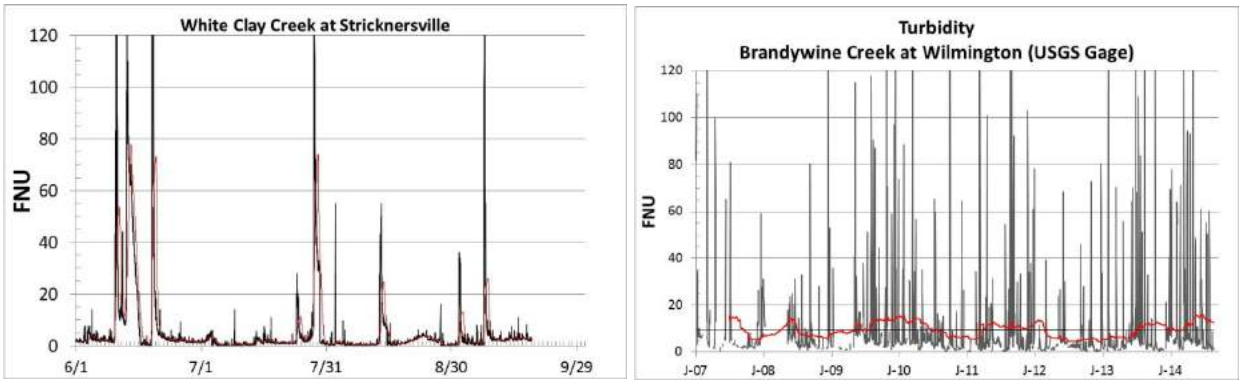


Figure 4.9. Turbidity at USGS stream gages at White Clay Creek at Stricknersville and Brandywine Creek at Wilmington

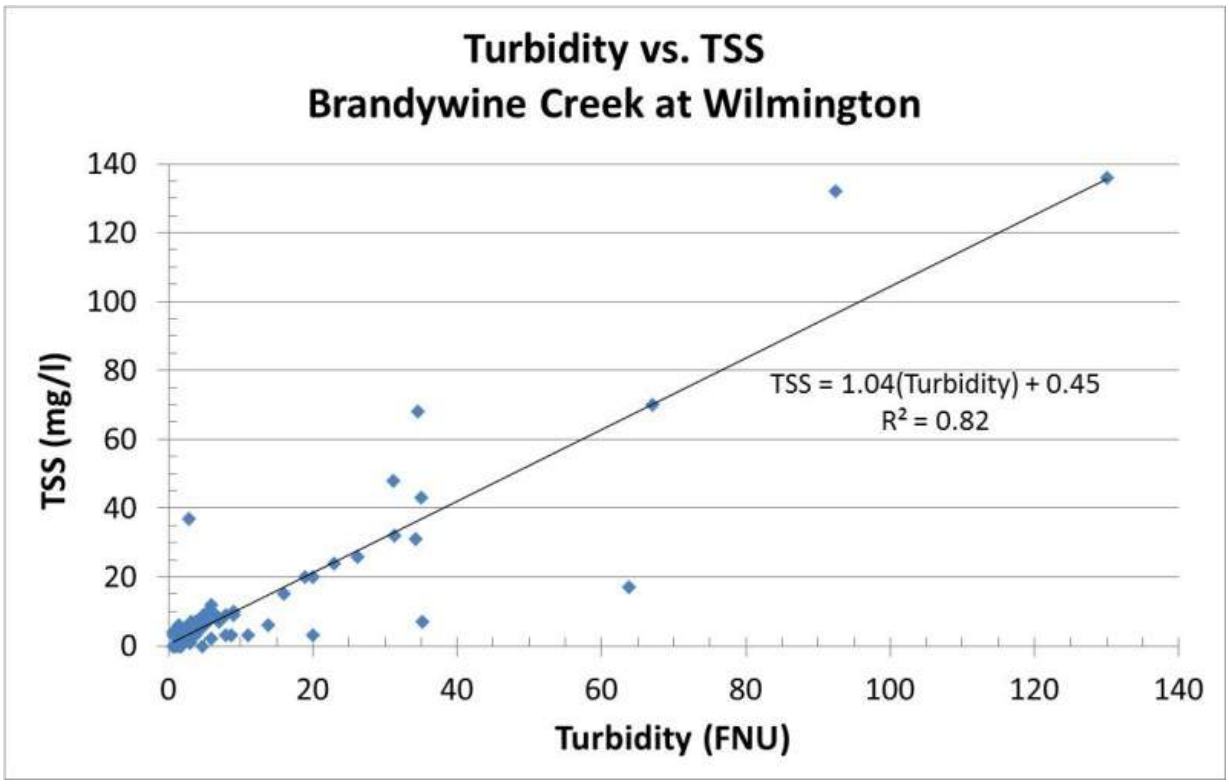


Figure 4.10. Turbidity and sediment USGS stream gage and DNREC water quality monitoring station at Brandywine Creek at Wilmington

4.5. Pollutant Load Reduction Costs

Pollutant load reduction costs are calculated based on 2006 TMDLs (USEPA 2006), impaired streams maps (Figures 1.5 and 1.6), and water quality monitoring data. Most watersheds suffer from multiple impairments as shown in Figures 4.11–4.13 and Table 4.2. For this example analysis, nitrogen and sediment are selected as "currency" to derive pollutant reduction costs for the Brandywine-Christina watershed because: (1) water utilities are concerned about costs and public-health risks of treating high nutrient and sediment loads, (2) the conservation strategies that reduce nitrogen and sediments reduce other pollutants such as phosphorus and bacteria as well, (3) good reduction cost data is available for nitrogen and sediment, and (4) nitrogen levels continue to degrade in the watershed. Furthermore, there is significant overlap of the subwatersheds that require TMDLs for nitrogen and phosphorus; and most of those subwatersheds also require sediment reductions to meet TMDLs. Also, BMPs that reduce nitrogen and sediment will also reduce phosphorus and bacteria.

Table 4.2. TMDL reductions and impaired streams in Brandywine-Christina watershed

Subwatershed	Nitrogen[1] Reduction	Phosphorus[1] Reduction	Sediment[1] Reduction	Nutrient[2] Impaired Stream	Siltation[2] Impaired Stream
Brandywine Creek					
B01 (WB Honey Brook)	37%	21%	31%	Yes	Yes
B02 (West Branch)	40%	40%		Yes	
B03 (West Branch)	10%	10%		Yes	
B04 (West Branch)	0%	0%	46%		Yes
B05 (West Branch)	5%	12%	54%	Yes	Yes
B06 (West Branch)	30%	30%	32%	Yes	Yes
B09 (EB Honey Brook)	18%	18%	16%	Yes	Yes
B10 (East Branch)	18%	16%			
B14 (East Branch)			56%		Yes
B15 (Brandywine Cr.)			55%		Yes
B17 (Brandywine Cr.)	7%	7%			
B20 (Buck Run)			35%		Yes
B31 (Pocopson Cr.)			60%		Yes
B32 (Birch Run)	10%	10%		Yes	
B33 (Rock Run)	10%	9%		Yes	
B34 (L. Brandywine)	16%	26%			
Red Clay Creek					
R01 (West Branch)	49%	36%	52%		Yes
R02 (West Branch)	34%	77%	52%	Yes	Yes
R03 (East Branch)	47%	32%	45%	Yes	Yes
R04 (Red Clay Cr.)	48%	55%			
R05 (Red Clay Cr.)	49%	0%			
White Clay Creek					
W01 (West Branch)	49%	49%	42%	Yes	Yes
W02 (Middle Branch)	49%	19%	64%	Yes	Yes
W03 (Middle Branch)	50%	55%	39%	Yes	Yes
W04 (East Branch Trib.)	50%	55%	64%	Yes	Yes
W06 (East Branch Trib.)	37%	19%	68%	Yes	Yes
W07 (Trout Run)	38%	52%	71%	Yes	Yes
W08 (East Branch)	50%	72%	51%	Yes	Yes
W09 (East Branch)	50%	55%	26%	Yes	Yes
W10 (White Clay Cr.)	50%	55%			
Christina River					
C01 (West Branch)	52%	26%			
C05 (Little Mill Cr.)	13%	27%			
C09 (Lower Christina)	5%	9%			

[1]Christina Basin High Flow TMDLs (EPA, DNREC, PADEP 2006). [2]PADEP Impaired Streams Map (2014).

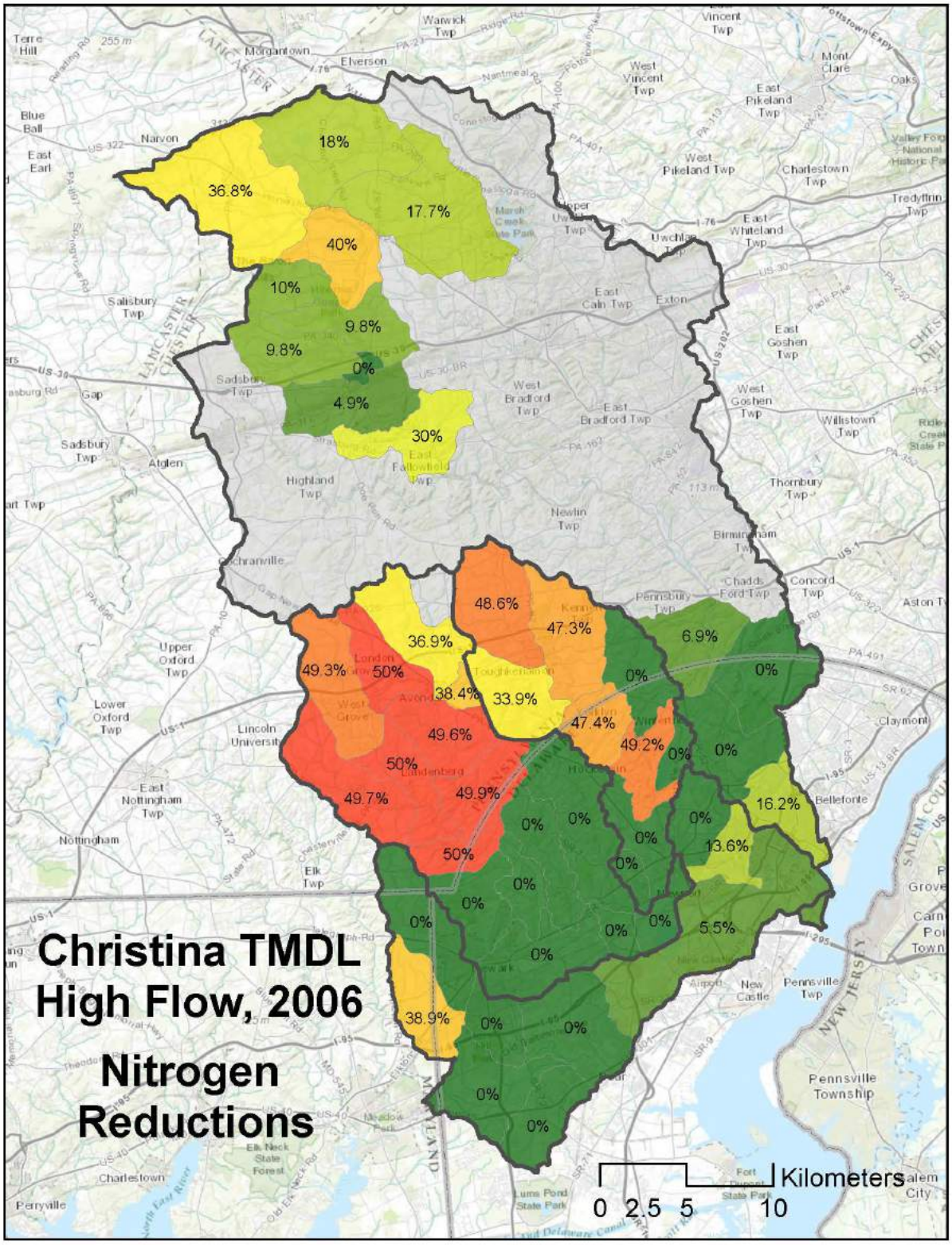


Figure 4.11. Nitrogen TMDL reductions in the Brandywine-Christina watershed (USEPA 2006)

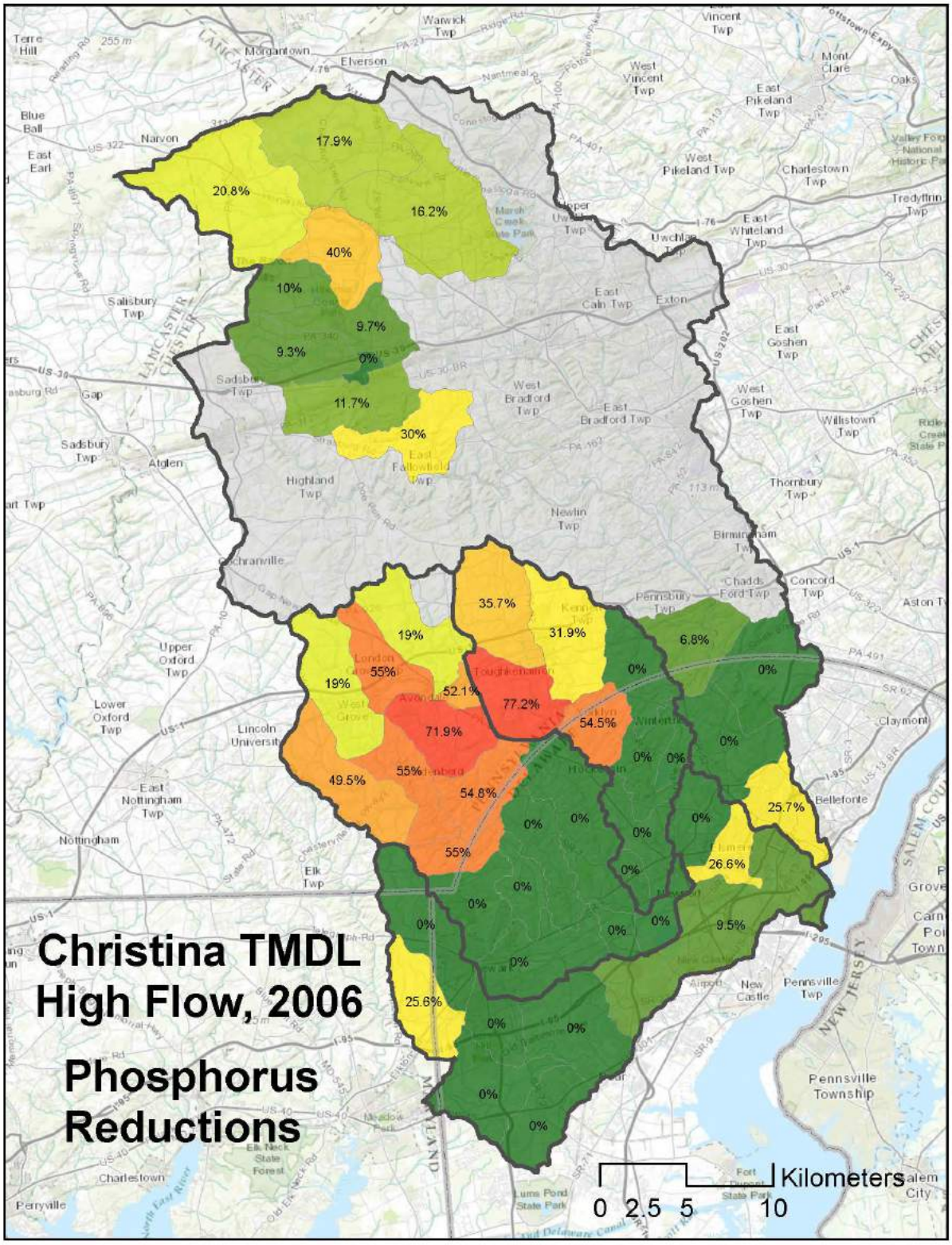


Figure 4.12. Phosphorus TMDL reductions in the Brandywine-Christina watershed (USEPA 2006)

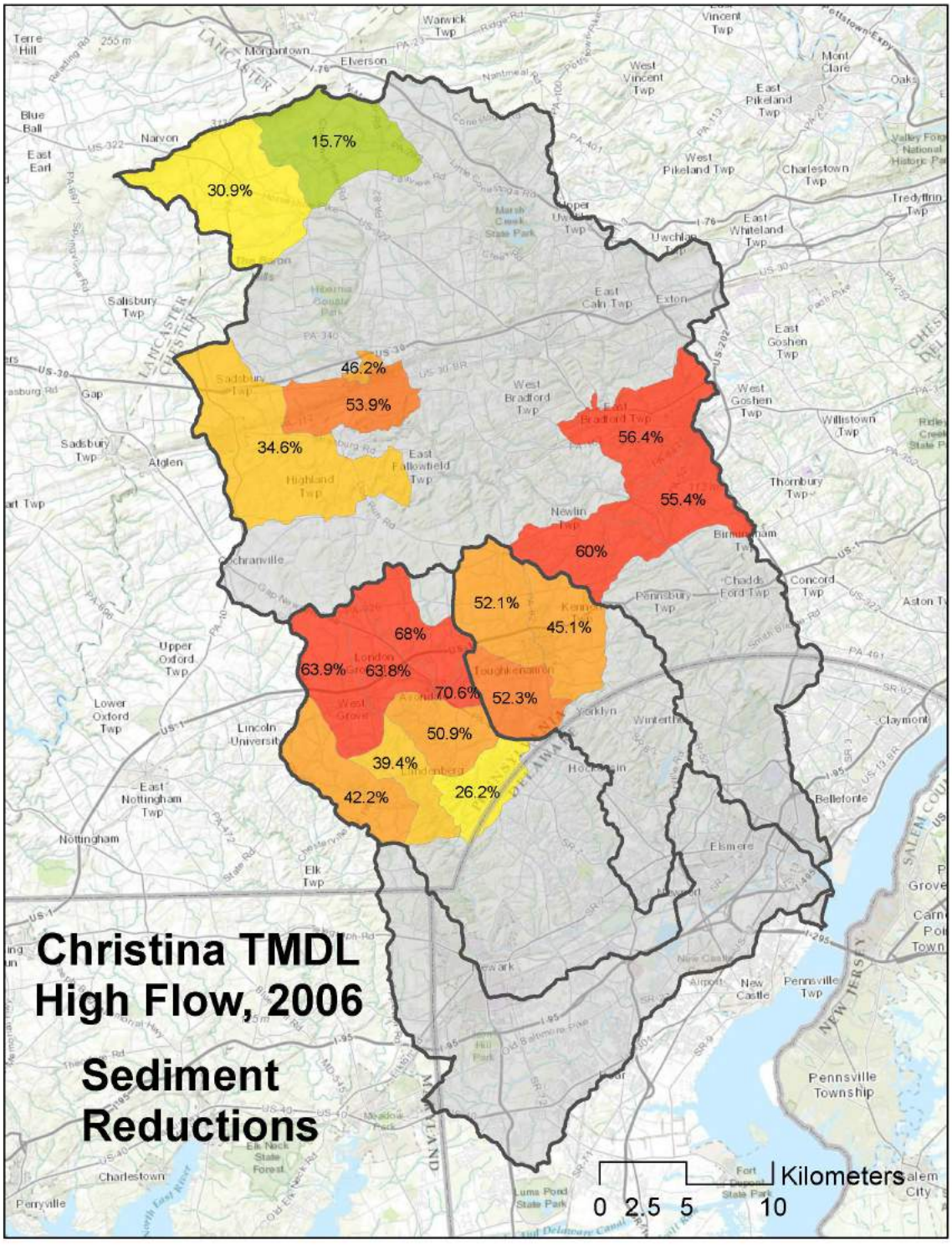


Figure 4.13. Sediment TMDL reductions in the Brandywine-Christina watershed (USEPA 2006)

Nitrogen Reduction Costs

Nitrogen load reduction costs are estimated by utilizing Brandywine-Christina watershed TMDLs as verified by the impaired streams map (see impairment maps in Figures 1.5 and 1.6) and multiplying by unit load reduction costs in $/lb N reduced. The TMDL requires nitrogen load reductions that range from 5% in the West Branch Brandywine Creek to 52% in the lower White Clay Creek watershed.

The literature indicates agriculture conservation BMP costs are an order to two orders of magnitude less than wastewater treatment and urban/suburban stormwater retrofitting BMPs (CBP 2004, Evans 2008, Jones et al. 2010, USDA NRCS undated, USEPA 1996, Trowbridge 2010, Weiland 2009). Nitrogen reduction costs vary from $1.50 to $11.00/lb N for agricultural conservation, $8.56 to $79.00 for wastewater treatment, $75.00 to $132.00 for airborne emissions controls, and $90.00 to $210.00/lb N for urban/suburban stormwater retrofitting (Table 4.3). Unit N load reduction costs include land-rental costs. We use N load reduction costs that range from $5/lb N for agriculture conservation to $100/lb N for urban stormwater retrofitting based on annualized costs over a ten-year period (Figure 4.14).

Table 4.3. Nitrogen reduction costs by source

Location	Source	Atmospheric Deposition ($/lb N)	Wastewater Treatment ($/lb N)	Urban/Sub. Stormwater ($/lb N)	Agriculture Conservation ($/lb N)
Chesapeake Bay	Jones et al. 2010		15.80–47.40	200+	1.50–4.70
New Hampshire	Trowbridge 2010		63.00–79.00		
Connecticut River	Evans 2008		17.30	137	4.93
Iowa	USDA NRCS			90	2.00–11.00
Chesapeake Bay	CBP 2004		8.56	>100	1.57–4.41
United States	EPA 1996	75–132			
Maryland	Weiland NOAA 2009			104-210	1.57–10.11

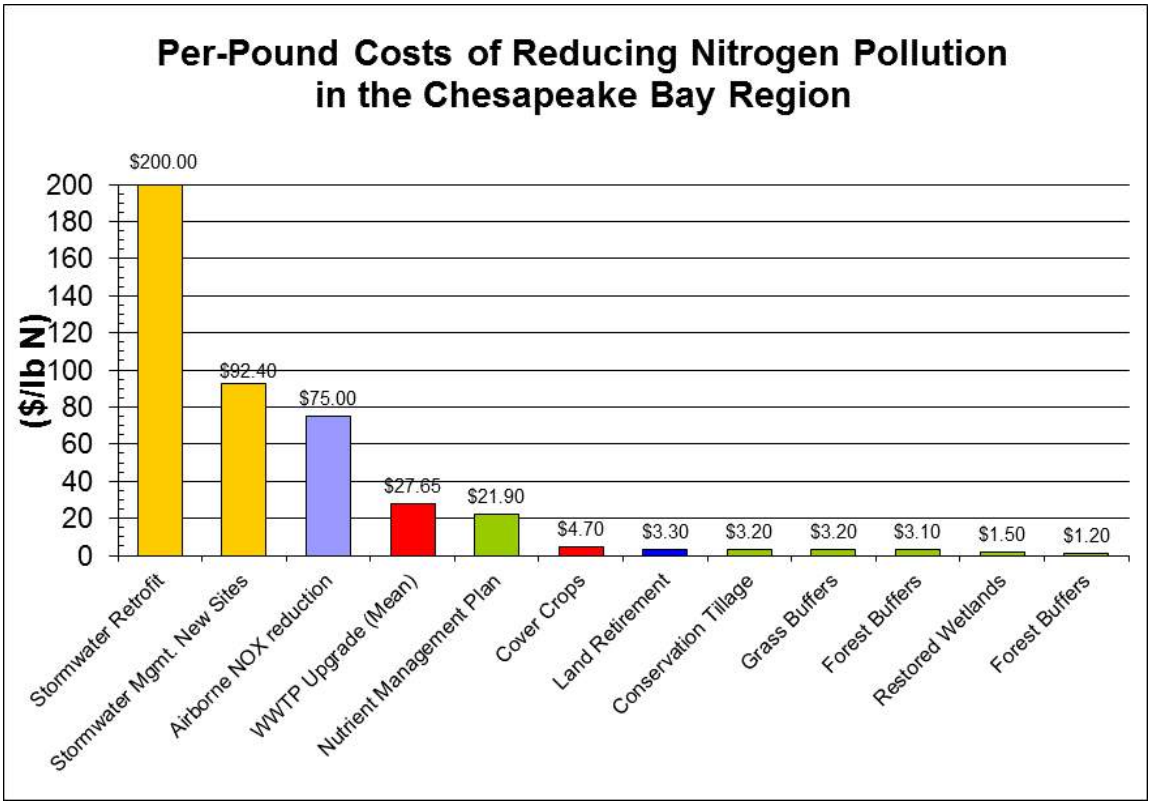


Figure 4.14. Per pound costs of nitrogen reduction (Jones et al. 2010 and USEPA 1996)

Nitrogen load reduction costs are estimated for two scenarios:

1. Load reduction costs spread evenly across all sources (atmospheric ($75/lb N), wastewater ($28/lb N), urban/suburban ($100/lb N), and agriculture ($5/lb N).
2. Invest in least-cost practices (primarily agriculture BMPs) based first on marginal abatement cost (MAC) principles.

Table 4.4 summarizes nitrogen load reduction costs for the Brandywine Creek watershed for both scenarios. For the entire watershed (Tables 4.5 and 4.6), annual N load reduction costs range from $18.3 million for Scenario A where costs are spread evenly across all sources (atmospheric, wastewater, urban/suburban, and agriculture) to $5.6 million for Scenario B where least-cost principles are applied to agriculture conservation (Figure 4.15 and Table 4.5). Nitrogen load reduction costs are prioritized by subwatershed for the Brandywine, Red Clay, White Clay, and Christina watersheds (Figure 4.16 and Table 4.6).

Table 4.4. Annual cost of nitrogen load reductions in Brandywine Creek watershed

Watershed	N Load Reduc. (ton)	Atmos. (ton)	Waste Water (ton)	Urban/ Suburb (ton)	Ag. (ton)	TMDL % Reduc.	Atmos. ($75/lb)	Waste water ($28/lb)	Urban/ Suburb. ($100/lb)	Ag. ($5/lb)	Total
A											
B01	72	4	0	1	67	38%	627,105	0	273,971	668,088	1,569,164
B02	49	3	8	4	34	20%	461,744	450,258	855,797	335,800	2,103,599
B03	4	0	0	0	4	9%	41,919	0	31,170	38,819	111,907
B08	51	3	4	1	43	18%	470,105	233,074	167,963	426,925	1,298,067
B16	2	0	0	1	2	2%	54,893	0	106,697	15,447	177,037
B17	2	0	0	2	0	16%	47,766	0	357,417	3,888	409,070
Total	**181**	**11**	**12**	**9**	**149**		**1,703,531**	**683,332**	**1,793,015**	**1,488,966**	**5,668,844**
B											
B01	72	0	0	0	72.4	38%	3,772	0	2,805	724,315	730,892
B02	49	0	0	0	48.8	20%	1,855	0	227	488,363	490,445
B03	4	0	0	0	4.4	9%	724	0	546	43,976	45,245
B08	50	0.1	0.1	0	50.0	18%	1,288	4,146	3,294	500,487	509,215
B16	3	0	0	0	3	2%	232	85	368	26,260	26,945
B17	2	0	0	0	2	16%	0	0	0	19,994	19,994
Total	**181**	**0.1**	**0.1**	**0**	**181**		**7,871**	**4,231**	**7,240**	**1,803,394**	**1,822,736**

Table 4.5. Nitrogen load reduction costs in the Brandywine-Christina watershed

Watershed	Atmospheric ($)	Wastewater ($)	Urban/Sub. ($)	Agriculture ($)	Total ($)
Apply costs evenly					
Brandywine	1,703,531	683,332	1,793,015	1,488,966	5,668,844
Red Clay	1,200,377	241,948	2,008,546	937,302	4,388,172
White Clay	2,021,978	0	2,133,067	2,271,787	6,426,831
Christina	304,830	0	1,418,483	116,455	1,839,768
Brandywine-Christina	**5,230,716**	**925,280**	**7,353,111**	**4,814,510**	**18,323,615**
Least-cost by source					
Brandywine	7,871	4,231	7,240	1,545,775	1,565,117
Red Clay	0	0	600,000	859,210	1,459,210
White Clay	0	0	200,000	1,826,825	2,026,825
Christina	39,072	0	286,835	192,720	518,627
Brandywine-Christina	**46,943**	**4,231**	**1,094,075**	**4,424,530**	**5,569,779**

Table 4.6. Nitrogen load reduction costs in the Brandywine-Christina watershed

Subwatershed	Area (mi^2)	Load (lb/yr)	Allocation (lb/yr)	Reduction (lb/yr)	% Reduction	Agriculture ($5.00/lb N)
Brandywine Creek						
B01 (WB Honey Brook)	18.4	316,382	199,144	117,238	37%	$586,190
B02 (West Branch)	7.4	91,542	55,407	36,135	39%	$180,675
B03 (West Branch)	6.8	73,073	65,846	7,227	10%	$36,135
B04 (West Branch)	0.8	4,015	4,015	0	0%	$0
B05 (West Branch)	8.8	510,708	485,815	24,893	5%	$124,465
B06 (West Branch)	8.1	98,769	69,058	29,711	30%	$148,555
B09 (EB Honey Brook)	14.7	202,356	166,221	36,135	18%	$180,675
B10 (East Branch)	18.3	205,568	168,630	36,938	18%	$184,690
B17 (Brandywine Cr.)	7.5	68,255	63,437	4,818	7%	$24,090
B18 (Brandywine Cr.)	10.4	83,512	83,512	0	0%	$0
B19 (Brandywine Cr.)	8.6	52,998	52,998	0	0%	$0
B32 (Birch Run)	4.7	23,287	20,878	2,409	10%	$12,045
B33 (Rock Run)	8.0	77,891	69,861	8,030	10%	$40,150
B34 (L. Brandywine)	6.0	36,135	30,514	5,621	16%	$28,105
	128.5	**1,844,491**	**1,535,336**	**309,155**	**17%**	**1,545,775**
Red Clay Creek						
R01 (West Branch)	10.1	105,193	53,801	51,392	49%	$256,960
R02 (West Branch)	7.4	124,465	81,906	42,559	34%	$212,795
R03 (East Branch)	9.9	101,981	53,801	48,180	47%	$240,900
R04 (Red Clay Cr.)	5.1	33,726	17,666	16,060	48%	$80,300
R05 (Red Clay Cr.)	5.2	28,105	14,454	13,651	49%	$68,255
	54.0	**474,573**	**302,731**	**171,842**	**36%**	**$859,210**
White Clay Creek						
W01 (West Branch)	10.2	126,874	64,240	62,634	49%	$313,170
W02 (Middle Branch)	9.5	119,647	61,028	58,619	49%	$293,095
W03 (Middle Branch)	6.3	69,861	35,332	34,529	49%	$172,645
W04 (East Branch Trib.)	6.2	66,649	33,726	32,923	49%	$164,615
W06 (East Branch Trib.)	8.6	183,084	115,632	67,452	37%	$337,260
W07 (Trout Run)	1.4	30,514	19,272	11,242	37%	$56,210
W08 (East Branch)	7.5	105,193	52,998	52,195	50%	$260,975
W09 (East Branch)	6.8	64,240	32,120	32,120	50%	$160,600
W10 (White Clay Cr.)	3.6	26,499	12,848	13,651	52%	$68,255
	107.0	**1,015,795**	**650,430**	**365,365**	**4**	**1,826,825**
Christina River						
C01 (West Branch)	6.7	88,330	54,604	33,726	38%	$168,630
C05 (Little Mill Cr.)	3.8	12,045	10,439	1,606	13%	$8,030
C09 (Lower Christina)	21.9	62,634	59,422	3,212	5%	$16,060
	77.7	**342,881**	**304,337**	**38,544**	**1**	**192,720**

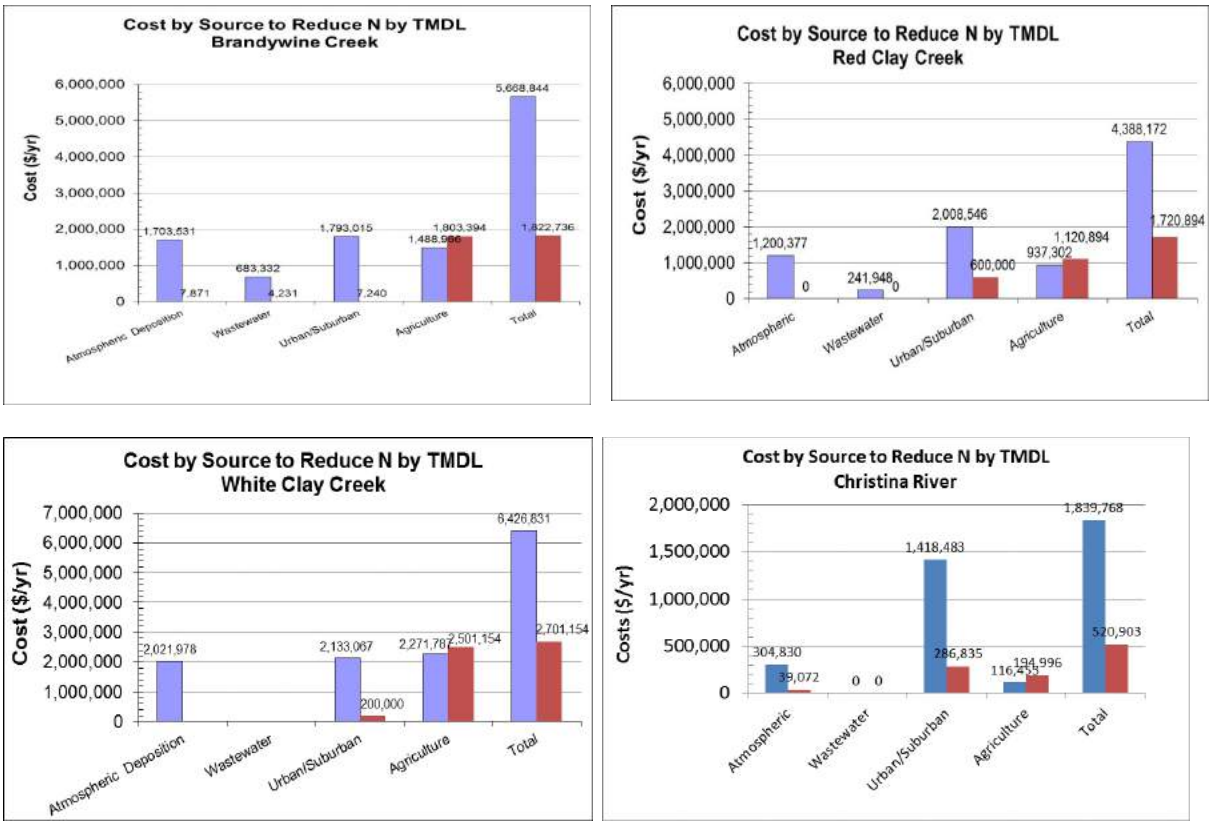


Figure 4.15. Cost by source to reduce nitrogen in the Brandywine-Christina watershed

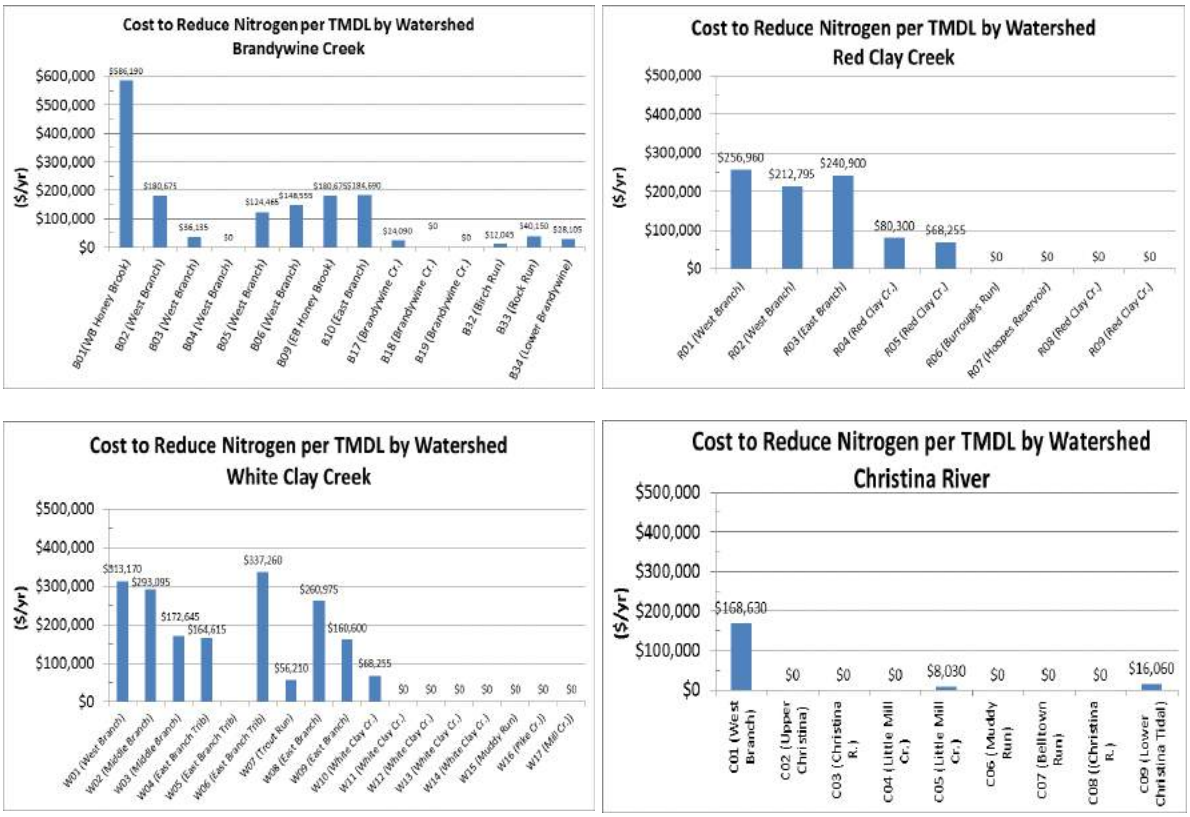


Figure 4.16. Least-cost to reduce nitrogen in the Brandywine-Christina watershed

Sediment Reduction Costs

Sediment load reduction costs are estimated by utilizing Brandywine-Christina watershed TMDLs (Figure 4.17) verified by the impaired streams map and multiplying by unit load reduction costs in $/lb TSS reduced. The TMDL requires sediment load reductions that range from 16% in the West Branch Brandywine at Honey Brook to 71% along Trout Run in the White Clay watershed. The Chesapeake Bay Foundation (2013) concluded annual costs of sediment reduction vary from $3.07/ton ($0.002/lb) for conservation tillage to $114.02/ton ($ 0.057/lb) for cover crops (Table 4.7). This analysis assumes an annual TSS reduction cost of $0.06/lb for agriculture conservation practices.

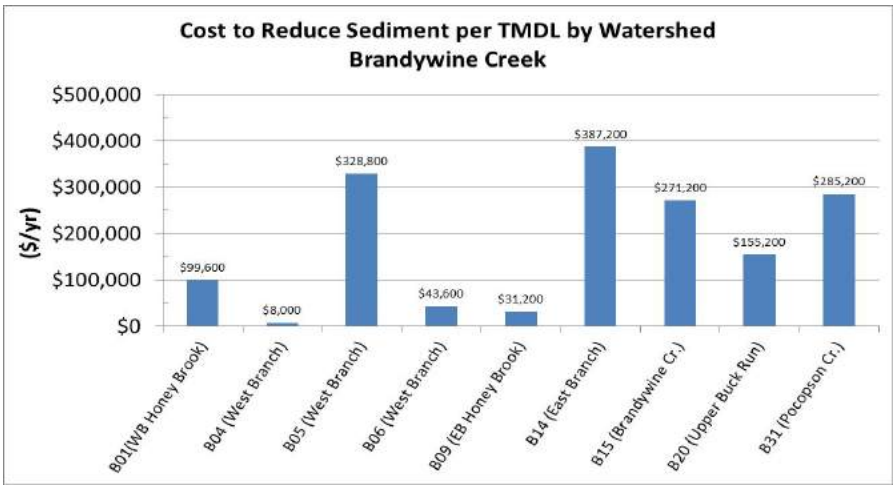
Table 4.7. Sediment reduction costs in Pennsylvania (Chesapeake Bay Foundation 2013)

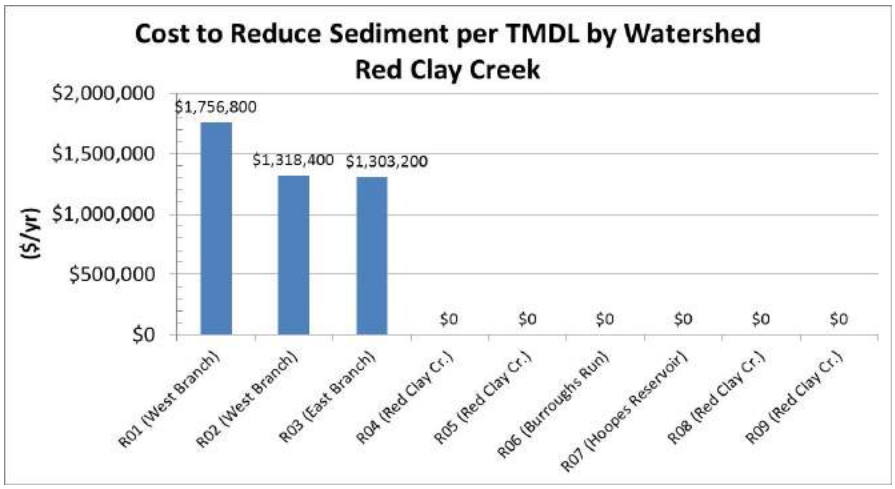
Nonpoint source practice	Annual Cost ($/ac)	Effectiveness (ton reduced/ac)	Cost-effectiveness ($/ton reduced)	Cost-effectiveness ($/lb reduced)
Conservation Tillage	2.72	0.89	3.07	0.002
Land Retirement	17.00	1.04	16.42	0.008
Forest Buffers	108.00	1.81	59.55	0.030
Cover Crops (early)	27.00	0.24	114.02	0.057
Wetland Restoration	108.00	1.81	59.55	0.030
Conservation Plans	17.00	0.30	57.43	0.029

Table 4.8. Costs to reduce sediment loads in the Brandywine-Christina watershed

Subwatershed	Area (mi^2)	TSS Load (lb/yr)	Allocation (lb/yr)	Reduction (lb/yr)	% Reduction	Cost ($0.06/lb)
Brandywine Creek						
B01 (WB Honey Brook)	18.4	1,612,000	1,114,000	498,000	31%	$29,880
B04 (West Branch)	0.8	86,000	46,000	40,000	47%	$2,400
B05 (West Branch)	8.8	3,050,000	1,406,000	1,644,000	54%	$98,640
B06 (West Branch)	8.1	680,000	462,000	218,000	32%	$13,080
B09 (EB Honey Brook)	14.7	998,000	842,000	156,000	16%	$9,360
B14 (East Branch)	12.9	3,434,000	1,498,000	1,936,000	56%	$116,160
B15 (Brandywine Cr.)	10.4	2,448,000	1,092,000	1,356,000	55%	$81,360
B20 (Upper Buck Run)	25.5	2,242,000	1,466,000	776,000	35%	$46,560
B31 (Pocopson Cr.)	9.2	2,378,000	952,000	1,426,000	60%	$85,560
	108.8	**16,928,000**	**8,878,000**	**8,050,000**	**48%**	**483,000**
Red Clay Creek						
R01 (West Branch)	10.1	16,864,000	8,080,000	8,784,000	52%	$527,040
R02 (West Branch)	7.4	12,604,000	6,012,000	6,592,000	52%	$395,520
R03 (East Branch)	9.9	14,448,000	7,932,000	6,516,000	45%	$390,960
	54.0	**43,916,000**	**22,024,000**	**21,892,000**	**50%**	**$1,313,520**
White Clay Creek						
W01 (West Branch)	10.2	10,708,000	6,190,000	4,518,000	42%	$271,080
W02 (Middle Branch)	9.5	16,022,000	5,776,000	10,246,000	64%	$614,760
W03 (Middle Branch)	6.3	6,338,000	3,842,000	2,496,000	39%	$149,760
W04 (East Branch Trib.)	6.2	10,376,000	3,750,000	6,626,000	64%	$397,560
W06 (East Branch Trib.)	8.6	16,234,000	5,192,000	11,042,000	68%	$662,520
W07 (Trout Run)	1.4	2,836,000	834,000	2,002,000	71%	$120,120
W08 (East Branch)	7.5	9,218,000	4,524,000	4,694,000	51%	$281,640
W09 (East Branch)	6.8	5,616,000	4,144,000	1,472,000	26%	$88,320
	107.0	**77,348,000**	**34,252,000**	**43,096,000**	**56%**	**$2,585,760**

Sediment load reduction costs range from $0.5 million/yr in the Brandywine Creek watershed to $1.3 million/yr in the Red Clay Creek and $2.6 million/yr in the White Clay Creek (Table 4.8). Sediment load reduction costs are prioritized by subwatershed for the Brandywine Creek, Red Clay Creek, and White Clay Creek watersheds (Figure 4.17).





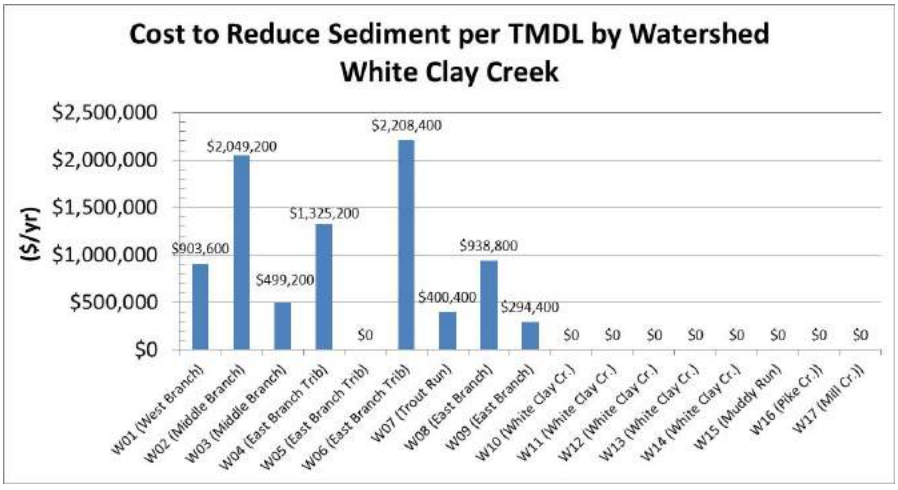


Figure 4.17. Cost to reduce sediment per TMDL in the Brandywine-Christina watershed

Open Space Preservation Costs

The City of Wilmington (2010) Source Water Protection Plan identified agricultural preservation areas in the West Branch of the Brandywine Creek in Honey Brook (Figure 4.18). The Chester County open space program funded land conservancy grants to protect 354 acres in 2013 at costs that ranged from $1,125/ac to $3,289/ac (Table 4.9). Therefore, if 1,000 acres of watershed land are preserved, the costs would range from $1.1 to $3.3 million.

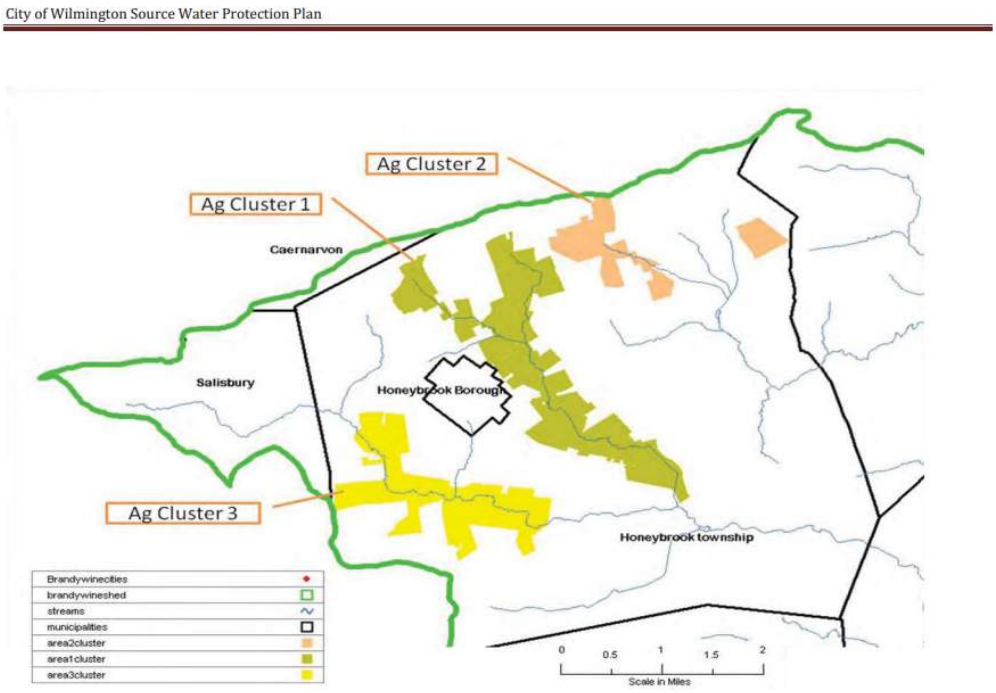


Figure 4.18. Agricultural preservation areas West Branch Brandywine Creek in Honey Brook (City of Wilmington 2010)

Table 4.9. Land conservancy grants by Chester County Open Space Program in 2013

Conservancy	Municipality	Project	Acres	County Funds ($)	Funds ($/Acre)
French & Pickering Creeks Conservation Trust	E. Nantmeal	Why Not Farm	91	158,500	1,742
Natural Lands Trust	W. Pikeland	Carmichael	21	42,000	2,000
French & Pickering Creeks Conservation Trust	W. Pikeland	Thayer Farm	28	92,084	3,289
Natural Lands Trust	E. Nantmeal	Conamoore Farm	44	68,053	1,547
Natural Lands Trust	E. Brandywine	Dilworth Farm	82	268,000	3,268
Natural Lands Trust	W. Pikeland	Woodland	20	39,800	1,990
Brandywine Conservancy	Honey Brook Twp.	Fisher	68	76,500	1,125
			354	744,937	2,104

4.6. Benefits

This analysis addresses risk-reduction benefits and economic benefits of improved water quality in the Brandywine-Christina watershed in the following sectors: (1)drinking water, (2) forests, (3) agriculture, (4) navigation (avoided dredging), and (5) nonuse swimming recreation.

Risk Reduction for Drinking Water Supply

Investing in water quality protections now can help water purveyors manage long-term risk. Improved water quality provides municipal water supply benefits from human-health, aesthetic, and water treatment process effects (USEPA 2002). Clean drinking water provides human-health benefits through reduced mortality, cancer risk, illness, and neurological and reproductive risks. Aesthetic benefits of purified drinking water supplies include improved taste and odor and less discoloration of laundry and plumbing fixtures. Improved water quality reduces scaling and clogging of water treatment plants that leads to lowered processing costs. Municipal water suppliers require the highest-quality water supplies as inputs to the water treatment process (Koteen et al. 2002). Municipal water suppliers are most concerned with quantity, salinity, and total suspended solids. If water quality is insufficient, municipal water suppliers may have to relocate water treatment plants elsewhere at substantial cost.

The quality of municipal water supplies can have a significant effect on treatment costs (USEPA 2012). The USEPA regulates drinking water quality according to standards developed under the Safe Drinking Water Act. The Safe Drinking Water Act Amendments require cost-benefit analysis that estimates benefits of source water protection and water quality improvements due to (1) human-health improvements, (2) enhanced aesthetic qualities in taste, odor, and visual appearance, and (3) reduced water treatment costs.

The risk of waterborne disease should be considered in the economics of source water protection and public drinking water supply safety. Contaminated drinking water caused 400,000 people to become ill from a cryptosporidium outbreak in Milwaukee, Wisconsin, in 2003 (Corso et al. 2003). A study in the American Journal of Public Health (Gaffield et al. 2003) found that 123 waterborne outbreaks occurred between 1991 and 2000 in 30 states due to pathogens or other gastrointestinal illnesses. During the summer of 2014, Toledo, Ohio, shut down its water intakes on Lake Erie due to algal blooms from nutrient-laden runoff (Lee 2014).

Sediment is the leading cause of impairment along 5,500 rivers and streams in the United States (Figure 4.19) and pathogens are the second-leading cause of impairment (Gaffield et al. 2003). Cryptosporidium is resistant to filtration and disinfection from chlorine and suspended sediment in source waters reduces the disinfection capacity of chlorine. The USEPA mandates for conventional or direct filtration water treatment systems that turbidity (cloudiness of water) should be no more than 1 NTU and no higher than 0.3 NTU in at least 95% of samples in any month.

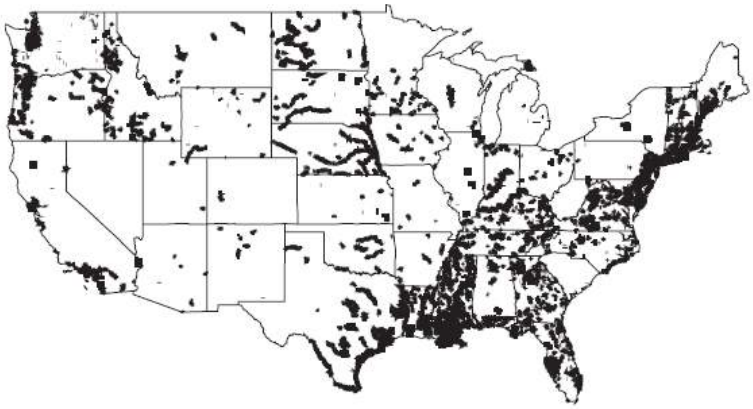


Figure 4.19. Pathogen impaired waters in the United States (Gaffield et al. 2003 from USEPA data)

The Safe Drinking Water Act (SDWA) Surface Water Treatment Rule requires surface water purveyors to monitor source watersheds and (1) provide cryptosporidium treatment for higher-risk systems and (2) maintain microbial protection to reduce formation of disinfection byproducts (USEPA 2009). A typical water treatment plant, (1) draws source water and removes sediment and contaminants through (2) screening, (3) coagulation, (4) flocculation, (5) sedimentation, (6) filtration, and (7) disinfection (Figure 4.20).

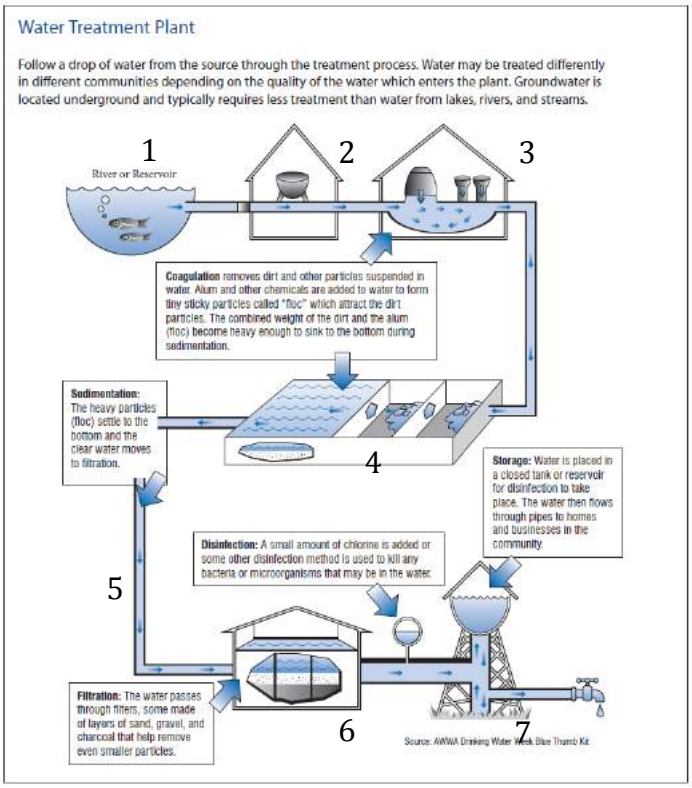


Figure 4.20. Water Treatment Plant Process (USEPA 2009)

Avoided Water Treatment Costs

Improved water quality can reduce water treatment costs for municipal water utilities in the Brandywine-Christina watershed. At stakeholder interviews and the regional advisory panel meetings, water purveyors such as Newark, Wilmington, United Water Delaware, Aqua Pennsylvania, PA American Water Co., Downingtown, and Honey Brook have expressed the following concerns and considerations about sediments and nitrogen/phosphorus and health risks and high costs of treating high turbidity and nutrient-laden source water. Newark and Wilmington are concerned about treating nutrient-laden water (high N and P) and eutrophication and the possibility of algal blooms from pumping this water into their reservoirs. The City of Newark invested almost $1 million during the construction of the $16 million Newark Reservoir (Figure 4.21) to build a wetland recirculation system around the perimeter of the reservoir to prevent algal blooms and eutrophication of high nitrogen water from the White Clay Creek. Aqua Pennsylvania monitors phosphorus levels in the source waters above their intake along the East Branch Brandywine Creek.

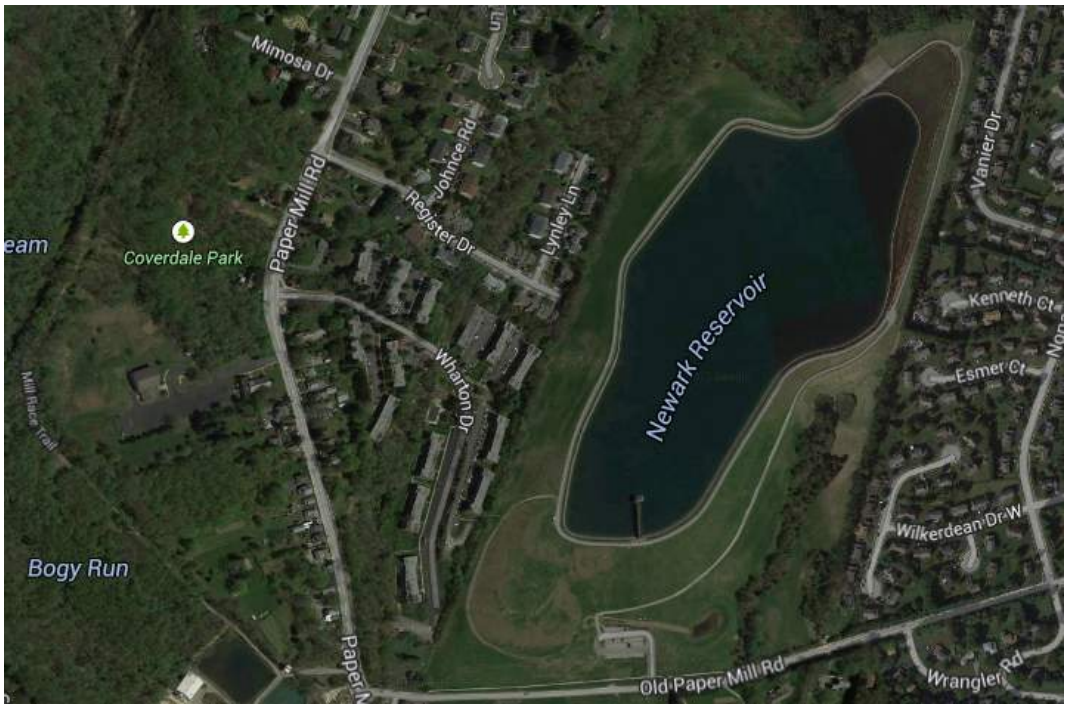


Figure 4.21. Newark Reservoir with perimeter wetland recirculation system (www.usgs.gov)

Municipal water supply benefits are calculated by estimating the reduced water treatment costs associated with improved source water quality. Poor water quality raises treatment costs due need for more chemicals, taste/odor control, energy use, and screening/filtration processes. Researchers from the University of Southern Maine (Colgan, Yakovleff, and Merrill 2013) found that investments in green infrastructure had present value cost of $44.4 million compared to water treament plant membrane filtration cost of $155.3 million, a savings of $111 million with a benefit-cost ratio over 3:1 (Table 4.10).

Table 4.10. Avoided costs of green infrastructure versus membrane filtration in Maine (Colgan, Yakovleff, and Merrill 2013)

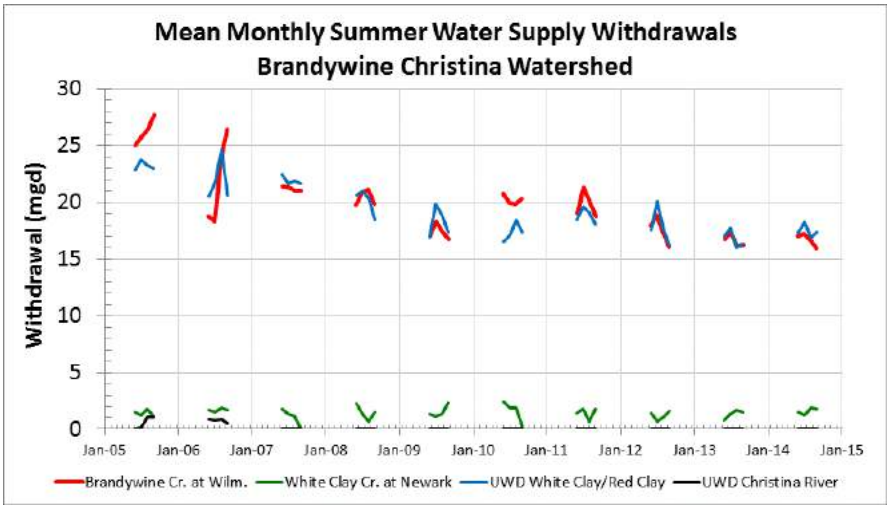
Infrastructure	Unit	Quantity	Present Value Costs ($ mil)
Riparian Buffers	ac	367	16.33
Culvert Upgrades	unit	44	1.38
Conservation	ac	4,699	0.14
Reforestation	ac	9,395	14.67
Conservation Easements (80% Forest)	ac	13,215	11.85
Green Infrastructure Cost			44.37
Gray infrastructure (membrane filtration)			155.28
Avoided Costs (gray minus green)			110.91

Surface waters in the Brandywine-Christina watershed provide drinking water to meet summer monthly demands in Chester County, Pennsylvania, and New Castle County, Delaware, including 30 mgd from the Brandywine Creek watershed and 24 mgd from the Red Clay/White Clay Creek watershed (Table 4.11). Water demands for Delaware suppliers have declined over the last decade and United Water Delaware has curtailed use of the Christina River water treatment plant since 2006 (Figure 4.22). Because the potential exists for this facility to come back on line, its historic use is included in the analysis. At current water rates, the annual value of treated surface water (55 mgd) in the Brandywine-Christina watershed is $130 million or $356,000 per day. The value of drinking water supply from streams by subwatershed are:

Brandywine Creek	$70 million
Red/White Clay Creek	$58 million
Christina River	$2 million
Brandywine-Christina	$130 million

Table 4.11. Estimated value of public surface water supplies in the Brandywine-Christina watershed

State	Watershed	Purveyor	Demand[1] (mgd)	Water Rate[2] ($/1,000 gal)	Value/day ($)	Value/year ($)
PA	Brandywine	PA American Water	4	9.21	36,840	13,446,600
PA	Brandywine	Downington MUA	2	7.65	15,300	5,584,500
PA	Brandywine	Aqua Pennsylvania	4	10.27	41,080	14,994,200
DE	Brandywine	City of Wilmington	20	4.88	97,600	35,624,000
			30		**190,820**	**69,649,300**
DE	White Clay	City of Newark	2	5.92	11,840	4,321,600
DE	White Clay	Artesian Water Co.	2	10.74	21,480	7,840,200
DE	Red/White Clay	United Water Delaware	20	6.28	125,600	45,844,000
			24		**158,920**	**58,005,800**
DE	Christina	United Water Delaware	1	6.28	6,280	2,292,200
			55		**356,020**	**129,947,300**



[1]Average summer demand (2005–2014). [2]Residential water rate at 15,000 gal/quarter per customer.

Figure 4.22. Monthly water supply withdrawals in the Brandywine-Christina watershed as reported by water purveyors

High pollutant loads lead to higher operations and maintenance (O&M) costs in water treatment and greater use of coagulants, increasing costs and the amount of time water needs to remain in settling basins. High sediment concentrations in source water generate more wastewater and sludge, which are both costly to treat and transport. Increased sediment also increases the frequency of dredging storage tanks and reservoirs. Data on O&M costs for 100 water treatment plants in the United States indicate that a 10% reduction in sediment is associated with a 2.6% average reduction in O&M costs as reported by TNC and IWA 2014 (Figure 4.23). A study by Texas A&M University found that water treatment costs increase by 1% for every 4% increase in water turbidity (McCarl 1997). At water treatment plants that draw water from high-nutrient sources, a 10% decrease in nutrients can reduce treatment costs by 1.9% (TNC and IWA 2014). Therefore, from these studies, we assume that a 4% decrease in sediment loads will decrease water treatment costs by 1%.

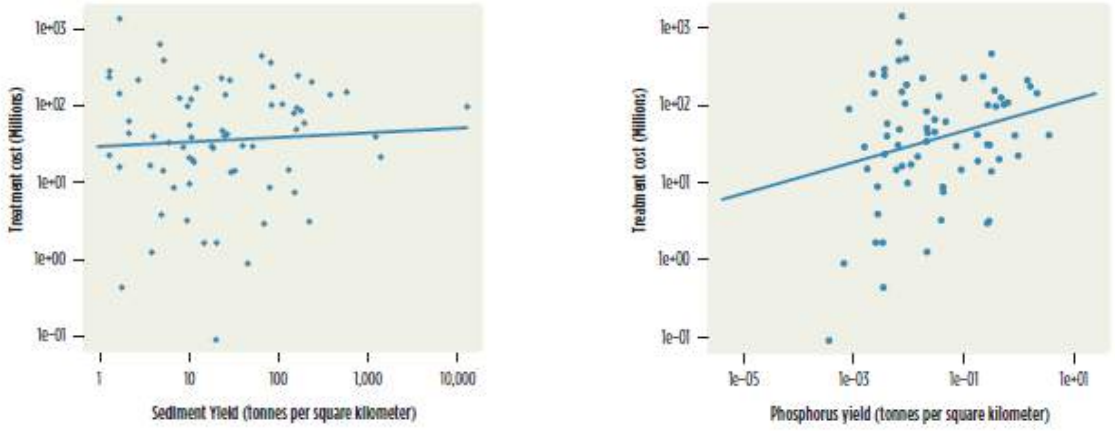


Figure 4.23. Relationship between sediment/nutrient loads and water treatment costs (TNC and IWA 2014)

Municipal water supply benefits are estimated by tabulating withdrawals (mgd) in the Brandywine-Christina watershed and then multiplying by existing water treatment costs ($/1000 gal) at current water quality. Municipal water supply benefits due to reduced watershed sediment loads are calculated by multiplying existing value by a 1% reduction in water treatment costs for every 4% reduction in sediment loads as per the TMDL.

USEPA (2004) estimates costs of water treatment by public and private water utilities are approximately 15% of the total cost of delivering water to customers at current water rates. At this proportion (15%), the existing cost of drinking water treatment is $26 million/yr in the Brandywine-Christina watershed. If a 4% reduction in sediment loads in the Brandywine-Christina watershed can reduce water treatment costs by 1% and the Brandywine-Christina TMDL requires sediment load reductions in the Brandywine (48%), Red Clay (50%), and White Clay (56%) watersheds and we assume a 50% sediment reduction in the Christina River, then potential water supply benefits are $2.5 million/yr ($1.2 million along the Brandywine, $1.2 million on the Red/White Clay, and $40,000 on the Christina River [Table 4.12]).

Table 4.12. Treatment savings from reduced sediment in Brandywine-Christina watershed

Watershed and State	Purveyor	Capacity (mgd)	Water Rate[1] ($/1,000 gal)	Treated Water 15% Cost[2] ($/yr)	Sediment TMDL Reduction (%)	Water Treatment Savings[1] ($/yr)
Brandywine						
PA	PA American	4	9.21	2,016,990	48%	242,039
PA	Downington MUA	2	7.65	837,675	48%	100,521
PA	Aqua Pennsylvania	4	10.27	2,249,130	48%	269,896
DE	Wilmington	20	4.88	5,343,600	48%	641,232
		30		**10,447,395**		**1,253,687**
Red/White Clay						
DE	Newark	2	5.92	648,240	56%	90,754
DE	Artesian Water	2	10.74	1,176,030	56%	164,644
DE	United Water Delaware	20	6.28	6,876,600	56%	962,724
		24		**8,700,870**		**1,218,122**
Christina						
DE	United Water Delaware	1	6.28	343,830	50%	42,979
Total		**55**		**25,989,460**		**2,514,788**

[1]Residential water rate at 15,000 gal/quarter per customer. [2]EPA (2004) estimated water treatment costs are 15% of total cost of delivering water. [3]Assumes 4% decrease in sediment load can decrease water treatment costs by 1% (TNC and IWA 2014 and McCarl 1997).

Forests

The Trust for Public Land and American Water Works Association (2004) found that for every 10% increase in forested watershed land, drinking water treatment and chemical costs are reduced by approximately 20% (Table 4.13). If the public drinking water supply from streams is 55 mgd and forests cover 133,760 acres (209 mi^2 or 37%) of the

Brandywine-Christina watershed, then increasing these forests by 10% would decrease drinking water treatment costs by $33 per mgd or $330,000/yr (Table 4.14).

Table 4.13. Drinking water treatment costs based on percent of forested watershed (TPL and AWWA 2004)

Watershed Forested	Treatment Costs ($/mg)	Change in Costs
0%	139	21%
10%	115	19%
20%	93	20%
30%	73	21%
40%	58	21%
50%	46	21%
60%	37	19%

Table 4.14. Water treatment benefits by 10% forest increase in the Brandywine-Christina watershed

Watershed	Forest[1] (ac)	Forest (%)	Drinking Water Supply (mgd)	Change in Treatment Cost[2] ($/mgd)	Change in Treatment Cost (%)	Benefits ($/yr)
Brandywine	86,400	42%	30	15	21%	164,250
Red Clay/White Clay	35,840	35%	24	18	21%	157,680
Christina	11,520	23%	1	22	20%	8,030
Brandywine-Christina	**133,760**		**55**	**33**		**329,960**

[1]NOAA CSC 2006. [2]TPL/AWWA 2004.

Agriculture

Approximately 39% of the Brandywine-Christina watershed is utilized for agriculture, 28% is developed as built-up urban/suburban land, and 33% is covered by natural forests, wetlands, and park lands (Figure 4.24). Soil erosion impairs agricultural production through reduced soil fertility and loss of crop sales. In the Brandywine-Christina watershed, data from the USDA agriculture census (2009) indicates the annual market value of agricultural products sold is $469 million on 135,808 acres (212 mi^2) for crops (mushrooms and corn, wheat, oats, barley, soybeans, potatoes, and vegetables) and livestock and poultry (Table 4.15). Mushroom farming accounts for around $400 million/yr of agricultural crop production in Chester County (USDA 2009) and, while not grown on cultivated land, the substrate for mushroom (hay and corn sillage) is grown on cultivated acreage and the spent substrate is often tilled back into the soil. Farmland occupies 4/10 of the watershed. This analysis assumes that soil erosion would result in loss of agricultural production on all of that land. The value of agricultural products sold is $3,400/ac, which ranks Chester County as the second-most valuable farm county in Pennsylvania, after Lancaster County.

In 2007, the USDA National Agricultural Statistics Service (2009) estimated the annual market value of agricultural products sold in Chester and Delaware Counties in Pennsylvania, and New Castle County in Delaware, was $609 million. Scaling by the area of farmland in the Brandywine-Christina watershed, the annual value of crops and farm products sold in the watershed is $469 million or $338 million in the Brandywine Creek, $48 million in the Red Clay Creek, $62 million in the White Clay Creek, and $22 million in the Christina River watershed (Table 4.16).

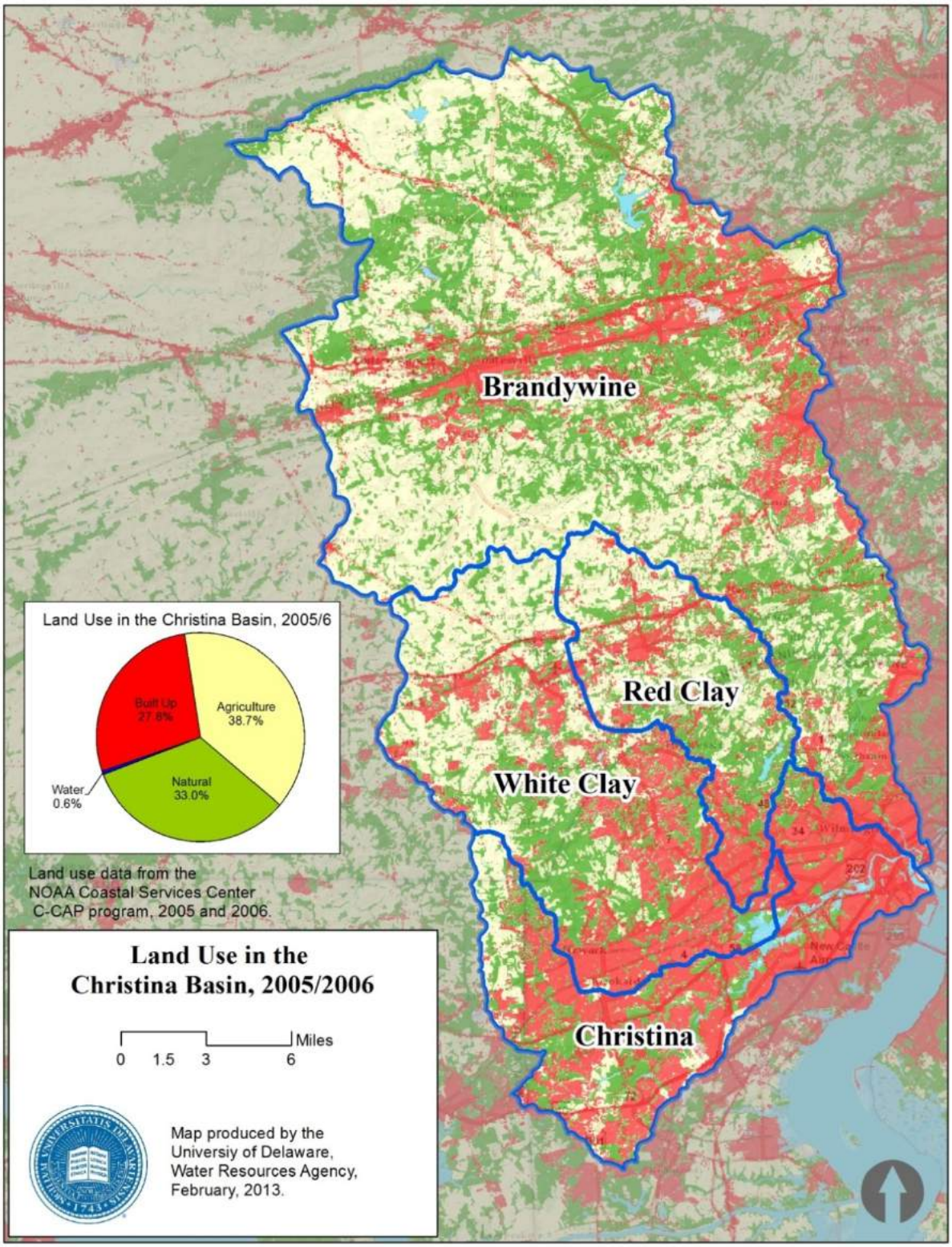


Figure 4.24. Land use in the Brandywine-Christina watershed (NOAA CSC 2005)

Table 4.15. Value of cropland and agriculture in the Brandywine-Christina watershed

Watershed	County	Farmland by County[1] (ac)	2007 Value by County[1] ($ million)	Farmland in Watershed (ac)[2]	2007 Value in Watershed ($ million)
Brandywine	Chester	117,145	553		
	Delaware	1,646	10		
	New Castle	51,913	46		
		170,704	**609**	**94,720**	**338**
Red Clay	Chester	117,145	553		
	New Castle	51,913	46		
		169,058	**599**	**13,440**	**48**
White Clay	Chester	117,145	553		
	Cecil	60,147	96		
	New Castle	51,913	46		
		229,205	**695**	**20,480**	**62**
Christina	Chester	117,145	553		
	Cecil	60,147	96		
	New Castle	51,913	46		
		229,205	**695**	**7,168**	**22**
				135,808	**469**

[1]USDA 2009. [2]NOAA CSC 2006.

Table 4.16. Estimated value of cropland and agriculture in the Brandywine-Christina watershed

Watershed	Farmland (ac)	Farmland (%)	Products Sold ($ million)	Products Sold ($/ac)
Brandywine	94,720	45%	338	3,568
Red Clay	13,440	39%	48	3,571
White Clay	20,480	36%	62	3,027
Christina	7,168	15%	22	3,069
Brandywine-Christina	**135,808**	**39%**	**469**	**3,453**

Soil erosion and sediment loss from cropland averages 1.2 ton/acre in the adjacent Chesapeake Bay watershed (USDA 2011). At this rate, soil erosion from 135,808 acres of farmland in the Brandywine-Christina watershed is 163,000 ton/yr (Table 4.17). If average top soil thickness is 3 inches and loose density of top soil is 75 lb/ft^3, then the erosion rate of 163,000 ton/yr is equivalent to taking 397 acres of cropland out of production in the Brandywine-Christina watershed. At an average value of farm products sold ($/ac), the estimated value of lost farm production due to loss of 397 acres from soil erosion in the watershed is $1.4 million. If optimally designed farm conservation BMPs reduce sediment

loads in accordance with TMDLs, then the benefits from restoring cropland through erosion control programs could be as high as $680,000/yr.

Pimentel et al. (1995) published an article in *Science* that concluded that 4 billion tons of soil in the United States were lost from 64 million acres of cropland at a cost of $7 billion per year ($110/ac) due to water erosion and siltation that damage downstream recreation, water storage facilities, navigation, flood control, and water treatment facilities. At $110/ac, estimated soil erosion damages due to sediment loss from 135,808 acres of farmland in the Brandywine-Christina watershed is $15 million/yr. If optimally designed farm BMPs are implemented to reduce sediment loads in accordance with the TMDLs, then the estimated agricultural benefits from reduced soil erosion damages is $7.4 million/yr or $5.0 million in the Brandywine Creek, $0.7 million in Red Clay, $1.3 million in White Clay, and $400,000 in the Christina watersheds (Table 4.18).

Table 4.17. Estimated avoided soil erosion benefits from agriculture in the Brandywine-Christina watershed

Watershed	Farmland[1] (ac)	Farmland (%)	Soil Erosion at 1.2 ton/ac[2] (ton/yr)	Lost Cropland[3] (ac)	Products Sold ($/ac)	Sediment TMDL Reduction (%)	Value of Lost Farm Production[4] ($)
Brandywine	94,720	45%	113,664	277	3,568	48%	474,401
Red Clay	13,440	39%	16,128	39	3,571	50%	69,635
White Clay	20,480	36%	24,576	60	3,027	56%	101,707
Christina	7,168	15%	8,602	21	3,069	50%	32,225
Brandywine-Christina	**135,808**	**39%**	**162,970**	**397**	**3,453**		**677,967**

[1]Census of Agriculture 2007 (USDA 2009) and scaled by ratio of farm area in watershed. [2]USDA 2011.
[3]Lost cropland production from soil erosion given 3 inches of topsoil and soil density of 75 lb/ft[3]. [4]Value of lost farm production assumes BMPs reduce sediment loads by 70% as per TMDLs.

Table 4.18. Estimated avoided soil erosion benefits in the Brandywine-Christina watershed

Watershed	Farmland[1] (ac)	Farmland (%)	Soil Erosion Damage[2] ($/ac)	Sediment TMDL Reduction (%)	Soil Erosion Damage[3] ($/yr)
Brandywine	94,720	45%	110	48%	5,001,216
Red Clay	13,440	39%	110	50%	739,200
White Clay	20,480	36%	110	56%	1,261,568
Christina	7,168	15%	110	50%	394,240
Brandywine-Christina	**135,808**	**39%**	**110**		**7,396,224**

[1]Census of Agriculture 2007 (USDA 2009) and scaled by ratio of farm area in watershed. [2]Pimental et al. 1995.
[3]Value of lost farm production assumes BMPs reduce sediment loads by 70% as per TMDLs.

Navigation

The Port of Wilmington is located at the confluence of the Delaware and Christina Rivers, 65 miles from the Atlantic Ocean. The port is one of the largest importers of orange juice, Chilean grapes, bananas, and automobiles nationally. The port provides significant economic value to the region, and the water resources of the Christina River watershed play a significant role in navigation and port activity. Martin Associates (2005) reported to the Diamond State Port Corporation that the cargo activity at the Port of Wilmington generated a total of $3.2 billion of total economic activity in the region.

Pollutant load reductions in the Brandywine-Christina watershed can decrease sediment loads that in turn can reduce navigation dredging costs in the Port of Wilmington ship channel at the tidal Christina River. Navigation benefits are estimated from sediment load reductions (lb/yr or yd^3/yr) from urban/suburban and agricultural conservation practices multiplied by dredging costs ($/$yd^3$) from the U.S. Army Corps of Engineers.

The annual sediment discharge from the Brandywine-Christina watershed TMDL model is 200,000 cubic yards (CY). In 2010 the U.S. Army Corps of Engineers began a $267 million dredging project to deepen the Delaware River ship channel to 45 feet and remove 33 million CY of material at a unit cost of $8.09/CY. Brandywine-Christina watershed TMDLs require watershed-sediment load reductions of 48%–56%. Urban/suburban and agricultural conservation BMPs reduce sediment loads and provide water quality benefits through avoided costs of dredging. With watershed BMPs in place to reduce sediment loads by 48% to 56% in accordance with TMDLs, the annual avoided cost to dredge 200,000 CY from the tidal Christina River at $8.09/CY ranges from $777,000 to $906,000.

Nonuse Benefits

Nonuse benefits accrue from the "existence value" people place on the knowledge that a resource (such as a river) exists and could be improved and the "bequest value" that the river will be preserved for future generations. The contingent value method estimates nonuse benefits through a survey of individual willingness to pay for improved water quality for recreational viewing, boating, fishing, and swimming uses.

Carson and Mitchell (1993) conducted a contingent value (CV) study to estimate the national benefits of freshwater pollution control to meet the goals of the Clean Water Act. The study surveyed public preferences or willingness to pay (WTP) for improved water quality to achieve use (instream, withdrawal, aesthetic, ecosystem) benefits and nonuse (vicarious consumption and stewardship) benefits (Table 4.19). The authors measured nonmarket benefits through a 1983 contingent valuation survey that asked 813 people at 61 sites about their willingness to pay more taxes for cleaner water. Respondents were asked to view a water quality ladder with levels from below "boatable" to "drinkable" and asked to state how much they would be willing to pay to maintain or achieve various levels of minimum water quality throughout the country (Table 4.20).

Table 4.19. Typical benefits from improved freshwater quality (Carson and Mitchell 1993)

Benefit	Category	Examples
Use	Instream	Recreational (fishing, swimming, boating)
		Commercial (fishing, navigation)
	Withdrawal	Municipal (drinking water, waste disposal)
		Agriculture (irrigation)
		Industrial/commercial (waste treatment)
	Aesthetic	Near water recreation (hiking, picnicking, photography)
		Viewing (commuting, office/home views)
	Ecosystem	Hunting/bird watching
		Ecosystem support (food chain)
Nonuse	Vicarious	Significant others (relatives, friends)
		American public
	Stewardship	Inherent (preserving remote wetlands)
		Bequest (family, future generations)

Individuals were asked how much they would be willing to pay to achieve boatable, fishable, and swimmable uses based on a water quality ladder (Figure 4.25). According to the water quality ladder, the Brandywine Creek, Red Clay Creek, White Clay Creek, and Christina River would be rated as boatable and fishable (B rating) but not yet swimmable (A rating).

Table 4.20. Water quality ladder values (Carson and Mitchell 1993 from Resources for the Future)

Rating	Beneficial Use	TSS (mg/l)	DO (mg/l)	Bacteria (#/100ml)
A	Swimmable	10	5	200
B	Fishable	50	4	1000
C	Boatable	100	3	2000

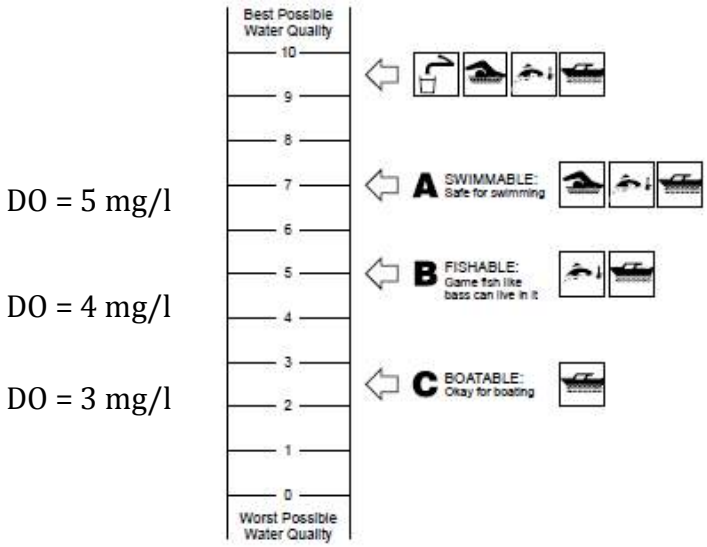


Figure 4.25. Water quality ladder
(Carson and Mitchell 1993 from Resources for the Future)

Per-person recreation benefits to achieve boatable and fishable water quality are determined from WTP studies conducted by Carson and Mitchell (1993) and then converting to 2010 dollars (Table 4.21). Nonuse benefits are determined by multiplying the individual WTP ($/person) by the adult population (>18 yr old) of the watershed and then multiplying this value by 33% (Johnston et al. 2003). When converted to 2010 dollars, Carson and Mitchell (1993) concluded mean annual household WTP to improve water quality was $60 to go from fishable to swimmable uses, which compares favorably to a mean WTP of $83 in a range of $31–$331 from 90 publications during 1977–2003 (Houtven et al. 2007).

Table 4.21. Nonuse benefits of swimmable water quality in the Brandywine-Christina watershed
(Carson and Mitchell 1993)

Subwatershed	2010 Population	% Adult Pop. (> 18 yr)	Adult Pop. (> 18 yr)	2010 WTP ($/person)	2010 WQ Benefits ($)	Nonuse Benefit (33% of WQ)
Brandywine	246,702	78%	192,428	60	11,545,654	3,810,066
Red Clay	46,893	78%	36,577	60	2,194,592	724,215
White Clay	123,506	78%	96,335	60	5,780,081	1,907,427
Christina	174,196	78%	135,873	60	8,152,373	2,690,283
Brandywine-Christina	**591,297**	**78%**	**461,212**	**60**	**27,672,700**	**9,131,991**

Parsons, Helm, and Bondelid (2003) measured the economic benefits of water quality improvements to recreational users in the New England states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut and found per-person willingness to pay (WTP) for good water quality was $6.00 for swimming use support in 1994 dollars.

Adjusting to 2010 dollars based on the change in the Consumer Price Index (CPI) in the Northeast Region by the Bureau of Labor Statistics, per person WTP is $10.62 for swimming uses (Table 4.22).

Table 4.22. Nonuse benefits of swimmable water quality in the Brandywine-Christina watershed (Parsons et al. 2003)

Subwatershed	2010 Population	% Adult Pop. (> 18 yr)	Adult Pop. (> 18 yr)	WQ Benefit ($/person)	WQ Benefits ($)	Nonuse Benefit (33% of WQ)
Brandywine	246,702	78%	192,428	10.62	2,043,581	674,382
Red Clay	46,893	78%	36,577	10.62	388,443	128,186
White Clay	123,506	78%	96,335	10.62	1,023,074	337,615
Christina	174,196	78%	135,873	10.62	1,442,970	476,180
Brandywine-Christina	**591,297**	**78%**	**461,212**	**10.62**	**4,898,068**	**1,616,362**

Based on Parsons et al. 2003 and Carson and Mitchell (1993), nonuse benefits of WTP for improved water quality to achieve swimmable uses in the Brandywine-Christina watershed ranges from $1.6 million to $9.1 million/yr (Figure 4.26).

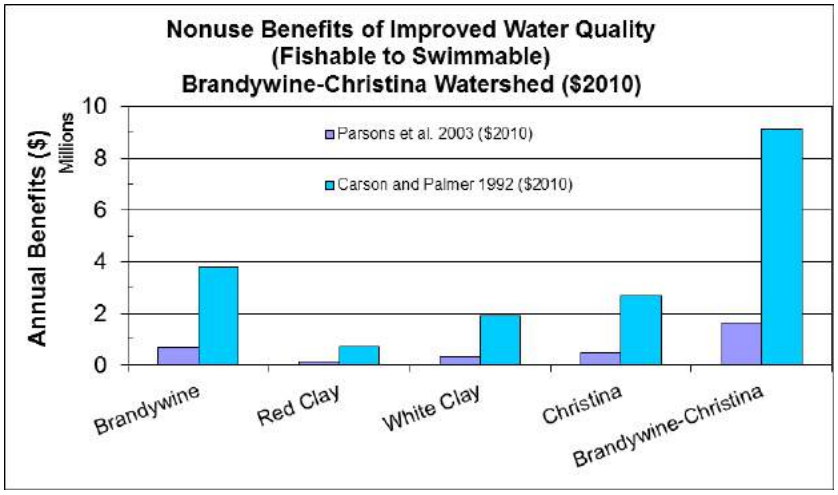


Figure 4.26. Nonuse benefits of swimmable water quality in the Brandywine-Christina watershed

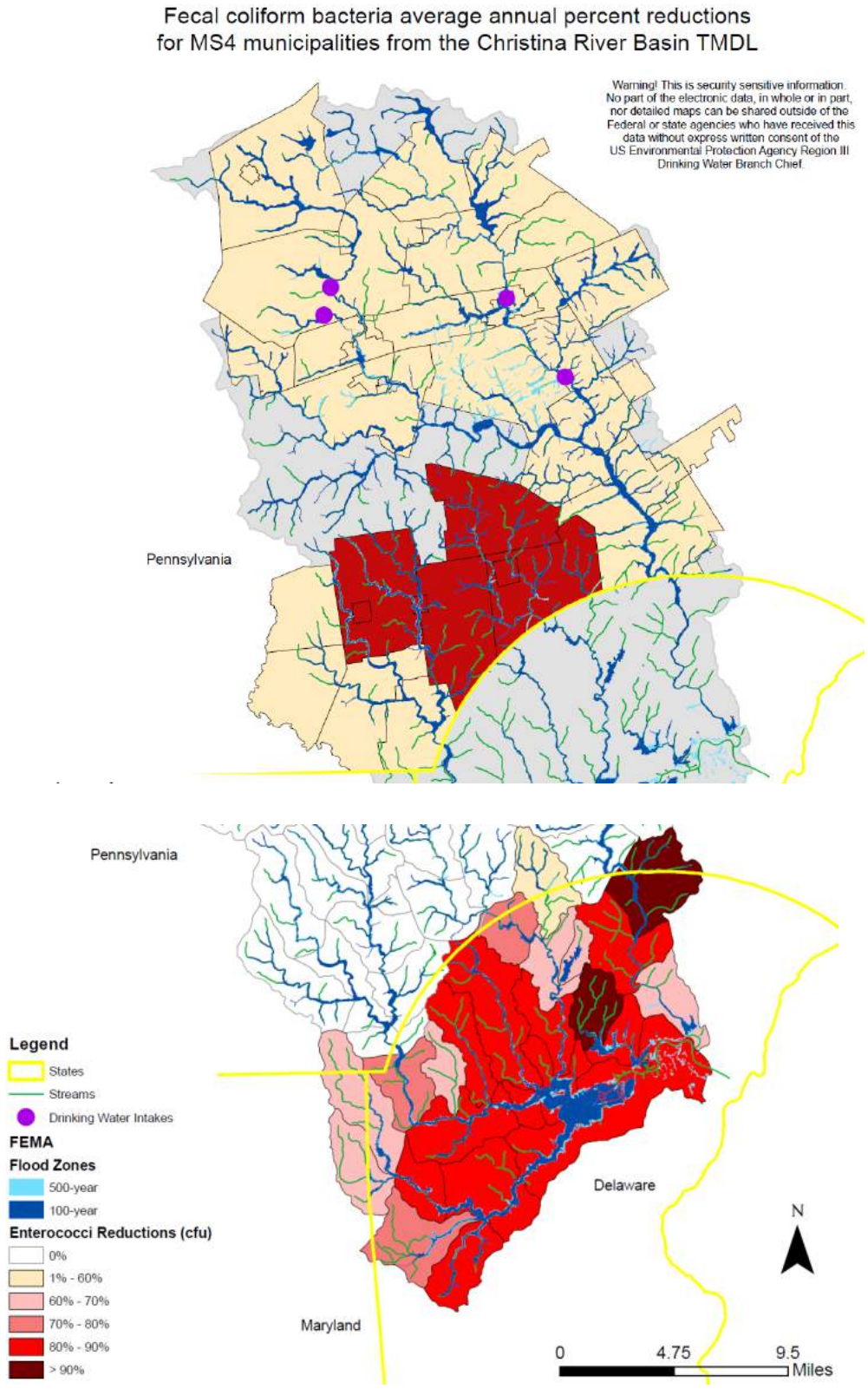


Figure 4.27. Bacteria TMDL load reductions in the Brandywine-Christina watershed

4.7. Key Findings

1. **Economic Approach:** Researchers from Harvard and Resources for the Future in Washington, D.C. have concluded that a water quality market administered by a river basin organization that involves water use fees or charges would "internalize the externalities" and set up a pricing system that provides financial incentives for dischargers and water suppliers to invest upstream to reduce water pollution. If the Delaware River Basin managed water use as an industry, then the tendency to pass off costs to downstream users would evaporate because negative externalities would become internal within the basin organization.
2. **Diminishing Water Appropriations:** Scientific methods that restore watersheds are becoming increasingly successful, however they are hamstrung by diminishing appropriations at the federal, state, and local levels. In 2012, the Corps of Engineers Institute for Water Resources reiterated the call for a new national water policy initiative to maximize net benefits through water charges as first set forth by the Harvard Water Program almost a half century ago. A $1 million/yr investment to improve water quality in the Brandywine-Christina watershed would boost GDP by $6.3 million and yield 28 direct water jobs.
3. **Market-Based Funding Models:** With declining federal, state, and local funding, watershed managers have trained renewed interest on market-based funding models such as user charges as more efficient alternatives to traditional command/control regulatory approaches that rely on subsidies and grants. New York City (Catskill Reservoirs), Boston (Quabbin Reservoir), San Francisco (Hetch Hetchy), and Seattle have tapped investment in watershed services to fund upstream watershed restoration efforts through water use charges (Bennett et al. 2013). The USEPA surveyed six communities and found improved source water quality resulted in lower water treatment/chemical costs and that every dollar invested in source water protection resulted in $27 in water treatment savings (Gartner et al. 2014). The survey concluded that natural infrastructure such as reforestation in source watersheds costs 2 to 30 times less than built water treatment infrastructure in Oregon, New Mexico, Maine, and New York.
4. **The Diamond-Water Paradox:** The diamond-water paradox points out a significant challenge in water resources management that the value of water and the prices charged to utilize this resource do not reflect the full opportunity cost at its highest use. In the public policy realm, consumers pay for the right to use water at its average cost when water is abundant—not at its highest value for all uses (not just drinking water) based on its scarcity value. Since water is undervalued compared to its highest and best opportunity cost, federal, state, and local governments are inclined to underinvest in water resources and watershed programs.
5. **Public Willingness to Pay for Clean Water:** The Delaware Nature Society (OpinionWorks LLC 2015) commissioned a survey of 400 Delaware residents (Table 4.23) and found that the public (without knowing the amount) profoundly supported the concept of a clean water fee by nearly a 2 to 1 margin (57% in favor, 32% opposed). When the residents were informed the fee would be $3.75/month, the support

increased to a 3 to 1 margin (74% in favor, 21%). Support for the fee crosses party and county lines as 57%, 53%, and 58% of the people supported the clean water fee in New Castle, Kent, and Sussex Counties, respectively, and 66% of Democrats and 52% of Republicans support the measure.

Table 4.23. Support for Clean Water Fee in Delaware (OpinionWorks LLC 2015)

Subgroup	Support	Oppose	Margin
All Residents	57%	32%	25%
Party			
Democrats	66%	25%	41%
Republicans	52%	39%	13%
Unaffiliated/Third Party	47%	38%	9%
County			
New Castle	57%	32%	25%
Kent	53%	24%	29%
Sussex	58%	39%	19%

6. **Water Quality Monitoring:** A water quality monitoring network operated by the Delaware DNREC and the USGS may be used to monitor the performance of BMPs financed by the Water Fund. In the Brandywine-Christina watershed, dissolved oxygen, bacteria, phosphorus, and sediment have improved while nitrogen continues to degrade. According to the USGS SPARROW model, nitrogen loads in the Brandywine-Christina watershed are among the highest on the East Coast. Since close to 40% of the watershed is utilized for agriculture, over 80% of the nitrogen loads in the Brandywine Creek watershed emanate from agriculture. The Brandywine-Christina watershed delivers 8% of the total nitrogen loads to the Delaware Estuary, the third-highest tributary yield after the Delaware River at Trenton and the Schuylkill.
7. **Real-Time Monitoring:** The City of Newark along the White Clay Creek and City of Wilmington along Brandywine Creek and other water purveyors often curtail withdrawals and incur higher treatment costs when turbidity exceeds 20 NTU at USGS stream gaging stations. A real-time turbidity station is needed along the Red Clay Creek at the state line. Monitoring the performance of watershed investment programs can be improved by installing relatively inexpensive ($25,000/yr) real-time nitrate nitrogen sensors along the three streams at the USGS gages near the state arc boundary.
8. **Pollutant Load Reduction Costs:** Nitrogen and sediment are selected as the "currency" to derive pollutant reduction costs for the Brandywine-Christina watershed because: (1) water utilities (Newark, Wilmington, Aqua Pennsylvania) are concerned about costs and public health risks of treating high nutrient/sediment loads, (2) BMPs that reduce N and TSS also reduce P and bacteria, (3) good reduction cost data ($/lb/yr) are available for N and TSS, and (4) while DO, P, and TSS levels are improving, N continues to degrade in these streams. Pollutant load reduction costs are complementary because BMPs that reduce nitrogen and sediment will also reduce phosphorus and bacteria.

9. **Nitrogen Load Reduction Costs:** The Brandywine-Christina watershed TMDL requires nitrogen load reductions that range from 5% in the West Branch Brandywine Creek to 52% in the lower White Clay Creek watershed. Nitrogen load reduction costs range from near $5/lb N for agriculture conservation practices to $100/lb N for urban stormwater retrofitting based on annualized costs over a ten-year period. Annual nitrogen load reduction costs range from $18.3 million for costs spread evenly across all sources (atmospheric, wastewater treatment, urban/suburban, agriculture conservation) to $5.6 million for least-costs applied to agriculture conservation (Table 4.24).

Table 4.24. Nitrogen load reduction costs in the Brandywine-Christina watershed

Watershed	Atmospheric	Wastewater	Urban/Sub.	Agriculture	Total
Apply costs evenly					
Brandywine	1,703,531	683,332	1,793,015	1,488,966	5,668,844
Red Clay	1,200,377	241,948	2,008,546	937,302	4,388,172
White Clay	2,021,978	0	2,133,067	2,271,787	6,426,831
Christina	304,830	0	1,418,483	116,455	1,839,768
Brandywine-Christina	**5,230,716**	**925,280**	**7,353,111**	**4,814,510**	**18,323,615**
Least-cost by source					
Brandywine	7,871	4,231	7,240	1,545,775	1,565,117
Red Clay	0	0	600,000	859,210	1,459,210
White Clay	0	0	200,000	1,826,825	2,026,825
Christina	39,072	0	286,835	192,720	518,627
Brandywine-Christina	**46,943**	**4,231**	**1,094,075**	**4,424,530**	**5,569,779**

10. **Sediment Load Reduction Costs:** The Brandywine-Christina watershed TMDL requires sediment load reductions that range from 16% in the West Branch Brandywine at Honeybrook to 71% along Trout Run in the White Clay watershed. The Chesapeake Bay Foundation (2013) concluded that the annual cost of sediment reduction for nonpoint source practices vary from $3.07/ton ($0.002/lb) for conservation tillage to $114.02/ton ($ 0.057/lb) for cover crops. At an annual TSS load reduction cost of $0.06/lb/yr for agriculture conservation, sediment load reduction costs range from $0.5 million/yr in the Brandywine to $1.3 million/yr in the Red Clay and $2.6 million/yr in the White Clay watersheds (Table 4.25).

Table 4.25. Costs to reduce sediment loads in the Brandywine-Christina watershed

Subwatershed	Area (mi^2)	TSS Load (lb/yr)	Allocation (lb/yr)	Reduction (lb/yr)	% Reduct.	($0.06/lb TSS/yr)
Brandywine	109	16,928,000	8,878,000	8,050,000	47%	483,000
Red Clay	54	43,916,000	22,024,000	21,892,000	50%	1,313,520
White Clay	107	77,348,000	34,252,000	43,096,000	56%	2,585,760
Brandywine-Christina	**270**	**138,192,000**	**65,154,000**	**73,038,000**	**52%**	**4,382,280**

11. **Costs:** Estimated annual costs to reduce pollutant loads in the Brandywine-Christina range from $5.5 million for nitrogen to $4.4 million for sediment over a ten-year period between 2015 and 2025 (Table 4.26). Load reduction costs are complementary since agriculture conservation BMPs that reduce nitrogen also reduce sediment.

Table 4.26. Estimated annual costs to nitrogen and sediments in the Brandywine-Christina watershed

Watershed	Nitrogen ($ mil/yr)	Sediment ($ mil/yr)
Brandywine	1.6	0.5
Red Clay	1.4	1.3
White Clay	2.0	2.6
Christina	0.5	No DE TMDL
Brandywine-Christina	**5.5**	**4.4**

A water fund could be designed to cover some but not all of the annual costs since existing investments are being made by federal, state, local, and nonprofit sources. For instance, if the USDA Farm Bill provides 80% of agriculture conservation costs, then the Water Fund could be utilized to provide the 20% local share to incentivize farmers.

12. **Open Space Preservation Costs:** The Chester County open space program funded land conservancy grants to protect 354 acres in 2013 at costs that ranged from $1,125/ac to $3,289/ac. Therefore, if 1,000 acres of watershed land are preserved, the costs would range from $1.1 million to $3.3 million.

13. **Drinking Water Value:** At current water rates, the potential annual value of treated surface water (55 mgd) in the Brandywine-Christina watershed is $130 million or $356,000 per day.

Brandywine Creek	$70 million
Red/White Clay Creek	$58 million
Christina River	$ 2 million
Brandywine-Christina	$130 million

14. **Risk Avoidance:** Clean drinking water provides human-health benefits through reduced mortality, cancer risk, illness, and neurological/reproductive risks (Table 4.27). The risk of waterborne disease should be considered in the economics of source water protection and public drinking water safety. Contaminated drinking water caused 400,000 illnesses in Milwaukee in 2003, over 2,000 illnesses in Walkerton, Ontario, and 5800 to 7100 illnesses in Saskatchewan in 2001. The American Journal of Public Health reported that 123 waterborne outbreaks occurred between 1991 and 2000 in 30 states due to pathogens or other gastrointestinal illnesses.

Table 4.27. Benefits of improved water quality for municipal water supplies (EPA 2002)

Category	Benefits
Human-health	Reduced mortality
	Decreased cancer risk
	Decreased illness
	Reduced neurological/reproductive effects
Aesthetics	Improved taste
	Improved odor
	Reduced discoloration
Water Treatment	Reduced corrosion or scaling
	Reduced clogging in piping
	Lowered water treatment costs

15. **Benefits:** Reduced nitrogen, sediment, and associated bacteria pollutant loads can provide annual benefits that range from a low bound of $5.9 million to a high bound of $20.2 million in the water supply, forest, agriculture, navigation, and nonuse swimming recreation sectors in the Brandywine-Christina watershed (Table 4.28).

Table 4.28. Estimated benefits of improved water quality in the Brandywine-Christina watershed

Sector	Activity	2010 ($ mil)		Source
Water Supply	Reduced sediment load by 4% decreases surface water treatment costs by 1% for capacity of 55 mgd	2.5	2.5	McCarl Texas A&M 1997 The Nature Conservancy and IWA 2014
Forests	Increased forests acres by 10%, 133,760 acres of forests, reduces water treatment costs (55 mgd) by 20% (33/mgd)	0.3	0.3	Trust for Public Land/AWWA (2004)
Agriculture	Reduced soil erosion and loss of crop and agriculture sales from 135,000 acres of farmland	0.7	7.4	USDA Census of Agriculture 2007 (2009) USDA 2011, Pimentel et al. (1995)
Navigation	Reduced sediment loads by 48%–56% as per TMDL to avoid dredging costs for 200,000 CY of sediment at $8.09/CY	0.8	0.9	U.S. Army Corps of Engineers (2010)
Nonuse	Willingness to pay for swimmable water quality for adult population of 461,000 in watershed	1.6	9.1	Carson and Palmer 1993 Parsons et al. 2003
Total		**5.9**	**20.2**	

CHAPTER FIVE—KEY STAKEHOLDERS

5.1. Key Stakeholder Identification

The informed participation of key stakeholders is critical to the success of a water fund. The advisory panel was convened prior to stakeholder identification to help inform the process. Drawing from existing watershed projects and planning processes, the project team initially identified more than 250 entities throughout the watershed. Once these stakeholders were identified, the list was categorized into the following sectors:

- Governmental bodies/ public agencies
- Drinking water purveyors
- Wastewater dischargers
- Private commercial/business interests
- Nonprofits
- Colleges and universities
- Chambers of commerce
- Agricultural organizations
- Electric and gas utilities

The project team determined that the engagement of a select group of these stakeholders was an appropriate initial step; it is anticipated that that there will be additional stakeholder engagement as the fund-development process moves forward.

The largest consumers of surface waters are the logical initial partners in projects addressing water quality in the watershed (Calvache & Ramos, 2012). As evidenced by the case studies, water purveyors and large water users have been key stakeholders in many of the projects. Water use information from the Delaware River Basin Commission was reviewed. In the Brandywine-Christina watershed, the largest water users in the watershed are the public and private water purveyors. One industrial water user also falls within the group of the large water users—ArcelorMittal. However, the company representatives were not able to commit to an interview at this time. Two smaller municipal water purveyors were also included in the survey based on recommendations from other stakeholders and due to their locations in the watershed—Downingtown Municipal Water Authority and Honey Brook Borough Authority.

The team also identified an opportunity for strategic collaboration with municipalities and other stormwater managers in the Brandywine-Christina watershed. Many municipalities are beginning to plan for implementation of requirements under their municipal separate storm sewer (MS4) permits under the Clean Water Act. In the Brandywine-Christina watershed, these permits are designed to help attain the total daily maximum loads (TMDLs) for specific pollutants. The municipal permittees are tasked with developing strategies to reduce their share of pollutants that enter the surface waters. Therefore, municipalities throughout the watershed will be investing in a variety of strategies to reduce pollutant loads, including conservation strategies. There is overlap between projects that protect drinking water and projects designed to address stormwater issues.

There is the potential to achieve efficiencies in that area of overlap. Many Pennsylvania municipalities within the Brandywine-Christina watershed with MS4 obligations have been working together through the Christina TMDL Implementation Plan (CTIP) process. In Delaware, there are four larger entities with MS4 obligations in the Brandywine-Christina watershed—the City of Wilmington, the City of Newark, New Castle County, and the Delaware Department of Transportation.

Using the parameters discussed above, the team conducted nine interviews with the following entities, which we refer to as the key stakeholders for the preliminary phase of the feasibility study:

- City of Wilmington (public water purveyor and stormwater manager)
- City of Newark (public water purveyor and stormwater manager)
- Downingtown Municipal Water Authority (public water purveyor)
- Honey Brook Borough Authority (public water purveyor)
- PA American (private water purveyor)
- Aqua Pennsylvania (private water purveyor)
- United Water Delaware (private water purveyor)
- CTIP representatives (Pennsylvania MS4 municipalities)
- New Castle County (stormwater manager)
- Delaware Department of Transportation (stormwater manager)

5.2. Interview Protocol

The team conducted face-to-face interviews with project team members and key stakeholder representatives to better understand the stakeholders' concerns and priorities with respect to water quality in the Brandywine-Christina watershed. The interview process began in September 2014 and was completed in December 2014. The project team shared project materials with the participants prior to each interview. At least two team members attended each interview. At each interview, team members provided background on the project and used a common set of questions to guide the discussion but also included additional topics unique to the stakeholder.

The questions focused on the key stakeholders' concerns, priorities and preferences. Examples include:

- What are the water quality problems in the Brandywine-Christina that most affect you right now? What about within the next ten years?
- What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- What is the most important consideration among these three in terms of your preferences—cost reduction, regulatory compliance, or economic development/return?

The interview process was also used to gauge stakeholder interest in continuing to discuss a collaborative watershed approach. After each interview, team members generated an interview summary that was shared with the participants for their approval to ensure that the interviewers documented their responses correctly.

5.3. Key Stakeholder Interview Outcomes

The next step in the stakeholder-consultation process was to compare responses across the interviews to look for common interests and priorities. The following common interests and priorities were raised in the key stakeholder interviews:

- All stakeholders interviewed identified partnerships and leveraging funds as highly important to their interests.
- Current priorities for water purveyors focus on infrastructure maintenance and improvements.
- All purveyors are experiencing a decline in use per customer.
- All purveyors are making investments in green infrastructure/watershed restoration; the level of annual commitments varies.
- One purveyor is making a larger investment in watershed restoration work because of its Long Term 2 Surface Water Treatment Rule (LT2) permit under the Safe Drinking Water Act.
- All water purveyors mentioned sediments as the primary pollutant of concern.
- Many of the water purveyors are implementing alternative management as a result of high turbidity levels.
- Many water purveyors mentioned heightened concern about the risk of spills as a result of the events in West Virginia.
- Stormwater managers are all planning on MS4 implementation investments within the next several years, but are not sure of the funding sources for those investments.
- Stormwater managers are dealing with regulatory uncertainty; this can be viewed as advantageous if it delays the need for expenditures.
- Current regulatory structure forces MS4 permit holders to focus on urbanized areas.
- Volume reduction is the main concern for stormwater managers.
- MS4 permit holders have many legacy sites within jurisdictions NOT subject to stormwater regulations.

This information is based on stakeholder interviews and summarized in the detailed interview notes in Appendix D.

Not surprisingly, all of the key stakeholders interviewed placed a high priority on partnerships and leveraging funds in terms of their involvement in watershed restoration work. This was true whether the stakeholder was a private or public entity, water

purveyor, or stormwater manager. Partnerships are seen as a mechanism to share responsibility and build community involvement. Leveraging funds with state, federal, or private grants is seen as good business, making every dollar of investment go as far as possible to achieve better water quality outcomes.

With respect to water purveyors, both public and private entities shared priorities and concerns. All of the purveyors are experiencing a decline in consumption, which translates to a decline in revenue from their existing customer base. They are all currently investing in their infrastructure, most often replacing and lining pipes to make sure that there is no loss of processed water outside the system. Some are investing in their treatment plants. While their largest investments are in physical or gray infrastructure, all of the water purveyors are investing in watershed restoration projects that focus on restoring, protecting, or replacing natural systems that help clean water. These kinds of projects are also known as natural or green infrastructure. The level of investment in these projects varies. The largest investment is being made by one water purveyor to reduce the potential of the occurrence of cryptosporidium in the water supply as part of compliance with the Safe Drinking Water Act.

Almost all of the water purveyors mentioned sediments as their primary pollutant of concern. While they all discussed sources of the sediment from upland land uses including agricultural uses and land development, several also mentioned new studies showing instream sources of sediment as being a concern as well. Several of the water purveyors implement alternative management when sediment levels are high. The alternative measures can include switching to reservoir supplies, which were originally designed for dry-weather events. Switching to the reservoir supplies can result in increased treatment costs because there are often higher levels of other pollutants in the reservoir water resulting in the need for additional treatment. Two reservoirs have high levels of nutrients creating algal blooms. Another alternative management involves switching to groundwater supplies. This can result in increased costs because of the increased energy costs associated with pumping the water into the system. In a very general sense, the water purveyors view watershed restoration as a means for cost reduction, regulatory compliance, and long-term risk management.

The water purveyors have a heightened concern about the risk of spills that could impact the source water supply, as a result of the January 2014 chemical spill in Charleston, West Virginia. Two of the private water purveyors have either recently completed or are in the process of completing more in-depth source water assessments to better understand the likely risks to their source waters. The purveyors are interested in establishing a better early warning system throughout the watershed.

With respect to the stormwater managers, these are public entities including townships, cities, counties, and state-level departments tasked with improving the quality of stormwater leaving their facilities before it enters surface waters. All of these public entities are faced with permit obligations that will require water quality improvements, but the timing and exact nature of those obligations is not entirely clear across the watershed. This lack of certainty can be both positive and negative—positive to the extent that it

allows the entities to delay expenditures, but negative in that they are not able to plan and budget for implementation. All of the stormwater permittees would like to engage in discussions about alternative approaches to achieve permit compliance including whether and how participating in conservation strategies that improve water quality outside their jurisdictional boundaries can help meet permit requirements.

The MS4 permits require that these public entities work within their jurisdictional area, which can make achieving true water quality improvements challenging in smaller jurisdictions. While there are various pollutants that the stormwater managers must address, we heard most concern about addressing the volume of stormwater. In some places, large volumes of stormwater can come from private sites that do not fall within the stormwater manager's jurisdiction. Generally, stormwater managers view watershed restoration primarily as a means to achieve regulatory compliance.

While the water purveyors were more concerned about the impacts of sediments on the water supply and stormwater managers were more concerned about volume and nutrients, all key stakeholders recognized that some conservation strategies that reduce sediment flows also serve to reduce the flow of nutrients. Other conservation strategies, such as reconnecting floodplains and restoring wetlands, can help address volume, sediment, and nutrient concerns.

As mentioned above, another goal of the interview process was to assess key stakeholder interest in continuing discussions about how to work collaboratively on watershed restoration. All of the key stakeholders expressed a willingness to continue to participate in the project as it moves forward. They see the value of pooling local resources to better access leveraging opportunities, want to partner with others who are similarly motivated and bring a variety of expertise to the table, and want to be strategic in investing in watershed restoration projects that will have the best outcomes for water quality.

CHAPTER SIX—COMMUNICATIONS

6.1. Project Communication Actions

Communication and outreach are important components of this project. The project team developed and conducted targeted communication with stakeholders and the regional advisory panel. A variety of methods were used to engage these groups, including regional advisory panel meetings, project website, written communication, stakeholder interviews, presentations, and informal meetings and discussions. Detailed information about the communication tools developed and the communication strategies employed are outlined below.

The project team conducted three Regional Advisory Panel meetings spanning the yearlong project timeframe (Table 6.1). Each meeting served as a forum for the project team to present and discuss the project's findings, analysis, and conclusions. The meetings were central to creating dialogue among the Regional Panel Advisory members and the project team. Members of the Brandywine-Christina cluster for the William Penn Foundation's Delaware River Watershed Initiative were also invited to these meetings. The meetings provided the project team with critical input for consideration in the establishment of a water fund in the Brandywine-Christina watershed.

Table 6.1. Regional Advisory Panel meetings

Date	Place	Attendance (approximate)	Materials Developed
May 30, 2014	Longwood Gardens, Kennett Square, PA	40	Meeting booklet, presentation boards (see website)
September 18, 2014	Mount Cuba Center, Hockessin, DE	30	Meeting booklet, PowerPoint presentations (see website)
January 14, 2015	Stroud Water Research Center, Avondale, PA	60	Final report (draft) (see website)

In May 2014, a project website was developed to house all project information and meeting materials and serve as a communication hub for the project. The website contains project information and overview, Regional Advisory Panel meeting materials and presentations, and project team contact information. The website can be viewed at: www.wra.udel.edu/brandywine-christina-healthy-water-fund/.

Written communication, key stakeholder interviews, and presentations were utilized to engage stakeholders and the public. Written communication was used to publicize the project and provide materials to stakeholders and those interested in the project. This communication was shared through the project website, press releases, newsletters, and academic publications (Table 6.2). As discussed in detail in Chapter Five, multiple key stakeholder interviews were conducted with private and municipal water purveyors as well as stormwater managers (Table 6.3). Project team members also presented detailed information about this project to local, regional, and national groups (Table 6.4).

Table 6.2. Written communication for the Brandywine-Christina Water Fund

Date	Type	Title	Source and Author
April 1, 2014	Press Release	Water quality program seeks to protect Brandywine, Christina Rivers	NPR Delaware (Authored by Jon Hurdle
April 8, 2014	Press Release	Watershed Investment: The Nature Conservancy and the University of Delaware Partner on an Innovative Market-based Funding Mechanism for Brandywine-Christina	UDaily (Authored by Richie Jones, State Director, The Nature Conservancy in Delaware and Jerry Kauffman, Director, Water Resources Agency, Institute for Public Administration, University of Delaware)
Spring/Summer 2014	Newsletter	A Watershed Moment: Partners turn collective focus to Delaware's freshwater resources	Delaware, Acorns – Delaware Waters: We are making a splash around the First State.[1] (Authored by Staff of The Nature Conservancy in Delaware)
May 30, 2014	Booklet	Regional Advisory Panel Meeting: Brandywine-Christina Healthy Water Fund	Project Website (Developed by Project Team)
September 18, 2014	Booklet	Regional Advisory Panel Meeting: Brandywine-Christina Healthy Water Fund	Project Website (Developed by Project Team)
January 14, 2015	Booklet	Regional Advisory Panel Meeting: Brandywine-Christina Healthy Water Fund	Project Website (Developed by Project Team)
2014	Academic Magazine	SPPA Publication	Jerry Kauffman
N/A	Web Feature	Learn how working in the Brandywine-Christina watershed advances the Conservancy's mission in Delaware	The Nature Conservancy in Delaware Website
N/A	Project Communication	Brandywine-Christina Healthy Water Fund	Maria Dziembowska, The Nature Conservancy in Delaware and Martha Narvaez, Water Resources Agency, Institute for Public Administration, University of Delaware

[1]Approximately 3,000 people receive the Acorns newsletter.

Table 6.3. Stakeholder interviews

Date	Organization	Interviewees	Interviewers
August 27, 2014	City of Newark	Tom Coleman, Director of Public Works and Water Resources Tim Filasky, Assistant Director of Public Works	Martha Narvaez and Ellen Kohler
August 28, 2014	City of Wilmington	Jeffrey J. Starkey, Public Works Commissioner Sean Duffy, Water Division Director Matt Miller, Assistant Water Division Director Christiana Oh, Water Quality Manager Kelly Williams, Special Assistant to the Commissioner	Martha Narvaez and Ellen Kohler
September 24, 2014	PA American	James Gable, Operations Superintendent, Coatesville District	Martha Narvaez and Ellen Kohler
October 9, 2014	Honey Brook Municipal Water Authority	Mike Shuler, Manager Dennis Patterson, Chief Operator	Andrew Homsey and Ellen Kohler
October 16, 2014	Downingtown Municipal Water Authority	Fred Bopp, Executive Director	Jerry Kauffman and Ellen Kohler
October 20, 2014	Aqua Pennsylvania	Colleen Arnold, Manager of Water Quality and Environmental Compliance Tony Fernandes, Manager of Water Resources Engineering	Jerry Kauffman and Ellen Kohler
October 23, 2104	New Castle County and DelDOT	Michael Harris, Environmental Compliance Manager, Special Services, New Castle County Ellie Mortazavi, Stormwater Program Coordinator, Special Services, New Castle County Marianne Walch, Environmental Scientist, DelDOT	Martha Narvaez and Ellen Kohler
October 27, 2014	Christina Basin TMDL and Implementation Plan (CTIP)	Jan Bowers, Executive Director, Chester County Water Resources Authority Bob Struble, Watershed Conservation Director, Brandywine Valley Association Chris Strohmaier, District Manager, Chester County Conservation District	Martha Narvaez and Ellen Kohler
December 3, 2014	United Water Delaware	Larry Finnicum, Operations Manager Tom Hubbard, Public Relations Manager	Martha Narvaez and Ellen Kohler

Table 6.4. Presentations conducted in Year One

Date	Host Organization	Location	Presenter	Presentation Title
June 6, 2014	Christina Basin Task Force	Mount Cuba Center, Hockessin, DE	Jerry Kauffman and Ellen Kohler	Brandywine-Christina Healthy Water Fund Overview
November 6, 2014	American Water Resources Association 2014 Annual Conference	Tysons Corner, VA	Jerry Kauffman and Richie Jones	The Brandywine-Christina Healthy Watershed Fund: Clean Water is Good Business
November 18, 2014	Arden Guild	Arden, DE	Jerry Kauffman	Economics and Water in Delaware

Throughout the year, project team members attended meetings as invited guests to gather additional information for the project and set up formal meetings with representatives from specific organization to discuss the project. Numerous one-on-one meetings with individuals who have significant expertise in the watershed were also conducted to gather and collect information. Detailed information about these meetings and discussions is included below:

- Source Water Protection Program, Steering Committee Meeting at Pennsylvania American Water Company in Coatesville, Pennsylvania, on October 20, 2014. Attended by Andrew Homsey. Summary: The company reviewed all source water protection issues and education/outreach efforts in their source water areas.
- Project overview meeting with the Pennsylvania Department of Environmental Protection (PADEP) at the Southeast Region Headquarters in Norristown, Pennsylvania, on December 3, 2014. Attended by Andrew Homsey, Ellen Kohler, and Martha Narvaez with the following PADEP representatives:
    - David Burke, Watershed Manager
    - Jenifer Fields, Environmental Program Manager
    - Zahra Nucci, Environmental Program Manager
    - Domenic Rocco, Environmental Program Manager
    - Sachin Shankar, Assistant Regional Director
    - Cosmo Servidio, Regional Director

  Summary: Briefing on the Brandywine-Christina Water Fund feasibility study and feedback from PADEP on the project, how it may play a role in their MS4 program, and other ideas on the implementation of a water fund in the Pennsylvania portion of the Brandywine-Christina watershed.

- Project meeting with USEPA Region 3 representatives in Philadelphia, Pennsylvania, on December 10, 2015. Attended by Richie Jones, Jerry Kauffman, and Ellen Kohler.

Summary: Discussion of watershed-based solutions for stormwater management specifically addressing the following objectives:

- Share specific tools/approaches for meeting stormwater management needs on a watershed basis (Pennsylvania and Delaware).
- Address the interface with the regulatory requirements for MS4s.
- Identify the best tools for analyzing least-cost solutions on a watershed basis.
- Inform the ongoing Healthy Water Fund options.

- Team member, Ellen Kohler, conducted numerous one-on-one meetings, both in-person and phone conversations, with advisory panel members and stakeholders for the project.

In summary, the project team conducted a thorough and targeted communication strategy in year one of this project. In ongoing communication with the project stakeholders and Regional Advisory Panel, several recommendations related to future communication strategies for the Brandywine-Christina Water Fund were provided to the project team. These include:

- A clear and focused communication strategy is necessary to gain public support across the watershed.
- A thoughtful and focused communication plan with the agricultural community is critical to the fund's success. This must include an engagement process and relationship building. It is also critical to include experts currently working with the agricultural community in the Brandywine-Christina watershed.
- A careful and deliberate communication plan is necessary with the municipalities in the watershed for them to understand why their participation is important, how this can benefit them, and how it can be a mutually advantageous initiative.

These recommendations will be given careful consideration and implemented in the next phases of the Brandywine-Christina Water Fund project.

CHAPTER SEVEN—CONCLUSIONS AND RECOMMENDATIONS

7.1. Water Fund Feasibility

This report reflects findings from the initial phase of analysis for a water fund to support water quality improvements in the Brandywine-Christina watershed. Based on the case-study research, economic analysis, feedback received from the Regional Advisory Panel, and stakeholder interviews, the project team concludes that a water fund offers a financially and politically viable approach to water quality (and perhaps quantity) improvement in the Brandywine-Christina watershed. This conclusion is based on the following factors (among others): (1) an opportunity exists to expand on and increase the efficiency of current conservation initiatives in the watershed, (2) regulators appear open to exploring more flexible regulatory approaches to achieving water quality (and possibly quantity) goals, and (3) water purveyors, stormwater managers, and potential public and private funders have expressed interest in exploring more cost-effective water quality (and possibly quantity) strategies, including nature-based solutions. The initial analysis has not indicated any insurmountable barriers to design and implementation for a water fund, and a set of key stakeholders interested in continuing discussions has been identified.

7.2. Conclusions

The preliminary feasibility study reaches the following conclusions:

Regulatory Structure: Based on feedback from the Regional Advisory Panel and key stakeholders, a water fund for the Brandywine-Christina watershed will have the greatest chance to accelerate the pace and increase the scale of pollution reduction if:

- The Water Fund can finance projects that are identified and prioritized based on their demonstrated ability to improve water quality (rather than on the basis of regulatory jurisdiction or other regulatory requirements).
- The Water Fund can ultimately scale up conservation finance in the watershed (e.g., using vehicles such as low interest loans, grants, or matching funds, etc.).
- A regulatory structure is in place that allows municipalities that contribute to the fund to receive offsets/credits to meet their MS4 permit pollutant reduction requirements (even if implementation of those projects occurs outside of the contributing municipality's jurisdiction).

Feedback from the Regional Advisory Panel and the stakeholder interviews identified the need for additional analysis of conservation strategies and prioritization. Three general conservation strategies were identified: land acquisition, conservation easements, and implementation of BMPs. Analysis needs to include scale, definition of practice, opportunities within target subwatersheds, and full costs of implementation and maintenance. The costs of no action also need to be determined.

To be successful, the Water Fund must:

- Add value to the watershed and not duplicate or diminish the overall impact of preexisting initiatives.
- Measure water quality improvements in the watershed against the goals of swimmable, fishable, and potable waters, requiring the removal of impairments from the watershed's streams.
- Must be able to demonstrate a favorable economic return on investment.

This conclusion stems from feedback from the Regional Advisory Panel, stakeholder interviews, and the WPF Cluster Partners.

Water Purveyors and Stormwater Managers: The next phase of analysis, design, and implementation must be driven by the water purveyors and stormwater managers in the watershed. These key stakeholders are making or may be making the largest local investments to protect and restore water quality. Their involvement in the design and implementation phase is essential for success. This conclusion is supported by the case-study research as well as feedback from the Regional Advisory Panel and stakeholder interviews.

This watershed presents the opportunity to design a program with water purveyors and stormwater managers. The case-study research shows that most existing programs involve water purveyors as the main stakeholders. However, given the overlap between the areas that provide the drinking water supply for purveyors and the jurisdictions subject to MS4 permits, there is an opportunity for collaboration between these two groups in this watershed, and this opportunity should be further explored. Meeting the goals of a water fund will require determining the broad areas of consensus among these groups and focusing efforts there (Figure 7.1). This area of overlap includes, among other things, identifying pollutants of concern and developing strategies for watershed protection (BMPs, prioritization of landscape position, and land use type, etc.). This conclusion is supported by the stakeholder interviews and the feedback from the Regional Advisory Panel.

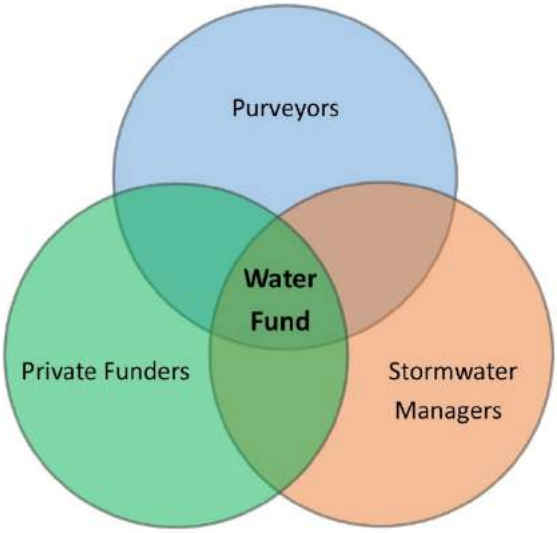


Figure 7.1. Areas of consensus for a multi-stakeholder water fund

Water Fund Structure: As demonstrated by the case studies, the financial structure for a water fund in the Brandywine-Christina watershed could be relatively simple: either one fund for the entire watershed or a fund for each of the four subwatersheds that is accompanied by an umbrella fund for the entire watershed. The revenue sources for contributions to the fund would be at the discretion of each contributor.

As demonstrated by the case studies, the governance structure would likely reflect the financial structure (i.e., one board for the entire watershed or separate boards for each of the four watersheds with an umbrella board). As the key stakeholders, water purveyors and stormwater managers would decide who sits on the board, how decisions are made about project selection, and whether there is a need for a technical advisory board to assist with project review. These decisions would be part of the design and implementation phases.

Given the level of existing expertise in the watershed with the design and implementation of conservation strategies, it seems unlikely that the administrative structure would include project design and implementation. The case studies demonstrated that programs such as the Quito Water Fund, which has an administrative structure that includes project design and implementation, are found in watersheds where there is no existing expertise.

Jurisdiction: As demonstrated by the case studies, these programs can cross jurisdictional lines. State lines should not prohibit the adoption of a watershed-wide fund. If a state line restricts funding, both restricted/unrestricted funds can be managed within the same financial structure. The case studies include examples of programs that include multiple jurisdictions, including the Upper Neuse Clean Water Initiative and the Intergovernmental Cooperation Agreement for Implementation of the York County Regional Chesapeake Bay Pollutant Plan.

Economic Analysis: The economic analysis provides an example of how selecting an interim water quality goal (meeting TMDLs) can help shape implementation of conservation strategies by helping to target the location of implementation (subwatersheds providing the largest loads of a pollutant) and how maximizing the least-cost approaches can reduce the costs of achieving significant water quality improvements. This conclusion is supported by the experience of New York City's source water protection program and its success working with farmers to implement whole farm plans as a cost-effective way to reduce pollutant loads.

Estimated annual costs to reduce pollutant loads in the Brandywine-Christina range from $5.5 million for nitrogen to $4.4 million for sediment over a ten-year period between 2015 and 2025 (Table 7.1). Load reduction costs are complementary since agriculture conservation BMPs that reduce nitrogen also reduce sediment and phosphorus and bacteria.

Risk Avoidance and Other Benefits: Clean drinking water provides human-health benefits through reduced mortality, cancer risk, illness, and neurological/reproductive risks.

Improving water quality could provide estimated annual benefits that range from a low bound of $5.9 million to a high bound of $20.2 million in the water supply ($2.5 million), forest ($0.3 million), agriculture ($0.7-$7.4 million), navigation ($0.8-$0.9 million), and nonuse swimming recreation ($1.6-$9.1 million) sectors in the Brandywine-Christina watershed.

Table 7.1. Estimated benefits and costs of improved water quality in the Brandywine-Christina watershed

Parameter	Low Bound ($ mil/yr)	High Bound ($ mil/yr)
Benefits (B)	5.9	20.2
Costs (C)	4.4	5.5

Agricultural Incentives: Because of the amount of agricultural land in the watershed, maximizing the benefits to be achieved through implementation of agricultural BMPs should be part of the strategic plan to improve water quality in the watershed. Given the recent announcement of new regional/state funding through the Natural Resource Conservation Service's Regional Conservation Partnership Program (RCPP), there is an important opportunity to maximize the impacts of federal investments in the Brandywine-Christina watershed to achieve the greatest improvements in water quality possible.

Communication: As recommended by both the Regional Advisory Panel and stakeholders interviewed, there is a need for effective communication throughout the watershed as well as communications targeting key constituencies.

7.3. Recommendations

The conclusions lead to the following recommendations for the next phase in the design and implementation of the Brandywine-Christina Water Fund:

1. Continue to draw upon the expertise, connections, and wisdom of the Regional Advisory Panel as necessary to further develop the Brandywine-Christina Water Fund. Expand the panel to include additional experts in the field and managers from existing programs.
2. Encourage regulators to consider alternative and additional approaches to achieving regulatory compliance.
3. Advance the dialogue with the water purveyors and stormwater managers who have expressed interest in remaining involved in this process, focusing in particular on (a) understanding the costs stakeholders currently are facing to address water quality and quantity issues, (b) quantifying the alternative costs associated with equivalent conservation strategies, and (c) modeling the effectiveness of such conservation strategies. Build on the information gained in the above dialogue to develop a refined benefit-cost analysis and assessment of conservation strategies that will result in a comprehensive and strategic business plan for the entire Brandywine-Christina watershed. Essential components of this analysis should include:
    - Work with partners and stakeholders to consolidate the recommendations from existing watershed management plans for the Brandywine-Christina watershed and confirm their continued validity.
    - Work with partners in the watershed to evaluate the opportunities, relative implementation costs, and water quality improvements associated with three conservation strategies: land acquisition, conservation easements, and implementation of agricultural BMPs. Costs should include technical assistance and maintenance over the expected life of the projects.
    - Work with the agricultural community and partners in the watershed to conduct a subwatershed-scale analysis of existing agricultural BMPs and opportunities for implementation of additional agricultural BMPs.
    - Conduct an analysis of the most effective conservation strategies to reduce the volume of urban stormwater and identify where those strategies should be implemented.
    - Implement real-time monitoring of turbidity, nutrients, and volume at locations strategically selected to determine the sources of pollutants on a subwatershed basis.
    - Develop a decision-making process for prioritizing implementation of the strategic business plan and leveraging local investments with state, federal, and private foundation investments based on experience within the watershed.

4. Recognize that water purveyors and stormwater managers will have different motivations for participating, and structure the Brandywine-Christina Water Fund to ensure that the needs of both stakeholder groups are met.
5. Work with the agricultural community to develop a firm understanding of its business realities, needs, and concerns. Structure the Brandywine-Christina Water Fund to address those realities, needs, and concerns.
6. Work with partners in the watershed who have experience implementing conservation strategies to ensure that the Brandywine-Christina Water Fund adds value and momentum to these efforts as opposed to detracting from them.

REFERENCES

American Water Works Association and The Trust for Public Land, 2004. Source Water Protection Handbook: Using Land Conservation to Protect Drinking Water Supply. Washington D.C. 51 pp.

Arias, V., S. Benitez, and R. Goldman, 2010. The Economics of Ecosystems and Biodiversity: Water Fund for Catchment Management in Quito, Ecuador. TEEB Case Study. Ecuador.

Bennett, G. and N. Carroll, 2014. Gaining Depth: State of Watershed Payments 2014. Forest Trends. Washington, D.C.

Bennett, G., N. Carroll, and K. Hamilton, 2013. Charting New Waters: State of Watershed Payments 2012. Forest Trends. Washington, D.C.

Calvache, A. Benitez and A. Ramos, 2012. Fondos de Agua: Conservando la Infraestratura Verde. Guía de Diseño, Creación y Operación. Alianza Latinoamericana de Fondos de Agua (Water Funds: Conserving Green Infrastructure: A Guide to the Design, Creation and Operation). The Nature Conservancy, Fundación FEMSA y el Banco Interamericano de Desarrollo y Fondo para el Medio Ambiente Mundial (FMAM). Bogotá, Colombia. 144 pp.

Carson, R. T., and R. C. Mitchell, 1993. The Value of Clean Water: the Public's Willingness to Pay for Boatable, Fishable, and Swimmable Quality Water. Water Resources Research 29(7):2445–2454.

Cech, T. V., 2005. Principles of Water Resources History, Development, Management and Policy. John Wiley and Sons, Inc. 468 pp.

Chesapeake Bay Foundation, 2013. Cost Effective Pollution Solutions—Getting the Most Benefit from Our Investments. Pennsylvania Fact Sheet. 8 pp.

Chesapeake Bay Program, 2004. Chesapeake Bay Watershed BMP Potential Load Reductions and Cost-effectiveness Study. Annapolis, MD: Chesapeake Bay Program.

Chester County Economic Development Corporation, 2014. Vista 2025: Progress and Preservation, Chester County's Economic Development Strategy, October 2014.

City of Wilmington, 2010. City of Wilmington Source Water Protection Plan. 101 pp.

Colgan, C. S., D. Yakovleff, and S. B. Merrill, 2013. An Assessment of the Economics of Natural and Built Infrastructure for Water Resources in Maine. University of Southern Maine.

Corso, P. S., M. H. Kramer, K. A. Blair, D. G. Addiss, J. P. Davis, and A. C. Haddix, 2003. Cost of Illness in the 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin. Emerging Infectious Diseases. 3:9(4).

Daily, G. C. and K. Allison, 2002. The New Economy of Nature: The Quest to Make Conservation Profitable. Island Press, Washington, D.C. 260 pp.

Delaware Department of Natural Resources and Environmental Control, 2012. State of Delaware 2012 Combined Watershed Assessment Report (305[b]) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs.

Delaware Population Consortium, 2010. Annual Population Projections.

Dorfman, R., H. D. Jacoby, and H. A. Thomas, 1972. Models for Managing Regional Water Quality. Harvard University Press. Cambridge, Massachusetts.

Economy League of Greater Philadelphia, 2008. Maritime Commerce in Greater Philadelphia: Assessing Industry Trends and Growth Opportunities for Delaware River Ports. 78 pp.

Ernst, C., K. Hopper and D. Summers, 2004. Protecting the Source: Land Conservation and the Future of America's Drinking Water, Washington D.C.: The Trust for Public Land and American Water Works Association.

Evans, B. M., 2008. An Evaluation of Potential Nitrogen Load Reductions to Long Island Sound from the Connecticut River Basin. Penn State Institutes of Energy and the Environment. University Park, Pennsylvania. 66 pp.

Gaffield, S. J., R. L. Goo, L. A. Richards, and R. J. Jackson, 2003. Public Health Effects of Inadequately Managed Stormwater Runoff. American Journal of Public Health. 93:9.

Gartner, T., G. T. Mehan, J. Mulligan, J. A. Roberson, P. Stangel, and Y. Qin, 2014. Protecting Forested Watersheds is Smart Economics for Water Utilities. Journal of the American Water Resources Association (AWWA).

Gartner, T., J. Gunn, J. Mulligan, and R. Schmidt, 2013. Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States. World Resources Institute. Washington, D.C.

Goldman Sachs, 2014. Environmental Finance Innovation Summit. New York, New York. 11 pp.

Goulder, L. H., and D. Kennedy, 1997. Valuing Ecosystem Services: Philosophical Bases and Empirical Methods. Edited by G. Daily. Nature's Services. Island Press, Washington, D.C. 23-48.

Green For All, 2011. Water Works Rebuilding Infrastructure Creating Jobs Greening the Environment. Partnership with American Rivers, Economic Policy Institute, and Pacific Institute. 55 pp.

Hart, K. 2006. The Upper Neuse Clean Water Initiative Conservation Plan: Protecting Land and Drinking Water for the Future. The Trust for Public Land. Washington, D.C. 2006.

Hubbard, T., December 3, 2014. Personal interview.

Hulle, L., R. Weidenback, D. Dewing, J. Surface, 2013. Watershed Agricultural Program, 2012 Annual Report and 2013 Workload for the New York City Catskill/Delaware and Croton Watersheds.

ITT Corporation, 2010. Value of Water Survey: Americans on the U.S. Water Crisis. White Plains, New York.

Jones, C., E. Branosky, M. Selman, and M. Perez, 2010. How Nutrient Trading Could Help Restore the Chesapeake Bay, WRI Working Paper. World Resources Institute. 13 pp.

Kneese, A. V. and B. T. Bower, 1984. Managing Water Quality: Economics, Technology, Institutions. Resources for the Future. Washington, D.C. 328 pp.

Koteen, J., S. J. Alexander, and J. B. Loomis, 2002. Evaluating Benefits and Costs of Changes in Water Quality. General Technical Report PNW-GTR-548. Pacific Northwest Research Station. Portland, Oregon. 32 pp.

Lee, J. J., 2014. National Geographic News. http://news.nationalgeographic.com/.

Majanen, T., R. Friedman, and J. Milder, 2011. Innovations in Market-Based Watershed Conservation in the United States: Payments for Watershed Services for Agricultural and Forest Landowners. U.S. Endowment for Forestry & Communities, Inc. U.S. Department of Agriculture, Office of Environmental Markets.

Martins Associates, 2007. The Local and Regional Economic Impacts of the Port of Wilmington Delaware. Diamond State Port Corporation. 33 pp.

McCarl, B. A., 1997. Costs of Water Treatment Due to Diminished Water Quality: A Case Study in Texas. Texas A&M University. Department of Agricultural Economics.

McDonald, R. and D. Shemie, 2014. Urban Water Blueprint: Mapping Conservation Solutions to the Global Water Challenge. The Nature Conservancy. Washington, D.C.

Miller, M., August 28, 2014. Personal interview.

Narvaez, M.C., and G. J. Kauffman, January 2012. Economic Benefits and Jobs Provided by Delaware Watersheds. University of Delaware. Newark, Delaware.

New York City Department of Environmental Protection, Bureau of Water Supply, 2006. Long-Term Watershed Protection Program, December 2006.

OpinionWorks LLC, 2015. Citizen Attitudes about a Delaware Clean Water Fee. Delaware Nature Society. Annapolis, Maryland. 11 pp.

Parsons, G. R., E. C. Helm, and T. Bondelid, 2003. Measuring the Economic Benefits of Water Quality Improvements to Recreational Uses in Six Northeastern States: An Application of the Random Utility Maximization Model. 25 pp.

Pimentel, D., C. Harvey. P. Resosusdarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R. Saffouri, and R. Blair, 1995. Environmental and Economic Costs of Soil Erosion and Conservation Benefits. Science. 267(5201):1117-1123.

Quinn, C. S., C. Safriet, K. Feeney, and V. Lauf, 2014. National Economic and Labor Impacts of the Water Utility Sector: Executive Report. Water Environment Research Foundation. Alexandria, Virginia.

Schmeer, K., 1999. Guidelines for Conducting a Stakeholder Analysis. Partnerships for Health Reform. Abt Associates Inc. Bethesda, Maryland.

Shellenberger, P., 2014. Chief, Long Range Planning, York County Planning Commission, e-mail communications October 16, 2014 and December 11, 2014.

Shellenberger, P., 2014. Intergovernmental Cooperation Agreement for the Implementation of the York County Regional Chesapeake Bay Pollution Reduction Plan 2014.

Stakhiv, E. Z., 2011. Pragmatic Approaches for Water Management Under Climate Change Uncertainty. Journal of the American Water Resources Association. 47(6):1183-1196.

Struble, R., October 27, 2014. Personal interview.

Thacher, J., M. Marsee, H. Pitts, J. Hansen, J. Chermak, and B. Thomson, 2011. Assessing Customer Preferences and Willingness to Pay: A Handbook for Water Utilities. Water Environment Federation. Denver, Colorado.

The Nature Conservancy and International Water Association, 2014. Urban Water Blueprint. 100 pp.

The Nature Conservancy Central Science and Northern Andes & Southern Central American Conservation Programs, 2012. Report on the Ecological and Socioeconomic Assessments of the Quito Water Fund.

The Conservation Gateway (www.conservationgateway.org).

The Pinchot Institute (www.pinchot.org/doc/465).

Thurston, H. W., M. T. Heberling, and A. Schrecongost, 2009. Environmental Economics for Watershed Restoration. CRC Press. 173 pp.

Transportation Research Board, 2014. Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices. NCHRP Report 792. Washington, D.C.

Triangle Land Conservancy and Tar River Land Conservancy for the Healthy Forests Initiative, 2010. Upper Neuse Clean Water Initiative: Technical Report.

Trowbridge, P., 2010. Analysis of Nitrogen Loading Reductions for Wastewater Treatment Facilities and Non-Point Sources in the Great Bay Estuary Watershed. New Hampshire Department of Environmental Services. 27 pp.

U.S. Army Corps of Engineers, Pennsylvania Department of Environmental Protection, and AECOM Technical Services, Inc., August 1, 2012. Chester, Delaware, and Montgomery Counties Regional Watershed Improvement Project: Final Prioritization Report.

U.S. Department of Agriculture, Natural Resources Conservation Service, 2011. Assessment of the Effects of Conservation Practices on Cultivated Cropland in the Chesapeake Bay Region. 158 pp.

U.S. Department of Agriculture, 2009. 2007 Census of Agriculture.

U.S. Endowment for Forestry and Communities. Source Water Protection Case Study, Raleigh, North Carolina – Upper Neuse Watershed.

U.S. Environmental Protection Agency, 1996. Atmospheric Nitrogen Deposition Loadings to the Chesapeake Bay, An Initial Analysis of the Cost-Effectiveness of Control Options. Washington, D.C. 29 pp.

U.S. Environmental Protection Agency, 2002. Assessing the Benefits of Drinking Water Regulations: A Primer for Stakeholders. Office of Groundwater and Drinking Water. 137 pp.

U.S. Environmental Protection Agency, 2004. Drinking Water Costs and Federal Funding. EPA 816-F-04-038. 2 pp.

U.S. Environmental Protection Agency, 2006. Revisions to Total Maximum Daily Loads for Nutrient and Low Dissolved Oxygen under High Flow Conditions Christina River Basin, Pennsylvania, Delaware and Maryland.

U.S. Environmental Protection Agency. Response to Comments, 2007 Filtration Avoidance Determination, New York City's Catskill/Delaware Water Supply.

U.S. Environmental Protection Agency, 2009. Water on Tap, What You Need to Know. EPA Office of Water. 816-K-09-002.

U.S. Environmental Protection Agency, 2012. The Importance of Water to the U.S. Economy Part 1: Background Report Public Review Draft. 262 pp.

Victory Brewing. http://www.victorybeer.com/about/victory-for-the-environment/headwaters/.

Wieland, R., D. Parker, W. Gans, and A. Martin, 2009. Costs and Cost Efficiencies for Some Nutrient Reduction Practices in Maryland. NOAA Chesapeake Bay Office. 58 pp.

APPENDICES

APPENDIX A – REGIONAL ADVISORY PANEL MEETING SUMMARIES

The Nature Conservancy
Protecting nature. Preserving life.

WILLIAM PENN FOUNDATION

Brandywine-Christina Healthy Water Fund Feasibility Study

Regional Advisory Panel Meeting

Meeting Summary

Longwood Gardens

Kennett Square, Pa.

May 30, 2014

Brandywine-Christina Healthy Water Fund

www.nature.org/Delaware • www.williampennfoundation.org • www.wra.udel.edu

Welcome and Introduction – Richie Jones, State Director, The Nature Conservancy in Delaware

Brief introduction of the project team, Regional Advisory Panel, and meeting attendees.

Richie reflected on the tremendous wealth of talent present and pointed out the need to apply this talent in the project work that lies ahead.

Richie provided a brief overview of his background:

I grew up on a farm about ten miles from here. Doe Run flows through our farm. Doe Run is one of the only unimpaired waterways in the Brandywine-Christina watershed; only a small part is impaired. Two visionaries are largely responsible for that:

Lammot du Pont - Brother of P.S. du Pont lived at Longwood. In the 1920s, Mr. du Pont bought thousands of acres around Doe Run valley to run cattle. He picked this area because it was the cleanest source of Wilmington's drinking water. That was visionary. In the 1950s, Bob Kleiburg bought Mr. du Pont's land for the King Ranch, and he used it to fatten cattle after his trip from Texas. In the mid-80s, King Ranch decided to sell the property. Among the rumored buyers were the Walt Disney Company, which wanted to build an East Coast Disney World there, and a nuclear power company.

That's where the second visionary entered the picture—Frolic Weymouth. Frolic formed the Brandywine Conservancy in the late 1960s. The Brandywine Conservancy helped pull together local landowners and put much of the King Ranch under conservation easements. Frolic understood back then that land protection was critical to healthy waters.

And that's why the Doe Run remains largely unimpaired today.

Of course, there were many other visionaries along the way, some in this room. They've all done great work to protect the Brandywine-Christina. There has been a lot of progress in this watershed, but there is still a long way to go.

Now there is a new visionary—the leadership of the William Penn Foundation. Nathan Boon will tell you a little more about the Foundation's unprecedented investment in eight subwatersheds in the Delaware River Basin. William Penn is investing conservation measures designed to improve water quality in the watershed. William Penn is also investing in monitoring and floodplain work. All of these investments are critical. This is all moving us rapidly toward proving the efficacy of natural solutions to water quality and quantity challenges.

In closing, what do all three of these visionaries—Lammot du Pont, Frolic Weymouth, and the William Penn Foundation—have in common? They had big visions and the capital to back it up.

This project is part of the William Penn-funded work in the Brandywine-Christina watershed. The charge is to conduct a feasibility study on market-based funding mechanisms for restoring the Brandywine-Christina watershed. More specifically, the project team will conduct a feasibility study of a "water fund"—a vehicle through which downstream beneficiaries invest in upstream conservation for water quality. We have big aspirations—[aspirations in] which we're fairly confident most of you share, and they are as follows:

- Make the Brandywine-Christina the healthiest urban watershed on the East Coast.
- Restore it to swimable, fishable, and potable within a generation.
- Advance freshwater conservation on a national scale.
- Develop a holistic model that can be applied to watersheds throughout the Delaware Basin and across the country.

It's going to take a lot of financial resources. It's going to take more than what the William Penn Foundation has to invest and more than any one state or government has to invest. It is going to take a new business model, one that consolidates a variety of funding sources on both sides of the state line—Delaware and Pennsylvania. It is going to require leveraging regulatory drivers and targeting conservation investments that produce scientifically measurable results. We'll be looking at cutting-edge capital sources, socially responsible investors, and impact investors.

These are big goals, and they're only achievable with the active involvement of people like you.

So what are we asking of you?

- We need your experience, wisdom, and advice.
- We need you to vet the process and ensure transparency.
- We need you to help us decide what is and what isn't feasible.

It all comes down to relationships, so we're hoping you'll be able to get behind this project, point us to the right decision-makers, act as ambassadors for us, and ultimately help us champion the project in your own spheres of influence. To be successful, we'll need robust strategies—financial, political, regulatory, public-relations, and community-outreach [strategies]. The case studies show it can be done.

With your help, we can make it happen here!

And if we do, it will be a legacy we can all be proud of!

So, thanks again for participating.

Overview – Nathan Boon, Program Officer, Grantmaking Programs, William Penn Foundation

William Penn's mission focuses on the arts, education, and the environment in the Philadelphia region. William Penn works in thousands of square miles and hundreds of jurisdictions throughout the region. It is a huge undertaking for the organization to decide how to allocate dollars that will have the greatest impact and will also have replication.

William Penn's goal with this initiative is to make a difference in water quality in the Brandywine-Christina watershed. They are focusing on a set of geographies, aligning work, and monitoring for changes.

The challenge is to reach across boundaries, work with stakeholders, and develop a new range of strategies to improve the watershed. The project team is being tasked with working with existing regulations and established mechanisms, but to bring new ideas.

This Advisory Panel is a critical piece of the water fund feasibility study, and it is important to get this group's input and recommendations as part of this feasibility study.

Vision – Jerry Kauffman, Director, Water Resources Agency, Institute for Public Administration, University of Delaware

The Brandywine-Christina watershed is the second-largest watershed in the Delaware Estuary, and is one of only two watersheds in the 13,000-square-mile Delaware Basin that crosses state boundaries. The watershed supplies 100 million gallons per day of drinking water to over half a million people in both states including over 60% of Delaware's drinking water. However, legacy pollutants, excess nutrients, failing septic systems, and urban runoff have rendered over half of the streams, rivers, and lakes in the watershed unsafe for swimming and fishing.

The Brandywine-Christina watershed is an economic engine for the region. Keeping the water clean and the watershed healthy ensures that the resources and character sustaining this value remain viable in the long-term. The watershed provides:

(1) $1.5 billion in direct economic activity from water supply, fish and wildlife, recreation, agriculture, etc.

(2) $900 million in ecosystem goods and services from the value of habitat such as wetlands and forest with a net present value of $29.5 billion over 100 years.

(3) 90,000 direct and indirect jobs accounting for $3 billion in annual wages.

Grant Concept – Brian Boutin, Director of Conservation Programs, The Nature Conservancy in Delaware

The economic health of the region, and subsequently the quality of life of its citizens, is wholly tied to the health of the lands and waters within the Brandywine-Christina watershed. However, environmental degradation has led to the impairment of the vast majority of streams in the watershed. These impairments range from excess nutrients to low dissolved oxygen to toxins to bacteria, with most associated with nonpoint sources.

For several decades, conservation organizations and multi-institutional partnerships have been working toward addressing the sources of impairment and restoring the health of the watershed. Strategies have included acquisition of conservation easements, implementation of agricultural BMPs, and restoring riparian buffers. However, a lack of a sustainable and substantial source of funding for conservation projects has hampered large-scale conservation efforts.

In light of this, the University of Delaware Water Resources Agency and The Nature Conservancy in Delaware are conducting a feasibility study on the implementation of a water fund for the Brandywine-Christina to provide that sustainable funding source. This yearlong process includes a review of domestic and international watershed funding programs to identify case studies of financing options, completion of an alternatives analysis to refine financial approaches appropriate for the Brandywine-Christina watershed, and directed outreach to key beneficiaries to ensure the outcomes suit their needs. Ultimately, the project team will develop financial and governance recommendations and implementation steps necessary to establish a pilot water fund in the Brandywine-Christina watershed by 2016.

We aim to leverage the expertise of this Advisory Panel to vet the approach of the feasibility study to ensure our process is well informed, transparent, and representative of diverse interests in the watershed. We ask that each panel member provides the project team with frank feedback and opinions both during Advisory Panel meetings and in between and point us toward critical pieces of information where necessary.

While some of you on the Advisory Panel are familiar with the water fund concept, this may be new to others. Therefore, I want to touch briefly on what a water fund is and how they work.

- Water funds are sophisticated financial tools that provide a multi-objective, long-term, sustainable solution to funding watershed-scale conservation.
- The funds provide an innovative way for businesses, governments, and communities to minimize water treatment costs, address stormwater regulations, and reduce the risk of flooding by proactively investing in the protection and restoration of natural areas that regulate the supply of clean water.
- They can be thought of as a partnership among participating institutions to promote and sustain watershed health, providing benefits to nature, communities, government, and business.

In general, water funds invest in conservation of watersheds in order to improve or maintain water quality and/or quantity, ecosystem biodiversity, and human well-being and quality of life. However, these approaches to watershed conservation do not stand alone. Water funds aim to complement and build upon existing watershed investments and partnerships by providing a mechanism to leverage new and existing resources to achieve a common goal. The water fund model is based on investment in watershed services (IWS) principles that incentivize beneficiaries of the resource to make strategic investments in

the watershed. These beneficiaries are often not well represented in existing funding streams or, in some cases, are not well connected with each other. Public and private partnerships are established early in the process to ensure the needs and desires of a broad range of stakeholders are well represented. The mechanism by which funds are generated can vary widely and can include:

- Corporate contributions
- User fees
- Polluter fees
- Government funding
- Other mechanisms but often include multiple-revenue sources

As investments are gathered, a multi-institutional governing board, generally comprising entities that contribute money to the fund or have particular influence in the watershed, use the results of scientific models to guide funding to locations that maximize the return on investment in the watershed (environmental, economic, and social).

Key features of water funds include:

- Ecosystem services mechanisms that include people and nature.
- Sustainable financial mechanisms with transparent management.
- Multi-stakeholder institutional mechanisms including public and private partnerships.
- Concrete, science-based conservation actions to generate services and conservation benefits.
- Accountability system to ensure delivery of services and protection of natural ecosystems.

Review of Case Studies – Ellen Kohler, Conservation Coordinator, The Nature Conservancy in Delaware

In conducting our case-study research, we drew from many different sources, compiling a list of approximately 300 water fund programs from around the world. For our purposes today, we selected 14 representative programs. They are in the chart on page 8 of the meeting materials. In selecting these programs, we focused on programs that:

- Had been up and running for a while.
- Were watershed-based.
- Had readily accessible information about their revenue stream.
- Helped represent the variety of possible elements found in these programs.

These are not the only examples we intend to consider during the feasibility-study process. Also, the information collected to date has come from Internet resources. We will be contacting individuals directly involved in the creation and implementation of some of these programs to learn from their experiences and to get more details about the programs' current status.

In our review of these 14 programs and other case studies, we identified six themes. They are listed on page 9 in the meeting materials. I would like to briefly discuss each of these themes in the context of the extended case studies included the materials.

Theme 1: Developing Strong Public-Private Partnerships

For this theme, we will look at the New York City source water protection program in the Catskills and Delaware watersheds in New York. The city gets 90% of its drinking water from the Catskills and Delaware watersheds. In the 1990s, the quality of its drinking water supply was declining. The city was seeking ways to avoid building an $8 billion drinking water filtration plant. To do that, it had to get a filtration avoidance determination from the USEPA.

One part of the city's multi-pronged strategy was implementation of new nonpoint source regulations in the Catskills and Delaware watersheds. These are agricultural areas, and the farmers in the watersheds did not like the proposed regulations. Some representatives from the agricultural community proposed to meet the water quality goals by working with farmers on whole farm plans. This group formed what is now the Watershed Agricultural Council (WAC). State and federal regulators agreed to give the approach a chance.

Whole farm plans address environmental concerns to protect water resources without negatively impacting the farm business objectives. Farmers get payments to implement projects required in the plans. Where possible, Natural Resource Conservation Service programs provide cost-share funding; the remainder of the funding for implementation of the plans comes from the city.

Initially, WAC got 85% of farmers to adopt whole farm plans. Now they have 93% enrolled in this program. The acreage enlisted in whole farm plans is in addition to the 156,690 acres acquired or under easement through the city's land preservation strategy. The USEPA has stated that NYC's 2002 renewal of the filtration avoidance determination was dependent in part on its strong relationship with WAC and other partners.

To give you a fuller sense of how WAC has evolved, I'd like to share its vision for 2014:

We will start a five-year commitment to conserve an additional 10,000 acres of farm and forest as well as pilot a new forest conservation easement initiative that will focus on water quality through working landscapes. We will roll out a robust regional watershed education program that will span both watersheds. Finally, we will continue to grow and emphasize our regional efforts to support working landscapes and "buy local" initiatives.

Theme 2: Leveraging State, Federal, and Private Foundation Funding

For this theme, we are going to consider two case studies: the Rhode Island Water Resources Board and the Truckee River Fund.

The Rhode Island Water Resources Board demonstrates the role states can play in leveraging funds. The board is charged with protecting and conserving the state's water resources while providing for economic development. It has the power to issue revenue bonds to carry out its water supply mission. Since 1991, the board has administered a state surcharge on water customers. Approximately 36% of the funds from the surcharge are designated for watershed protection. The majority of the protection funds have been used for land acquisition, protecting 2,410 acres.

Rhode Island is not alone in providing state-level dedicated watershed protection funding. Other examples include the North Carolina Clean Water Management Trust Fund, the Minnesota Clean Water Fund, the Oregon Water Enhancement Board grant program, and the Pennsylvania Growing Greener grant program.

The Truckee River Fund demonstrates the role of local funding. It was established in 2004 by the Truckee Meadows Water Authority (TMWA), a regional water authority that operates in a watershed that crosses the Nevada–California border. Because the watershed includes multiple jurisdictions, it is difficult for one entity to implement improvement projects. The TMWA started the fund explicitly to enable local organizations and agencies to be in a better position to get matching funds and develop partnerships with other public agencies. The utility asserts that the fund makes good business sense because leveraging funds means that the utility's customers spend less money to protect the Truckee River and its watershed.

The fund has a simple structure. The utility commits 2% of its annual budget to the fund. It is managed by a community foundation. The fund advisors are separate from the TWMA. The TMWA board makes final determinations on what projects are funded. Over ten years, 101 projects have been funded.

Theme 3: Adopting a Conservation or Strategic Plan

Theme 4: Champions and Carriers/Stewards

I am going to use one case study to discuss these two themes. By "champion," I mean a local leader who was a robust supporter of the proposed program with key stakeholders. By "carriers" or "stewards," I mean those government or organizational staff members who helped put all the pieces of the program together and shepherded it through the design, development, adoption, and implementation phases.

Let's consider the Upper Neuse River Clean Water Initiative in the Raleigh–Durham area of North Carolina. The initiative had a champion in the Raleigh Mayor Charles Meeker. He founded the initiative in response to increasing development and resulting threats to water quality in his community. Because of these threats, Raleigh was considering building a new water filtration system, estimated at $150 million. He convened a group of local government officials to discuss a partnership approach, and he worked with his council to get the initial $500,000 seed money approved for the initiative.

One of the first tasks the initiative tackled was the adoption of a conservation plan. It was developed with the help of a technical team and stakeholder input. The plan prioritizes parcels for acquisition based on their ability to help protect water quality. The plan helped demonstrate to residents the connection between upstream and downstream communities.

The initiative's program activities now include adoption of BMPs on private forest lands in addition to land acquisition. Steady funding comes from a watershed protection fee on water bills for Raleigh and Durham residents.

Theme 5: Starting with Seed Money and Maturing into Identification of Steady Funding Source

The Conserve to Enhance program in Tucson, Arizona, has an innovative approach to developing seed money. The model for the program was developed by the University of Arizona's Water Resources Research Center. Tucson Water, the city utility, has set up a donation structure such that money saved by customers through water conservation is donated to the Conserve to Enhance program. The utility's monthly bill also includes a voluntary check-off for the program. It started in 2011 and has generated $40,000. The funds have been used to support local watershed restoration projects. That may not sound like a lot but, as we have seen, a little can go a long way.

Theme 6: Adapting to the Setting

FONAG in Quito, Ecuador, is a mature program. It has an established governance structure, multiple partners, and a mature funding structure with the dedicated revenue stream from the utility as well as contributions from water users such as the electric company and the Andean Ecuador Brewery. The fund uses interest from its endowment of $8 million to pay for projects.

Perhaps most importantly, the program design shows a deep understanding of the setting. The fund was developed to help address land conversion in and near the protected areas of the upper watersheds that provide Quito's drinking water. As a result of diminishing soil productivity, local people were starting to move into these areas and convert forests or natural grasslands to agricultural uses. The land conversion resulted in sediment and flow issues.

In recognition of this setting, one of the stated goals of the fund is to improve or maintain human well-being and quality of life for upstream communities. The main beneficiaries of program activities are the local communities close to the water resources. At the same time, the program helps link the citizens of Quito to their water supply.

Adapting to the setting can take several forms. Some programs have developed in response to a triggering event—like forest fires in western states that leave watersheds vulnerable to heavy sedimentation after storms. Others develop in response to a regulatory driver. Common federal regulatory drivers include maintaining a filtration avoidance determination and complying with the Long-Term 2 Enhanced Surface Water Treatment

Rule (LT2) under the Safe Drinking Water Act, and complying with permit requirements for point and nonpoint sources and meeting total maximum daily load (TMDL) allocations under the Clean Water Act.

Existing Regional Initiatives

Now I'd like to turn to some initiatives already under way within the Brandywine-Christina watershed. This is not a comprehensive review; we are still collecting information. These initiatives echo the six themes:

- In 2010, the City of Wilmington adopted its Source Water Protection Plan. The city has committed $279,850 for source water protection projects since its adoption.
- United Water Delaware, which is a private water purveyor in the White Clay Creek watershed, is committing $700,000 from 2012 through 2017 to watershed restoration projects as part of its LT2 permit.
- Delaware implemented a voluntary tax check-off for the benefit of the White Clay Creek. It has generated $11,000 in revenue since 2011.
- Christina TMDL Implementation Plan (CTIP) is a partnership of local organizations and 33 local governments. It has leveraged approximately $150,000 from the City of Wilmington and Pennsylvania local governments to bring in $3 million, mostly from Growing Greener, for seven restoration projects in the Brandywine-Christina watershed.
- Victory Brewing founded the Headwaters Grant Program. They pledge one cent from every Headwaters Pale Ale sold goes into the grant.
- DuPont developed Clear into the Future. The initiative is working with the community to preserve the Delaware Estuary. The initiative is "striving to secure a healthy future for the living and working river." It provides grants for research and restoration projects in the estuary, including the Brandywine-Christina basin.
- In addition to all the great work of land conservancies in the area in preserving land, Chester County began the Brandywine Headwaters Preservation Program in 2010. The county describes the program as an effort "to increase the number of partners, further leverage limited public funds, promote water quality improvements, and permanently preserve land." The program uses the agricultural priority areas set out in Wilmington's Source Water Protection Plan to determine eligibility for the funding.

What is already happening in the watershed is really exciting. The question moving forward is how best to keep that momentum going and build on it.

Resources:

Internet repositories of payment for watershed services programs, investment in watershed services programs, and water funds:

The Conservation Gateway – www.conservationgateway.org.
The Conservation Registry – www.conservationregistry.org.

Reports reviewing payment for watershed services programs, investment in watershed services programs, and water funds:

Genevieve Bennett, Nathaniel Carroll, and Katherine Hamilton, 2013. Charting New Waters: State of Watershed Payments 2012. Forest Trends, Washington, D.C. Available online at http://www.ecosystemmarketplace.com/reports/sowp2012.

Terhi Majanen, Rachel Friedman, and Jeffrey C. Milder, 2011. Innovations in Market-Based Watershed Conservation in the United States: Payments for Watershed Services for Agricultural and Forest Landowners. : Ecoagricultural Partners, Washington, D.C. Available online at http://ecoagriculture.org/publication_details.php?publicationID=362.

American Water Works Association and The Trust for Public Land, 2004. Source Water Protection Handbook: Using Land Conservation to Protect Drinking Water Supply. American Water Works Association and The Trust for Public Land, Washington, D.C. Available online at http://www.tpl.org/source-protection-handbook.

Caryn Ernst, author; Kim Hopper and David Summers, editors, 2004. Protecting the Source: Land Conservation and the Future of America's Drinking Water. The Trust for Public Land and American Water Works Association, Washington, D.C. Available online at http://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/water-protecting_the_source_final.pdf.

Todd Gartner, James Mulligan, Rowan Schmidt, and John Gunn, editors, 2013. Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States. World Resources Institute; Tacoma, WA: Earth Economics; Manomet, MA: Manomet Center for Conservation Sciences, Washington DC. Available online at http://www.wri.org/publication/ natural-infrastructure.

Next Steps – Richie Jones, State Director, The Nature Conservancy in Delaware

Jerry Kauffman and his team will be conducting an alternatives analysis of the various funding mechanisms that have been successfully employed. The project will also identify key stakeholders and develop an interview protocol for engaging them.

The goal will be to assess critical ecosystems in the watershed most in need of restoration and improvement.

Team members will be reaching out to you shortly to gather your thoughts one-on-one after this meeting.

We will be aiming to meet with you again in early September to review these subjects and get more feedback.

But for now we're hoping to get your feedback on the questions listed in the Agenda – page one of booklet provided to meeting attendees.

Advisory Panel Discussion – Advisory Panel

General thoughts:

- Develop a refined sense of what the needs of the watershed are in terms of finances and numbers. For example taking the existing plans that are out there and seeing how much needs to be invested in this watershed.
- Identify why the money is being raised and how it will be spent. Is it to improve water quality (e.g., bacteria, toxics, or DO), decrease flooding, or conserve land, etc.? Clearly define the goods and services we are marketing.
- Craft a strong communication and marketing plan.
- Involve stakeholders.
- Identify the beneficiaries.
- Consider funding multiple things (e.g., storage, restoration, etc.).
- Consider that successful water funds need a dedicated funding stream from public entities to serve as a base of ongoing support. It is critical to figure out this balance. In order to establish a solid base support from legislators is necessary and this must be established prior to requesting funds from private financers.
- Develop a unified statement driver. There are a number of objectives that need a unified driver (all these case studies have that).
- Consider user fees/tax rates: These are not uniform across the watersheds. The bi-state watershed is unique to this process; the governance structure is critical.
- Establish geographic integrity—watershed-wide. Consider that there is a city at one end of the watershed and not at the other. Equity across geography is critical.
- Understand the current funding needs. Currently $15-16 million is needed in the Brandywine-Christina for toxics alone. There are also stormwater needs and other water resource needs; there are a lot of funding needs in this watershed.
- Itemize the existing funding programs and be careful not to create a fund that removes existing funding programs.

What is missing?

- Invite participation from the agriculture community early on in the process. Do not invite them to the table too late in the process because there is sensitivity to this.
- Check to see if the City of Wilmington is missing from the Advisory Panel.
- Conduct further research on the case studies. Identify the mistakes that have been made. Are there local connections in any of the case studies? What are the management issues? What are the problems associated with working on a watershed basis?
- Avoid repeating the mistakes of other water funds. Regarding the case studies, identify the lessons learned in each. For example, there are no local people in the New York City case study, Look into this. Are there management problems with water funds? Are the other funds monitoring the success of the money?
- Generate a real number for what's needed in the watershed (using existing plans (wastewater, drinking water, etc.). There is a lot of information for funding needs in the

watershed (e.g., New Castle Conservation District has hundreds of assessment with identified needs).
- Aggregate the various inventories of needs that are available (e.g., capital budget plan, wastewater, drinking water facilities, nonpoint source projects). There are requirements/plans that say what's needed in investments/capital projects. This is the nut, why we are trying to aggregate funds. Additionally, management of the water resources and flooding is a huge issue downstream and those capital needs are very expensive.
- Identify water quality information before meetings with key stakeholders, map them, and identify high-priority issues/areas.
- Define outcomes: we need a fine point on what needs to happen to get to swimmable, fishable, and potable.
- Demonstrate how dollars invested translate directly to an amount spent on in the ground projects. For example, the USEPA's Targeted Watershed Initiative Grant (TWIG) implemented in the Christina Basin was augmented by an approximately 3:1 match.
- Consider allowing trading into this feasibility study.

What are the best pathways to success?
- Use the existing resources, expertise, and momentum occurring in this watershed. This project can't just be a dumping ground for money.
- Do more than craft a report. Momentum, an involved group, and vested interest in the process and plan are needed.
- Avoid inconsistencies in what we are buying/selling. Any market has a good sense of what is being bought and sold. There is an inequality because it is really hard to quantify ecosystem services.
- Follow an approach that makes good business sense with the farmers, the stakeholders, the public, and the investors. An important feature is mutual benefits—understanding the benefits to those who participate. What made this worth it to them?
- Develop a general theme but different stories for the multitude of stakeholders in the watershed. Each stakeholder needs a sense of place. Visions of success need to translate to on-the-ground projects.
- Think of this as a journey; don't try to be excellent, try to be better. Grow, learn, and modify as we go.
- Craft a massive marketing and communication strategy. This is being learned in Delaware with the Clean Water Initiative.
- Connect people to their local resource—reach people so that they can make that connection. Consider it will come down to people/public—their desire.
- Find our focus. Maryland has focused on the Chesapeake Bay. This is a unifying siren for that part of the world. Need something similar.
- Consider the differences between a partnership of shared interests and a partnership driven by financial incentives; they could include different set of players.
- Motivate people who aren't interested to become interested. This can be done through financial incentives/disincentives. In Philadelphia, for example, stormwater contributors are paying to help the city with their stormwater problem so that the city doesn't have to bear the entire financial burden.

- Identify a group of people who want to continue work on this. Make this the key objective. This project shouldn't just end with a report; relationships are needed to continue this work.
- Define the needs early in the process.
- Map the high-priority areas/problems and bring this to the stakeholders so there is background information provided before we go out to the public with these ideas. These are regulated waterways. There are a lot of organizations working in this watershed that know the area and the needs.

What are the likely barriers that will be encountered and how might they be overcome?

- Recall that the agriculture conservation districts were formed to connect farmers. Farmers are critical and it is not easy always easy to make that connection. Developing a relationship/connection with the farmers is critical. In some cases, a farmer implements a project and then it is not maintained or taken care of so it is important to have "boots on the ground" to work on maintenance and relationships with the farmers.
- Consider that the agricultural community has a high sensitivity to its presence at the table. You need to avoid a pre-conceived approach in which they weren't involved in the process from the beginning. Need to bring them to the table sooner, rather than later.
- Consider that the governance structure with multiple jurisdictions could prove difficult.
- Address geographic equality.
- Establish credibility when working with the agriculture community as well as the public with regard to how much money is needed, why it is needed, and how will it be spent.
- Look at resilience and water quality at the same time. Water quality doesn't seem to resonate with the public.
- Consider the multiple dimensions of water quality (bacteria, nutrients, toxics, DO, etc.). What is most important? "Water quality" is an umbrella placeholder for a tough discussion of what's most critical.
- Remember that there is a lot of good science data that do not make good business sense for farmers, (e.g., raising buffer distance from 15-25 ft to 100 ft). If we don't consider the farmer's business, you will be stalled before you start.
- Avoid inconsistent valuation. This project needs to make sure there is consistent valuation so that it makes good business sense to implement practices or give to the fund as well as it makes it worthwhile to participate in the fund.
- Tip the scale so it's worth ecological health for conservation practices on farms (i.e., increase financial incentives).
- Determine what you need from stakeholders. Science-based decision-makers are important. Stakeholders and the general public are important but if the goal is fishable, swimmable, and potable the comments from these groups may not lead to achieving these goals.

Action items:

- Provide the Advisory Panel with a scope of work for the project.
- Educate the group (the Advisory Panel) on where/what the needs are in the Brandywine-Christina. The needs must be in line with and tailored to the conservation/protection plans that exist.

Meeting Attendees

ADVISORY PANEL MEMBERS – MEETING ATTENDEES	
Jennifer Adkins	Partnership for the Delaware Estuary
Barbara D'Angelo	Chester County Water Resources Authority
Jon Capacasa	USEPA, Region 3
Kevin Donnelly	New Castle Conservation District
John Goodall	Brandywine Conservancy
Kenneth Najjar	Delaware River Basin Commission
Robert Tudor	Delaware River Basin Commission
Sarah Low	USDA/Urban Waters Federal Partnership
Robert Molzahn	Water Resources Association of the Delaware River Basin
Collin O'Mara	Delaware DNREC
David Small	Delaware DNREC
Blaine Phillips	The Conservation Fund
Dawn Rittenhouse	DuPont
Rhonda Manning	Pennsylvania DEP, Southeast Regional Office
Donna Siter	Western Chester County Chamber of Commerce
Christian Strohmaier	Chester County Conservation District

PROJECT TEAM MEMBERS AND MEETING ATTENDEES	
Brian Boutin*	The Nature Conservancy in Delaware
Maria Dziembowska*	The Nature Conservancy in Delaware
Andrew Homsey*	Water Resources Agency, Institute for Public Administration, University of Delaware
Richard Jones Jr.*	The Nature Conservancy in Delaware
Gerald Kauffman*	Water Resources Agency, Institute for Public Administration, University of Delaware
Ellen Kohler*	The Nature Conservancy in Delaware
Martha Narvaez*	Water Resources Agency, Institute for Public Administration, University of Delaware
Kash Srinivasan*	KS Group, LLC
Martin Wollaston*	Water Resources Agency, Institute for Public Administration, University of Delaware
Nathan Boon	William Penn Foundation
Clare Billett	William Penn Foundation
Peter Williamson	Natural Lands Trust
Eric Olsen	The Nature Conservancy in New Jersey
Nina Chen	The Nature Conservancy in New Jersey
Sebastian Laye	The Nature Conservancy in Delaware
Robert Struble	Brandywine Valley Association/Red Clay Valley Association

* Project Team Member

Brandywine-Christina Healthy Water Fund Feasibility Study

Regional Advisory Panel Meeting

Meeting Summary

Mount Cuba Center

Hockessin, Delaware

September 18, 2014

Brandywine-Christina Healthy Water Fund

www.nature.org/Delaware • www.williampennfoundation.org • www.wra.udel.edu

Welcome and Introduction – Richie Jones, State Director, The Nature Conservancy in Delaware

Richie Jones provided a brief introduction of the project team, Advisory Panel, and meeting attendees.

Thank you for the group's participation in this the second of two very important meetings of the Brandywine-Christina Healthy Water Fund Regional Advisory Panel.

Thank you to Mount Cuba for hosting the event at such a beautiful and important site.

Richie provided a brief overview of the project and the project goals, including:

- This work is part of the William Penn Foundation's cluster work in the Brandywine-Christina.
- This project is focused on the feasibility of a market-based funding model.
- The project work is focused on creating efficiencies in investments, attracting new investments, and prioritizing projects based on the highest-best return.

Update from May 30 Regional Advisory Panel Meeting – Brian Boutin, Director of Conservation Programs, The Nature Conservancy in Delaware

Brian Boutin discussed the action items requested by the Advisory Panel at the first meeting (May 30) to describe the project team's progress on these items/requests.

Action: Map high-priority areas,
Response: Presented in the benefit-cost analysis discussion during this meeting.

Action: Review existing plans.
Response: The team reviewed seven existing management plans; the summary of the findings from these plans is included in the September 18 meeting materials (pages 6 and 7).

Action: Define a unifying driver.
Response: In process through the stakeholder interviews being conducted by the project team.

Action: Itemize existing funding.
Response: In process.

Action: Develop a communications and marketing plan.
Response: The project team is inventorying existing communications through other organizations; the information will be included in planning for the continuation of this project.

Stakeholder Interview Process Update – Ellen Kohler, Conservation Coordinator, The Nature Conservancy in Delaware

Ellen Kohler discussed the stakeholder interview process that is being conducted to gather information for the development a Brandywine-Christina Healthy Water Fund.

The process began by identifying stakeholders throughout the watershed, drawing from other watershed projects and planning processes. The list included more than 250 entities.

The list was separated into sectors:

- Governmental bodies/ public agencies
- Drinking water purveyors
- Wastewater dischargers
- Private commercial/business interests
- Nonprofits
- Colleges and universities
- Chambers of commerce
- Agricultural organizations
- Electric and gas utilities

Next, the team reviewed the water withdrawal information for the watershed. The largest water withdrawers in this watershed are the water purveyors and ArcelorMittal.

As we saw with the case studies, water purveyors and large water users have been key stakeholders in many of these projects. We discussed at the meeting in May that several water purveyors in the Brandywine-Christina watershed are already investing in watershed restoration projects. The interview process will include the largest water users in the watershed.

In this watershed, there is an opportunity for strategic collaboration with stormwater managers/MS4 permittees in the Brandywine-Christina watershed. Many are beginning to plan for implementation of permit requirements. It is known there is overlap between projects that protect drinking water and projects designed to address stormwater problems. There are efficiencies to be achieved in that area of overlap. The process will also include interviewing stormwater managers.

The list of initial stakeholder interviews to be completed in this first phase of the project includes:

- City of Wilmington
- City of Newark
- Aqua Pennsylvania
- PA American
- United Water Delaware
- Downingtown Municipal Water Authority

- ArcelorMittal
- CTIP (Christina Basin TMDL Implementation Plan)
- New Castle County
- DelDOT

Through the interviews, the interviewers are looking for common interests and priorities, a willingness to consider investments in watershed restoration, and a commitment to continue to participate in the process as we move forward with the project.

We developed a set of interview questions to shape the discussion, but we do not intend to limit the discussion to these topics; we adjust the questions as appropriate for each stakeholder. The questions focus on the stakeholders' concerns, priorities, and preferences. Examples include:

- What are the water quality problems in the Brandywine-Christina that most affect you right now? What about within the next ten years?
- What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- What is the most important consideration among these three in terms of your preferences: cost reduction, regulatory compliance, or economic development/return?

Two team members attend each interview. After the interview, notes from the discussion are compared among the team members and shared with the stakeholder to confirm accuracy. The information gathered from the interview will be compiled and shared with all those interviewed. The final plan is to invite these key stakeholders to a joint meeting with this regional advisory panel in January 2015 to hear draft recommendations and provide comments.

To date, two interviews have been completed, and confirmation of the additional interviews with other key stakeholders are in process. The two interviews completed were with the City of Wilmington and the City of Newark—both are already investing in watershed restoration and have verbally committed to partner with us as we continue this process.

Brandywine-Christina Economic Analysis – Jerry Kauffman, Director, University of Delaware, Institute for Public Administration, Water Resources Agency

Detailed information from Jerry Kauffman's discussion can be found in his PowerPoint presentation and in the meeting materials (pages 8-14) at the following link: www.wra.udel.edu/brandywine-christina-healthy-water-fund/

Next Steps – Ellen Kohler, Conservation Coordinator, The Nature Conservancy in Delaware

Ellen Kohler briefed the group on the upcoming actions of the project team. They include the following:

- Complete initial stakeholder interviews with the large water users and the stormwater managers.
- Compile information from those interviews to share with the stakeholders interviewed.
- Amend the benefit-cost analysis based on comments and feedback.
- Begin to frame recommendations for the next phase of the project that will be shared with stakeholders interviewed and Regional Advisory Panel members.

Advisory Panel Discussion – Advisory Panel

Discussion on the benefit-cost analysis:

- Identify/incorporate land treatment so there is a better picture of the current loads, do not just use land use for the agriculture loads. NRCS data is a good source, extrapolate from this. Try to acknowledge that work has been done since the TMDLs.
  Response: Using the water quality monitoring data may be the best approach.
- Use Mapshed, it is a good resource; there is 2010/2011 one-meter resolution.
- The length of the forest buffer width for nitrogen reduction is critical. What was used in the HSPF or Sparrow model?
- Review the numbers for the TMDLs for accuracy. The TMDLs should be used as guideline not absolute numbers. Use them as a framework. Need to fix the impairment map because it should not be based on the TMDLs.
  Response: Need to rely more heavily on water quality monitoring data. Collectively all actions are reflected in the water quality data.
- Adjust with the timeframe so that the numbers aren't so daunting and are more achievable. Create intermediate milestones.
- Review the numbers in the maps and charts that are based on the 1998 impaired streams map. The current map will be three times as impaired as the 1998 map. This begs the question, is clean water affordable?
  Response: This data are being used as a starting point. Further refinement can be conducted as the project evolves.
- Consider the additional benefits to using the TMDLs.
- Achieve the sediment and nitrogen TMDL and this will go a long way to taking streams off the impaired list.
  Response: Need to consider preservation and protection.
- Remember that if you are developing a fee structure through water purveyors, you don't have 100% of the population; a large percentage of the population in served by private wells. In addition, you are asking the same people to pay for stormwater. There is competition for funding. All the funding is coming from the same pockets. This goes back to the importance of marketing; it is critical to market and communicate with the public. Effectiveness of mass media campaigns are the biggest bang for the buck.
  Response: The majority of these campaigns start with a voluntary effort to get the process going and once they are established and can show successes others join on.
- Consider revisiting the TMDLs to come up with different allocations. Specify timeframe, revisit, and reframe. States have the discretion to modify the TMDLs without re-doing them.

Discussion related to project communication:

- Create clear messaging. Farms contribute significant loads of pollution, but they are also a preferred land use over development. It is critical that the message isn't farms are the problem because they are better than development. Pollution levels will be much worse if everything is urbanized. Messaging with the public needs to focus not on the negative aspects of farming but on the good it provides, too.
  Response: Conversations with the agricultural community need to start with the good things they are doing. Messaging is important. Farmers play an important role. It may be useful to use the data to show the increase in loads if farms were urbanized.
- Work with the farmers because they are a huge asset, it may be beneficial to come up with LEED-type certification for farmers that are doing the right thing. Farmers can market themselves that way.
- Consider some possible approaches: incentivized BMPs; excellent O&M and effectiveness rewarded with payments; farmers opt into O&M program but reduces their payment.
- Educate the farmers coupled with monitoring will help them make the connection between BMPs and water quality.
- Remember, effective mass media education could be biggest bang for the buck in this watershed.

General discussion:

- Consider the situation with the MS4s. For the MS4 regulations you can only give credit in the regulated area. Credit is not given for reductions in the place where the pollution occurs so the reduced load must happen solely in the MS4 area. Urbanized areas are only a certain portion of the watershed. The current regulatory system does not have the flexibility to go where the problem is or to move across the regulated boundary.
- Work with the other entities that are also looking at needs to fund clean water compliance.
- Consider that the unassessed areas on Jerry's maps are not indicative of no load reduction but are just not assessed.
- Develop a watershed permit or overlay concept plan for review and discussion with USEPA. The USEPA representative discussed these options and if a concept plan is developed it can be taken to USEPA for review and discussion. The Chesapeake Bay Program is using a watershed overlay for nutrients. You can develop an overlay for one nutrient or one subject area.
- Recognize that you don't trade upstream and downstream compliance.
- Remember that investing upstream will benefit downstream.
- Look into the Sparrow Model because it has been updated with the 2000-MS4 data.
- Consider the lower portion of the basin. How are we addressing toxics? Is this a project limitation? We need talking points around this because elected officials are concerned about toxics in the Christina. If the water fund is not addressing toxics, how do you handle this? Fishable/swimmable is not attainable if toxics aren't considered.
- Consider looking for local dedicated funding sources.
  Response: This funding will supplement funding or be used as a cost-share approach. Identify a priority area.

Response: Priority areas have not been identified yet, that is part of this process.

- Develop a good model for funding and financing and use this for things not tied to the TMDL.
- Consider the cost of improvement. How long will it take to show improvement in water quality based on the actions taken?
  Response: A Stroud study shows a 5- to 8-year lag time for BMP benefits to be demonstrated on the ground. There is a long lag due to the complex geology of this area and can take up to ten years or more. There is a lag in functionality in BMPs that get put on the ground. For example, forest buffers have a lag due to the time it takes for them to get established.
- Consider the particle sizes of sediment that the BMP is intended to capture. For example, silts and clays are most damaging and also difficult to remove. Buffers/buffer width: a 30-foot-wide forest buffer on a small stream removes 64% of the sediment. If you are to increase the buffer to 100 feet, the efficiency will increase to 84% removal. The buffer does not capture the silts and clays until it is 100 feet in width, so less than 100 feet is not taking out the devastating particle size. There is a much greater return for the last 70 feet of a buffer. In the New York drinking water system silts and clays are a very big concern for the water supply. Silts and clays don't settle, and the cost of building a treatment plant to treat the silts and clays is very costly. So there is a very large advantage to removing them at the source with buffers.
- Remember that the DRBC has worked on a PCB TMDL.
- Consider both preservation and conservation practices.
- Evaluate how funding can address O&M on existing BMPs. It is important to shed more attention on what's already in the ground that will get a big return if there is focus on this.
- Remember, currently the cost relationship is 80/20 for cost-share. Farmers can typically come up with that 20%. Need to address the 80%, not the 20% coming from the farmer.
- Consider that staffing of the conservation districts may be a limiting factor.
- Consider who is going to pay for the local match. Programs are starting to look for a local match that is not available.
- Need numbers to back up the methods of protection that are being implemented. What are the existing BMPs doing? What is the existing benefit?
- Remember that trading and offsets are an option.
- To be successful, show that it's good business sense for the farmers. For example, no till conservation has been adopted for that reason.
- Consider that there has been resistance of the Pennsylvania municipalities to get a joint MS4 permit.
- Work on a watershed basis; MS4 permits aren't written this way. We need to use watershed efficiencies because jurisdictions can't meet the permit requirements without working on a watershed-level.

General project team responses:

- Work on the potential process and identification of the available data is the intent of the work in years two and three.

- Consider that there are multiple goals of the water fund: economic, social, and restoration goals. There are also a lot of constituencies of water quality that should be addressed. The TMDL is a starting point. The stakeholders and interview discussions will define what the water quality goals are and the best way to address them.
- Consider the best mechanism for delivering O&M. Is creating a workforce to do this an option?
  Response: Conservation district staff should be doing O&M, but there is not enough time and DEP enforcement needs to be stronger. This would go a long way with O&M. A workforce would work for O&M, but training would be required.
- Remember, a selling point of the contributions is leverage. This will be a voluntary approach.

General reaction to the project:

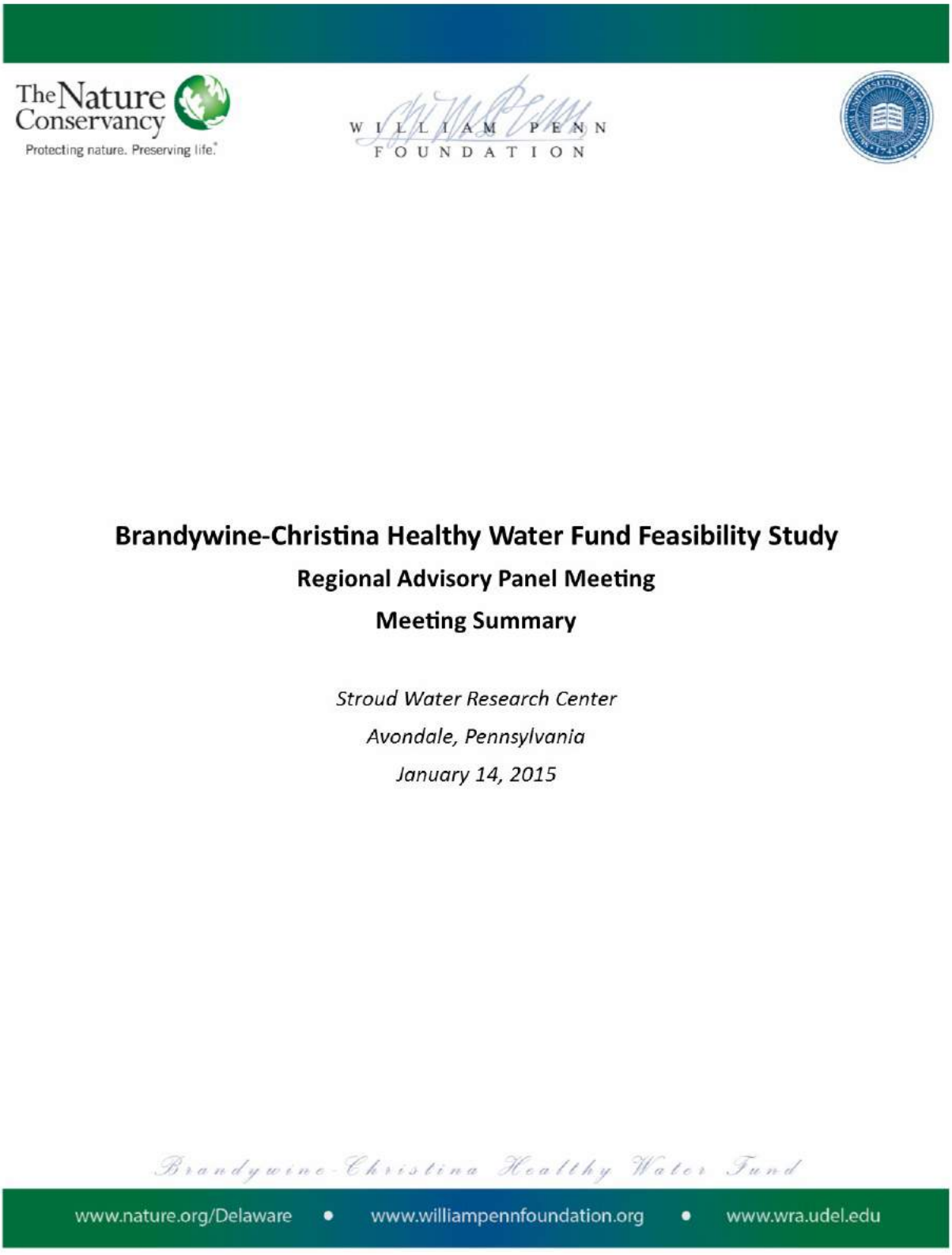
- Identify the unit cost, this would be a good strategy, a good message for the public, and would not appear overwhelming with huge and costly goals.
- Come up with a system that can incentivize—get the farmers to implement and perform O&M. Current programs, like CREP, don't have incentives to go above and beyond the norm. Come up with something that incentivizes farmers who are doing what's best for the environment.
- Develop an education campaign on monitoring because there is a need for this. When a farmer sells his development rights, there is an annual monitoring component. The preservation component will include this monitoring component.
- Determine if there is required protection for the actions implemented with the water fund money. If it is disturbed or not maintained, will the recipient of the money have to give money back?
  Response: The grantor can put stipulations on the funding, speaking to specific BMPs, there will need to be certain criteria and the grantee will have to develop this criteria.
- Consider program administration and monitoring. These will be components that require funding. What/who is the entity that is holding the money?
  Response: In years two and three, the project team will be identifying the legal and regulatory terms. There will be an agreed-upon structure and group of investors. There will be a firm, a board of directors an executive director, or a host agency. All of these details will depend on how the fund is developed.
- Consider how MS4s will work into this. Using the water-purveyor model will leave these groups out of the project.
- Consider that there will be issues with trying to cross the state line with the model.
- Look into a business model that will serve the variety of entities in the two states in order to attract the municipalities. The team will need to develop a program that will do this.
  Response: PDE and DRBC are two interstate organizations that can serve as models. DRBC can be the bank and get money from people with a permit or docket. This does not include the stormwater component.
- Consider how to get the funds that are necessary.

Meeting Attendees

ADVISORY PANEL MEMBERS – MEETING ATTENDEES	
Jennifer Adkins	Partnership for the Delaware Estuary
Janet Bowers, Alternate: Barbara D'Angelo	Chester County Water Resources Authority
Jon Capacasa	USEPA, Region 3
Kevin Donnelly	New Castle Conservation District
John Goodall	Brandywine Conservancy
Kenneth Najjar	Delaware River Basin Commission
Robert Tudor	Delaware River Basin Commission
Sarah Low	USDA/Urban Waters Federal Partnership
Robert Molzahn	Water Resources Association of the Delaware River Basin
Frank Piorko	Delaware DNREC
David Small	Delaware DNREC
Blaine Phillips	The Conservation Fund
Dawn Rittenhouse	DuPont
Rhonda Manning	Pennsylvania DEP, Southeast Regional Office
Donna Siter	Western Chester County Chamber of Commerce
Christian Strohmaier	Chester County Conservation District
Bernard Sweeney	Stroud Water Research Center

PROJECT TEAM MEMBERS AND MEETING ATTENDEES	
Brian Boutin*	The Nature Conservancy in Delaware
Maria Dziembowska*	The Nature Conservancy in Delaware
Andrew Homsey*	Water Resources Agency, Institute for Public Administration, University of Delaware
Richard Jones Jr.*	The Nature Conservancy in Delaware
Gerald Kauffman*	Water Resources Agency, Institute for Public Administration, University of Delaware
Ellen Kohler*	The Nature Conservancy in Delaware
Martha Narvaez*	Water Resources Agency, Institute for Public Administration, University of Delaware
Kash Srinivasan*	KS Group, LLC
Martin Wollaston*	Water Resources Agency, Institute for Public Administration, University of Delaware
Nathan Boon	William Penn Foundation
Clare Billett	William Penn Foundation
Peter Williamson	Natural Lands Trust
Eric Olsen	The Nature Conservancy in New Jersey
Nina Chen	The Nature Conservancy in New Jersey
Sebastian Laye	The Nature Conservancy in Delaware
Robert Struble	Brandywine Valley Association/Red Clay Valley Association

*Project Team Member



Brandywine-Christina Healthy Water Fund Feasibility Study

Regional Advisory Panel Meeting

Meeting Summary

Stroud Water Research Center

Avondale, Pennsylvania

January 14, 2015

Welcome and Introduction – Richie Jones, State Director, The Nature Conservancy in Delaware

Richie delivered a brief introduction of the project and the project team. The advisory panel and meeting attendees introduced themselves.

Update since the September 18 Regional Advisory Panel Meeting – Brian Boutin, Director of Conservation Programs, The Nature Conservancy in Delaware

Brian provided a brief overview and update of the project.

Review and Discussion of Draft Feasibility Study Recommendations – Ellen Kohler, Conservation Coordinator, The Nature Conservancy in Delaware

Ellen led a discussion on the nine recommendations drafted for the Brandywine-Christina Water Fund feasibility report. The project team is seeking feedback from the meeting attendees on each recommendation.

General discussion:

- Does the committee recommend that the fund be created?
- Should new watershed management plans be drawn up or are existing plans from the region sufficient?
- The benefit-cost analysis has been refined since the last meeting. There will be additional refinement.
- The project team reviewed about 300 watershed funding programs and conducted an in-depth analysis of four case studies to develop recommendations and improve the success of the Brandywine-Christina Water Fund.
    - Found six common themes among these studies:
        1. Develop strong public-private partnerships.
        2. Leverage state, federal, and private funding.
        3. Adopt a conservation/strategic plan.
        4. Depend on local champions and stewards.
        5. Start with seed money and over time develop a steady funding source.
        6. Adapt to the setting.
- Benefit-Cost Analysis Approach
    - Evaluated effectiveness of potential measures.
    - Provided examples to address goals (i.e., TMDLs).
    - Benefit-cost analysis emphasized importance of low-cost alternatives.
    - Agricultural lands shown to be important (critical part of solution to address Nitrogen/Sediment).

Recommendation #1

Continue to draw upon the expertise, connections, and wisdom of the Regional Advisory Panel as necessary to further develop the Brandywine-Christina Water Fund.

- Consider drawing people and resources from existing water funds (e.g., New York) to critically review/evaluate this plan.
- Expand panel to peer-reviewed group; reconsider composition of advisory panel.
- Consider paying for review from industry experts, possibly NY managers.
- Create within advisory panel; use existing groups more effectively.
- Provide a schedule and structured feedback, set time lines for feedback.
- Include this missing piece for all recommendations: "Strongly implied conclusion that the water fund is feasible and should be pursued; narrow down the ideas and key concepts"

Recommendation #2
Advance the dialogue with the stakeholders who have expressed interest in remaining involved in this process, focusing in particular on (1) understanding the costs stakeholders currently are facing to address water quality and quantity issues, (2) quantifying the alternative costs associated with equivalent conservation strategies, and (3) modeling the effectiveness of such conservation strategies.

- Emphasize the shared understanding of the value of collaboration.
- Incorporate understanding of efforts already underway by stakeholders and eliminate overlap where possible.
- Consider why quantity was dropped from the language. (Not heard as a big concern from stakeholders, but what about flooding?) Quality and quantity need to be considered together.
- Recognize that concerns depend on the stakeholders' viewpoint/goals: water purveyors are worried about having enough water, while stormwater managers are dictated by the regulations for the water flowing downstream.
- Understand that quantity as it relates to flooding may greatly affect the agricultural community.
- Recognize the multiple sources, this plan focuses on the stormwater side.
- Consider the language here and include agriculture as a stakeholder, not just on the implementation side. Agriculture is missing from the stakeholder list on the slide but identified as a key constituent.
- Consider the use of "stakeholders." Is it the correct term?

Recommendation #3
Build on the continuing dialogue with the Regional Advisory Panel and the stakeholders, develop a refined benefit-cost analysis and assessment of conservation strategies that will result in a comprehensive conservation plan for the entire Brandywine-Christina watershed. Essential components of this analysis should include:

- Compare costs, especially when presented, to the potential cost of doing nothing. This was one of the main factors driving the New York State water fund.
- Overlay cost-effectiveness with possible temporal risk.
- Determine/clearly identify the risk of flood (with size/impact) and drought for the area.

Work with partners in the watershed, evaluating the opportunities, relative implementation costs, and water quality improvements associated with three conservation strategies: land acquisition, conservation easements, and implementation of agricultural BMPs. Costs should include technical assistance and maintenance over the expected life of the projects.

- Remember these three strategies are intertwined.
- Consider how to blend these three strategies.
- Evaluate the cost of land acquisition. What do conservation easements cost? What does maintenance cost? This should be included in the benefit-cost analysis.
- Recall that the three strategies have a landowner component.
- Consider the different costs in different areas.
- Add land rights cost in the benefit-cost analysis, this is an upfront cost.
- How will you make the distinction between conservation, restoration, and land acquisition? A clear distinction among activities is important when serving polluters and those affected.
- Long-term valuation and costs of each should be clearly defined as best as possible, not just implementation costs.

Work with the agricultural community and partners in the watershed to conduct a subwatershed-scale analysis of existing agricultural BMPs and opportunities for implementation of additional agricultural BMPs.

- Re-evaluate existing agricultural BMPs to see if they are effective.
- Consider William Penn's suggestion for an individual watershed- or subwatershed-level analysis for recommendations. William Penn suggested the analysis occur at the lowest possible scale.

Because current data reflects an increase in nitrogen levels in the watershed, implement real-time nitrogen monitoring at locations strategically selected to determine why levels are increasing and what the sources of the increased loads are.

- Consider that nitrogen levels are increasing around state borders.
- Consider the possibility of increased monitoring—possible help from Stroud.
- Review national trends away from coal-fired power having possible effect, hoping to see peak/downward side of a bell-curve effect with nitrogen.

Develop a decision-making process for prioritizing implementation of the conservation plan and leveraging local investments with state, federal, and private foundation investments.

- Conserve vs. restore.
- Consolidate plans, mirror themes from case studies/existing watershed plans.
- Consider why "urban" is excluded from this recommendation? At least half of the stakeholders will be interested in the urban aspects.
- Consider the recommendation that TMDL not be the "end goal" because waterways will still be impaired.

- Consider making TMDLs a guideline, with fixing impaired streams as the end goal. Correct context of report.
- Remember that the TMDLs are based on the 1996 assessment. In 2014 DEP integrated the 303d list to augment the impaired maps.
- Remember that scale of analysis is also important: it's important what, when, and where.
- Focus on the lowest possible scale. Different strategies are necessary across the various subwatersheds.
- Evaluate the cost of doing nothing (long-term risk-management assessment).
- Clarify that the focus on nitrogen and sediment is not the only way to go.
- Consider how you include limits of future growth and development.
- Think about focus on demanders and suppliers rather than cost/benefit because it doesn't always gain traction. This puts you in a good economic framework.

Recommendation #4
Recognize that water purveyors and municipalities will have different motivations for participating, and structure the Brandywine-Christina Water Fund to ensure that the needs of both stakeholders groups are met.

- Consider whether water purveyors are concerned about nitrogen. Are drinking water systems affected? Sediment and bacteria are the biggest concerns. At this time, water purveyors are more concerned with Phosphorus as a pollutant than Nitrogen, but if the standard decreases things change.
- Understand that lowering Nitrogen levels in the future could become exorbitantly expensive versus addressing the pollutants now.
- Consider that right now Phosphorus is serving as the limiting factor in waterways.

Recommendation #5
Work with partners who have preexisting relationships with the agricultural community to develop a firm understanding of the community's business realities, needs, and concerns. Structure the Brandywine-Christina Water Fund to address those realities, needs, and concerns.

- Use general terms for complex issues.
- Focus on who is seeing what and the terms that are used. How do we communicate the nuances to the stakeholders who are relying on improvement that will make them want to work with this group?
- Consider how to communicate these nuances to the agricultural community. There is a need for buy-in from the agricultural community.
- Think about being more straight-forward and honest; everyone (including urban) will have to "pony up."
- Think about your intended audience versus the expected audience. Who will the audience really be? Focus energy on that. Think about the media.
- Remember, the report will be reviewed by William Penn, so it must be written to their standards/preferences.

- Think about taking out "partners who have pre-existing relationships with" and make it simply "work with the agricultural community."
- Account for a large range in agricultural operational sizes and functions.
- Acknowledge a lack of understanding and convey desire to better understand needs.
- Work to build the agricultural community's trust.
- Expand the target to meet all conservation needs. The Chesapeake Bay model is "every BMP everywhere." The reality is all areas matter, the "packaging matters."

Recommendation #6
Encourage regulators to consider alternative approaches to achieving regulatory compliance.

- Consider this as an area of high importance.
- Recognize this area is unique, therefore solutions will be unique and need to be tailored to fit.
- Define "alternative," meaning either in addition to existing plans/policies or as a change to them.
- Put emphasis on encouraging green infrastructure versus pipes and pipelines.
- Present options as a whole, as opposed to simply presenting effects on one area.
- Develop an approach that is flexible. On the regulatory side you need to meet a number and the flexibility is how you meet that number.

Recommendation #7
Develop a legal and governance structure for the Brandywine-Christina Water Fund that reflects the needs of stakeholders and addresses any issues related to the interstate nature of the watershed.

- Provide for geographic equity.
- Keep it simple, but respect state line. What are the states' roles?
- Most case studies reviewed were not state-driven; they were generally locally driven.
- Recall that some interviewed parties made it clear that they would not participate if government was leading/involved (not sure to what extent).
- Remember that it is important to leverage private and public dollars.

Recommendation #8
Finance the Brandywine-Christina Water Fund in stages to ensure its viability, possibly beginning with voluntary contributions from a first round of stakeholders and adding additional phases of investment according to the needs of other stakeholders and investors.

- Make the findings of this study clear.
- Include context. Are Recommendations #1–6 a continuing discussion or are we definitely planning on following up?
- Strike implementation; you are still developing.
- Make it clear that it is efficient to build another entity to distribute funds, or not?
- Clarify funding strategies; this will drive others involvement. The current strategy language is too loose and needs to be further defined.

- Work with experts from other panels (i.e., UMD, EFC) on the finance discussion.
- Begin with smaller-scale funding before moving up to larger-scale/more sustainable sources.
- Possibly start with private money to set up infrastructure, which will hopefully open up more avenues of investment.
- Consider that existing plans may be sufficient, no need for another plan.

Recommendation #9

Employ coordinated and robust communications and outreach strategies to ensure that all necessary constituencies (e.g., ratepayers, legislators, regulators, and the agricultural community) understand and support the Brandywine-Christina Water Fund.

- Need to edit what you are representing to be accurate.
- Note that in the report it states that work is underway to develop the fundraising structure, premature to state in report.
- Use wording that is clear to potential future partners and investors.
- Consider that communications should be adaptable and understandable to new members.

Meeting Attendees

ADVISORY PANEL MEMBERS	
Jennifer Adkins	Partnership for the Delaware Estuary
Ed Ambrogio	USEPA, Region 3
Jan Bowers	Chester County Water Resources Authority/CTIP
Kevin Donnelly	New Castle Conservation District
John Goodall	Brandywine Conservancy
Michael Leff	Urban Waters Federal Partnership
Rhonda Manning	Pennsylvania DEP, Southeast Regional Office
Adam Mowrey	Chester County Conservation District
Kenneth Najjar	Delaware River Basin Commission
Donna Siter	Western Chester County Chamber of Commerce
Christian Strohmaier	Chester County Conservation District/CTIP
Bob Struble	Brandywine Valley Association/CTIP
Brittany Sturgis	Delaware DNREC
Bern Sweeney	Stroud Water Research Center

PROJECT TEAM MEMBERS	
Brian Boutin	The Nature Conservancy in Delaware
Andrew Homsey	Water Resources Agency, Institute for Public Administration, University of Delaware
Richard Jones Jr.	The Nature Conservancy in Delaware
Gerald Kauffman	Water Resources Agency, Institute for Public Administration, University of Delaware
Ellen Kohler	The Nature Conservancy in Delaware
Martha Narvaez	Water Resources Agency, Institute for Public Administration, University of Delaware
Kash Srinivasan	KS Group, LLC
Martin Wollaston	Water Resources Agency, Institute for Public Administration, University of Delaware

INTERVIEWED STAKEHOLDERS AND OTHER MEETING ATTENDEES	
Laura Askin	Water Resources Agency, Institute for Public Administration, University of Delaware
Seung Ah Byun	Brandywine Conservancy
Clare Billett	William Penn Foundation
Tom Coleman	City of Newark
Jen Holloran	Water Resources Agency, Institute for Public Administration, University of Delaware
Ann Hutchinson	Natural Lands Trust
Tony Fernandes	Aqua Pennsylvania
INTERVIEWED STAKEHOLDERS AND OTHER MEETING ATTENDEES, CONTINUED	
Amy Kincaid	Institute for Conservation Leadership
Matt Ludington	Water Resources Agency, Institute for Public Administration, University of Delaware
Matt Miller	City of Wilmington
Kristen Molfetta	Water Resources Agency, Institute for Public Administration, University of Delaware
Shane Morgan	White Clay Wild and Scenic
Dan Nees	Environmental Finance Center, University of Maryland
Joanne Rufft	Artesian Water
David Shields	Brandywine Conservancy
Naomi Standing	Environmental Finance Center, University of Maryland
Joanne Throwe	Environmental Finance Center, University of Maryland

APPENDIX B – WATER FUND CASE STUDIES SUMMARY TABLE

Water Fund	Location	Comments	Rate	Revenue
Flagstaff Watershed Protection Project	Arizona	Reforest national forest land. Supported by 74% of Flagstaff voters.	$25/yr	$10,000,000
Tucson Conserve to Enhance	Arizona	Voluntary check box, property tax surcharge	$3.56/month	$15,000/yr
Central Arkansas Water	Arkansas	Voluntary water bill donation	$0.45/month	$996,000
Murray Darling Basin Water Trading Program	Australia	Reforestation for salinity control	$45/ha/yr	
California Beverage Recycling Program (Tax Surcharge)	California	Link between alcohol hops and agricultural water use	$0.01/bottle	
California Tobacco Health Protection Act (Tax Surcharge)	California	Tobacco is an agricultural product with water demand and water pollution impacts.		
Watershed and Environmental Improvement Program, San Francisco	California	Hetch Hetchy Reservoir serves 2.6 million customers.	PUC budget	$5,000,000
Truckee River Fund	California Nevada	Truckee Meadows Water Authority contributed an initial $340,000.	2% of annual budget	$9,200,000
Denver Water From Forests to Faucets	Colorado	Partnership includes cost share with U.S. Forest Service to restore headwater forest watersheds.	$0.04/1000 gal	$16,500,000
Colorado Healthy Rivers Fund	Colorado	Check-off option on state income tax return	$5.00/taxpayer	$650,000
Pitkin County Healthy Rivers and Streams Fund Program	Colorado	Sales tax	1%	
Great Outdoors Colorado	Colorado	Lottery proceeds		FY 2000 $44,000,000
Colorado Water Conservation Board	Colorado	Severance tax		FY 2013 $38,444,000
Bear Creek Watershed Association Trading Program	Colorado		$5,000/lb P	
Colorado River Water Bank	Colorado	Front Range municipalities pay for Western Slope water rights.	$100–$400/ac-ft	
Water Utility Bill Roundup	Colorado		$6.00/DU/yr	
Saugatuck River Watershed Conservation Compact	Connecticut	Compact of 11 towns along Long Island Sound	Fund administrator	
Long Island Sound Nitrogen Credit Exchange Program	Connecticut		$5.42/lb N	
Fondo Nacional de Financiamiento Forestal (FONAFIFO)	Costa Rica	Reforestation for freshwater supply	$45–$116/ha/yr	
Green Credit Card Fee	Delaware		$0.02/transaction	
DRBC Water Use Charge	Delaware Pennsylvania New Jersey	Since 1977, DRBC imposed a use charge on water withdrawals.	$0.08/1000 gal	$3,000,000
Fondo para la Protección del Agua (FONAG)	Quito, Ecuador	Initial funds are from TNC followed by the electric company and brewery.	1% water sales monthly	6 years $11,500,000

Water Fund	Location	Comments	Rate	Revenue
Florida Ranchlands Environmental Services Project	Florida	$7 million		$7,000,000
N. Everglades-Payment for Environmental Services Program (NE-PES)	Florida	$46 million through 2016	$134/ac-ft	Through 2016 $46,000,000
Les Agences de L'eau	France	User fees from dischargers in six water basin agencies	Fees on water bills	
Carroll County Water Authority	Georgia	Water utility budget		$11,840,455
Genossenschaften	Germany	Ruhr Water Associations		
Bottled Water Surcharge Chicago	Illinois		$0.05/bottle	
Performance-Based Incentives for Agricultural Pollution Control	Iowa	Iowa Farm Bureau: $90,000; Iowa corn growers: $180,000; grants: $978,000		$1,250,000
City of Lenexa	Kansas	Landowners with priority parcels and enrolled in NRCS cost-share programs		
Crooked River Initiative	Maine		Grant/reimbursement	$250,000
Chesapeake Bay Restoration Fund	Maryland		$2.50/DU/month	$65,000,000
Chesapeake Bay Commemorative License Plate Fee	Maryland		$25/license plate	
Potomac Water Fund	Maryland	TNC program		
SRBC Water Use Charge	Maryland Pennsylvania	In FY11, $590,000 from natural gas, $2,700,000 from other user fees	$0.29/1000 gal	
Quabbin-Wachusett	Massachusetts	Revenue includes bond funds and ratepayer fees.		$130,846,485
Minnesota Clean Water Fund	Minnesota	Water user fees		$201,960,000
Montana Water Project	Montana	Trout Unlimited water lease		
Polders	Netherlands	Dutch Water Boards – water board tax		
NJ Water Supply Authority Manasquan River Watershed	New Jersey	Surcharge on water supply withdrawals	$0.97/1000 gal	
Santa Fe Watershed Plan – Water Management	New Mexico	Cost share with U.S. Forest Service	$0.13/1000 gal	$200,000
New York City Source Water Protection Program	New York	Revenue includes utility user fees and bonding.		$1,500,000,000
Common Waters Fund (CWF) Upper Delaware River	New York Pennsylvania		Grant/reimbursement	
Regional Catchment Councils	New Zealand	Waikato-Waipa catchment rates	$27.73/property rate	
Agua por La Vida y la Sostenibilidad (FAVS)	Colombia	Constructs sustainable water systems		6 years $7,100,000
Upper Neuse Clean Water Initiative – Raleigh	North Carolina	Watershed protection fees in Raleigh and Durham	$0.40/month/hh	$400,000,000, $2,000,000
Cape Fear River Water Fund	North Carolina			

Water Fund	Location	Comments	Rate	Revenue
Tar-Pamlico Basin Association	North Carolina			
Mountain Island Lake	North Carolina	Revenue includes bond funding and a dedicated fee on the water bill.		$35,000,000
Willamette Partnership – Ecosystem Marketplace	Oregon			
The Freshwater Trust	Oregon			
Eugene Water & Electric Board – McKenzie Watershed	Oregon	Voluntary Incentives Program	$1.13 (potential?)	$225,000
Blue Water Program – Deschutes River	Oregon	Voluntary contribution added to water bill	$1.60 to $6.40/month	$14,544
Tualatin River Watershed – CWS Shade Credit Program (Hillsboro)	Oregon		Annual rental (utility to landowner)	
Bull Run Watershed – Portland	Oregon		City and USFS budget	$500,000.00
Schuylkill Action Network	Pennsylvania	Administered by Partnership for the Delaware Estuary		$400,000,000
Chesapeake Bay Nutrient Auction	Pennsylvania		$2.90/lb N	
Rhode Island Aqua Fund, RI Water Resources Board – Narragansett Bay	Rhode Island	Penny per 100 gallon	$0.10/100 gallon	
Confederaciones Hidrográficas	Spain	Polluter pays levies, water use charges, and discharge fees		
San Antonio Water Fund	Texas	Sales tax resulted in 6,500 acres protected from 2000 to 2005, TNC role	1/8 cent sales tax	$5,400,000 - $128,000,000
USDA Farm Bill Programs	United States	Soil conservation for farmers	$125/ha/yr	
Salt Lake City	Utah	Operating budget allocation	$1.50/meter/mo	$1,500,000
White River Partnership Landscape Auction	Vermont	Grant funding from USDA NRCS and U.S. Forest Service.		
Lake Whatcom Watershed – Bellingham	Washington	Voter-approved sales tax	$5/mo + $0.64/100 cf	
Cedar River Watershed – Seattle	Washington	Voter-approved sales tax		$82,000,000
Lake Whatcom – Bellingham	Washington		$5/month+$0.64/CCF	$1,807,142.86
Stormwater Utility – Wilmington/Philadelphia	Delaware Pennsylvania		$2.71, $10.80/month	$4,000,000-20,000,000
H2Oscore	Wisconsin	Voluntary reductions are matched by local businesses.	$.01/gallon	

APPENDIX C – IN-DEPTH SUMMARY OF 12 WATER FUND CASE STUDIES

AGUA POR LA VIDA Y LA SOSTENIBILIDAD (FAVS)

Location	East Cauca Valley, Colombia
Watershed and Acreage	14 watersheds, 483 sq. mi.
Population	900,000 people
Partners	Donors include ASOCAÑA, an association of 13 sugar mills (the largest water users in the region); Corporación Autónoma regional del Valle del Cauca (CVC); ECOPETROL; PROCAÑA; PAVCO Pipelines; The Nature Conservancy; Sab Miller Bavaria; The United Nations Children's Fund (UNICEF); United States Agency for International Development (USAID).
Revenue and Rates	Voluntary donations of $3,891,340 from partners and $1,000,000 leveraged through December 2013
Acres Enrolled/Protected	19,000 acres protected 198 springs protected 1,600 families benefited 14 institutions strengthened 20 projects funded The practices supported include: - Paramos (high-altitude Andean grasslands) and forest conservation - Paramos and forest restoration - Fencing of riparian buffers - Cattle-ranching and agriculture best-management practices - Environmental education and awareness - Environmental-friendly small local businesses

Description of Program
The two primary goals of the fund are base flow maintenance and the reduction of sediment load. As in many other Andean regions, use of the upper watersheds for cattle grazing and small-plot farming has led to altered water supplies, increased erosion and landslides, diminishing water quality, and new challenges for irrigation.

A cooperative agreement was signed by ASOCAÑA, nine associations of users of the Cauca Valley's rivers (grassroots organizations), the Vallenpaz Foundation, and TNC. The parties committed to developing a conservation program in line with TNC's studies and creating a structure to manage implementation. They agreed to establish a board of directors with representatives from all partner institutions, appoint a technical secretary to carry out projects, and contribute resources to a trust fund to guarantee transparency in their management and earn interest. ASOCAÑA initially allocated $1.8 million to cover operational costs, the technical secretary's salary, and the necessary funding for conservation projects in accordance with the guidelines provided in the TNC's studies. Since its creation in 2009, seven new river users associations have been accepted as partners, as well as CENICAÑA, a top-level research center that promotes sugar cane research, and Procaña, a trade association of sugar cane producers. Projects are selected after review of submissions in response to a call for proposals. FAVS and the selected beneficiaries enter into bilateral agreements to implement the projects.

History of Program
The sugar sector had been working in the region for 15 years on reforestation projects, source water protection, nurseries establishment and wastewater management improvement. In 2009, TNC helped the partners develop a process to prioritize projects that relied on models outputs and social preferences, design a sustainable funding mechanism, and implement a transparent governance mechanism.

Current Status
Ecosystem services will be monitored in two pilot watersheds by CENICAÑA with support of the local communities following a protocol designed under an agreement between TNC and CENICAÑA, and supported by USAID funding of $300,000. The monitoring has hydrologic, biological, and socioeconomic components. This protocol is in the final phase of design and will be implemented in the field soon. FAVS is also seeking to capitalize the endowment fund to cover operations.

CENTRAL ARKANSAS WATER (CAW)

Location	Greater Little Rock–North Little Rock, Arizona
Watershed and Acreage	Lake Maumelle and Lake Winona watersheds; 115,520 acres total
Population	388,000 customers
Partners	City of Little Rock, City of North Little Rock, Pulaski County, The Nature Conservancy, Audubon Arkansas, Arkansas Game and Fish Commission, Arkansas Forestry Commission, Arkansas Natural Resources Commission, U.S. Forest Service (USFS)
Revenue and Rates	CAW charges a Watershed Protection Fee based upon meter size with a charge of $0.45/month for a typical household (Table 1). The fee raises approximately $1 million/year for land purchases, debt service on larger land purchases, and administration of the Watershed Protection Program. If the Watershed Protection Fee account exceeds $3,000,000, the fee is not billed until the account balance is $2 million.
Acres Enrolled/Protected	CAW owns and manages 9,433 acres surrounding Lake Maumelle (as of 2012). Stewardship activities are coordinated beyond CAW-owned lands with other conservation landowners (e.g., USFS) and the general public.

Description of the Program
The CAW "Watershed Protection Fee" was created to fund measures to protect Lake Maumelle and Lake Winona from sediment, pollution, and other sources of possible contamination that affect drinking water quality. The board of commissioners of the utility allocates the funds to generate the Watershed Protection Program. The program targets the acquisition of priority lands as buffers for reservoirs, implements appropriate stewardship techniques, and funds extensive water quality monitoring.

The USFS is a primary partner in the Lake Winona watershed. Lake Winona is surrounded by Ouachita National Forest. The partners coordinate closely on stewardship activities that preserve water quantity and quality, including controlled burns and ecological thinning. In the Lake Maumelle watershed, activities are guided by the strategies outlined in the Lake Maumelle Watershed Management Plan such as prohibition of wastewater discharges, erosion control guidelines for new development, set asides of undeveloped land, purchase of at least 1,500 additional acres, management of CAW-owned lands and allowances for low impact public and recreational uses, and expanded water quality monitoring.

History of the Program
The CAW is a public utility formed through a merger of Little Rock Municipal Water Works and the North Little Rock Water Department in 2001. Recognizing the need for adequate protection of the reservoirs to achieve its goals, CAW worked with the Arkansas Department of Health to complete a Source Water Vulnerability Assessment. This process summarized the potential for drinking water contamination, as well as potential sources.

Considerable attention was focused on protecting the Lake Maumelle watershed. Nearly 25 partner organizations served on policy and technical advisory councils to guide the planning process for the watershed management plan. Although the watershed is approximately 80% forested, it was determined to be vulnerable to future development and other land use changes as stormwater from the surrounding lands drain into the lake. The plan is the basis for the majority of activities conducted by the Watershed Protection Program and was the impetus of the approval for the Watershed Protection Fee in 2009.

Current Status
The Watershed Protection Fee was established as a monthly base rate that increases with meter size. The fee costs homeowners an average of $0.45/month and generates approximately $1 million. Since implementation of the fee, CAW has acquired nearly 1,800 acres of lands, conducted numerous controlled burns to reduce woody debris, increased the intensity and extent of water quality monitoring, and worked with Pulaski County and the state of Arkansas to adopt ordnances and regulations that prohibit the surface discharge of wastewater throughout the Lake Maumelle Basin and set limits for stormwater pollutant loads.

TUCSON CONSERVE TO ENHANCE (C2E)

Location	Tucson, Arizona
Watershed and Acreage	N/A
Population	775,000 people
Partners	Tucson Water, University of Arizona Water Resources Research Center (WRRC), Sonoran Institute, Watershed Management Group, Inc.
Revenue and Rates	$40,000; donation amounts vary
Acres Enrolled/Protected	3 million gallons of water conserved

Description of the Program
The Tucson Conserve to Enhance (C2E) program links water conservation efforts with watershed restoration and enhancement to ensure that water conservation will translate into benefits for the environment. Participants conserve water, track the money saved through water conservation practices, and then donate their savings to C2E. The funds generated by program participants are overseen by a community advisory board, which chooses the beneficiary water enhancement projects within the Tucson community. Funds donated go directly to the environment to protect and restore desert rivers, create instream flows needed for a healthy ecosystem, and increase groundwater levels. Donations have come directly from participant water savings and the "Conserve to Enhance" checkbox on Tucson Water monthly bills.

History of the Program
The program was initiated in Tucson in 2011. The Tucson Conserve to Enhance Program is a collaborative program managed and developed by the Sonoran Institute, the University of Arizona's Water Resources Research Center (WRRC), and the Watershed Management Group, Inc. This program is piloting the WRRC's concept. Its research outlines the difficulty in securing water for riparian restoration projects and reviews some current efforts to link individual water users to environmental enhancement.

Current Status
The program funded projects in 2013. This is one of three Conserve to Enhance projects using this structure developed by the University of Arizona's WRRC.

CROOKED RIVER INITIATIVE

Location	Portland, Maine
Watershed and Acreage	Part of the Presumpscot watershed; the Crooked River joins the Songo River, which runs into Sebago Lake; Crooked River drainage area 275 square miles containing 76,000 acres of predominantly forested land
Population	The Portland Water District (PWD) serves a population of 200,000 in the Greater Portland area.
Partners	Loon Echo, Upper Lovell, Upper Saco Valley, and Western Foothills Land Trusts; Portland Water District
Revenue and Rates	Voluntary protection initiative supported by the land trusts and by a grants program funded by the PWD; the budget for the grant program is approximately $40,000 annually.
Acres Enrolled/Protected	1,500 acres

Description of the Program
The Presumpscot watershed is ranked number 1 out of 540 forested watersheds in the Northeast experiencing development pressure by the USDA Forest Service study, "Forests, Water and People," published in 2009. Lake Sebago is the primary water supply source for the PWD; the water is currently clean enough to avoid filtration. PWD owns 2,500 acres of forested lands in the area around its intake. The program partners use traditional land trust techniques to conserve privately held forested lands, supported by private donors and by a PWD grant program that contributes between 0% and 25% of the estimated conservation value for qualifying projects on a case-by-case basis.

History of the Program
PWD enacted Land Conservation Policy in 2007 to "support measures to preserve Sebago Lake watershed land in perpetuity and to provide open space for lake-friendly public access. The District acknowledges that it is neither feasible nor necessary to own all land in the watershed. Instead the District will cooperate and partner with organizations and individuals who seek to conserve and manage their watershed lands in a manner that protects water quality and therefore protects the health of drinking water consumers." The Land Conservation Program, supporting land conservation in perpetuity, was instituted in 2013.

Current Status
The land conservation strategy is embodied in its "Policy for watershed land conservation outside the two-mile limit [surrounding its water intake]" and explicitly authorizes direct district support for conservation easements or other types of landowner agreements and contributions to conservation groups seeking to protect watershed lands. PWD and the land trusts directly own land and hold conservation easements in the watershed.

DENVER WATER FROM FORESTS TO FAUCETS PARTNERSHIP

Location	Denver metropolitan area in Colorado and Rocky Mountain region of the U.S. Forest Service
Watershed and Acreage	South Platte River, 3,400 sq. mi.
Population	Watershed supplies 1.3 million people with drinking water in the Denver metropolitan area
Partners	Denver Water and the Rocky Mountain Region of the USDA Forest Service
Revenue and Rates	Denver Water increased water rates by $0.14/month/household or $0.04/1,000 gallons of water withdrawn. Denver matches the U.S. Forest Service $16.5 million to raise $33 million total.
Acres Enrolled/Protected	4,700 acres treated

Description of the Program
Denver Water and the U.S. Forest Service have a shared interest in improving forest and watershed conditions to protect water supplies and water quality and continue providing other public benefits such as wildlife habitat and recreation opportunities. The U.S. Forest Service administers more than 14.5 million acres of the National Forest System in Colorado, and nearly 90% of these lands are located in watersheds that contribute to public water supplies. Colorado's forests are critical to the water supply for tens of millions of Americans, billions of dollars of agricultural production, and vast economic activity from California to the Mississippi River. Forest treatment and watershed protection activities can help minimize sedimentation impacts on reservoirs and other water infrastructure by reducing soil erosion and the risk of wildfires.

History of the Program
Following wildfires in the Rocky Mountain headwaters, Denver Water has spent more than $26 million on water quality treatment, sediment and debris removal, reclamation techniques, and infrastructure projects. State and federal agencies spent more than $42 million. The U.S. Forest Service has spent $37 million on restoration and stabilization to protect wildlife habitat, esthetics, tourism, and recreation values. Denver Water's collection and delivery infrastructure receives water from snowpack and streams on national forest lands. The From Forests to Faucets partnership is a payment-for-ecosystem-services mechanism that connects downstream water users to upstream forests that protect their water supplies.

Current Status
Both the USFS and Denver Water were struggling to meet their budgets, so the Forest Service's Rocky Mountain office signed an MOA with Denver Water to raise $33 million to proactively manage 38,000 critical acres in five key watersheds, if Denver Water provided half the money. By spending money to save in the long run, the utility agreed to finance the removal of dead trees and the extermination of beetles in sensitive areas with steep slopes and other key features by implementing water fees that will amount to about $27 dollars per household over the next five years.

This targeted spending is typical of payment for ecosystem services (PES) that finance the preservation of nature by recognizing the economic value of nature's services and convincing beneficiaries to pay those who deliver the services. Such schemes offer more transparency and accountability than do normal governmental structures. Ecosystems are the watersheds being protected, and the ecosystem service is the provision of water.

SAN ANTONIO WATER FUND

Location	San Antonio, Texas
Watershed and Acreage	Edwards Aquifer, 4,400 sq. mi.
Population	1.4 million
Partners	City of San Antonio, The Nature Conservancy
Revenue and Rates	Funded through municipal bonds repaid by voter approved 1/8 cent sales tax; $225,000,000 since 2000
Acres Enrolled/Protected	116,683 acres protected since 2000

Description of the Program
The primary threats to the aquifer stem from drought and rapid growth. The only source for drinking water for the city is groundwater, so the program is designed to protect sensitive lands over the aquifer's recharge zone. The City of San Antonio developed a model to identify properties that most effectively recharged the aquifer. The first round of properties protected by the program were purchased in fee by the city and became natural areas managed by the city's parks and recreation department. The second two rounds of funding have funded conservation easements acquisition held by the city.

History of the Program
The funding program began in 2000 when the first sales tax was approved. The sales tax was reauthorized in 2005 and 2010. The first proposal was packaged as an open space initiative creating a new network of city parks over the recharge area. The funding was to be used for acquisition of properties and support of operations and maintenance of these lands. The initiative benefited from a supportive public that understood the water scarcity issue and participated in water conservation; per capita water use in the city has declined significantly since the 1980s. The public was also aware of Edwards Aquifer as a result of news about the rare species dependent on the aquifer and Endangered Species Act litigation.

Current Status
The Nature Conservancy is currently helping the city assess benefits; groundwater benefits are difficult to measure. It is assumed that the program results in cost-savings because groundwater needs less treatment than surface water. There is concern about the public's sensitivity to taxes and supply of suitable land tracts. The sales tax is approved through 2015.

EUGENE WATER & ELECTRIC BOARD
MCKENZIE RIVER

Location	Rhode Island and the Providence metropolitan area
Watershed and Acreage	McKenzie River watershed encompasses an area of approximately 1,300 sq. mi. in Lane and Linn Counties, Oregon. Eugene Water & Electric Board (EWEB) believes that 6,500 acres of riparian forests and floodplain areas are eligible to participate in its program.
Population	EWEB serves 50,000 water customers and 87,000 electric customers in Eugene and nearby communities. The service area spans approximately 236 sq. mi.
Partners	Upper Willamette Soil and Water Conservation District (SWCD), McKenzie Watershed Council, McKenzie River Trust (Land Trust), and Cascade Pacific Resource Conservation and Development
Revenue and Rates	The board proposes to annually set aside rate revenues of $200,000 to $250,000 and is considering other measures including a bond measure, corporate sponsorship, development mitigation fees (conceptually similar to wetland offsets), and new tax revenues generated by the Upper Willamette SWCD to be targeted to conservation activities.
Acres Enrolled/Protected	N/A

Description of the Program
Landowners are compensated for continued stewardship of their high-quality riparian forests or wetland areas through a valuation formula based on valuation studies for the watershed conducted by Earth Economics. Remote sensing and property visits will be used to monitor compliance. Interested landowners whose properties do not meet EWEB's standards are directed to other programs (e.g., USDA NRCS's Environmental Quality Incentives Program) for assistance with bringing their properties up to EWEB's minimum standards.

History of the Program
The vision articulated in a report prepared for EWEB by the Institute for Natural Resources (part of the Oregon University System) in 2012. EWEB expects to partner with the Upper Williamette Soil and Water Conservation District (SWCD) and the McKenzie Watershed Council to conduct the initial quality assessments of properties of interested owners, with the McKenzieRiver Trust (Land Trust) and SWCD to negotiate and hold agreements, and with the Cascade Pacific Resource Conservation & Development to manage the fund.

Current Status
The program is at a conceptual stage. EWEB will establish the boundaries of the Voluntary Incentives Program (VIP); establish criteria for participation (by adapting existing riparian forest and wetland habitat standards from NRCS, U.S. Forest Service, Willamette Partnership, Defenders of Wildlife, and other entities); establish the institutional infrastructure for managing the program, disbursing funds and tracking compliance; conduct market planning, education, outreach, and marketing activities; and establish a dashboard reporting system to provide information on the VIP to the public.

NORTHERN EVERGLADES – PAYMENT FOR ENVIRONMENTAL SERVICES PROGRAM (NE-PES)

Location	Everglades Region, Florida
Watershed and Acreage	Lake Okeechobee watershed, 4600 sq. mi.
Population	Approximately 300,000 people
Partners	World Wildlife Fund; South Florida Water Management District (SFWMD); Florida Department of Agriculture and Consumer Services (FDACS); Florida Department of Environmental Protection (FDEP); and the USDA NRCS
Revenue and Rates	Pilot raised over $7 million from NRCS Conservation Innovation Grants; SFWMD; FDACS; USEPA; and the W.K. Kellogg Foundation. SFWMD NE-PES program has designated $46 million in funding for five years.
Acres Enrolled/Protected	Over 171,000 acre-feet of storage created

Description of the Program
The program is designed to provide ranchers with a new source of income and an incentive to implement on-ranch water management practices that are economically viable and support ecosystem restoration in the Northern Everglades. Ranchers are participating; they also value this opportunity to provide a public service and demonstrate their land stewardship. SFWMD includes the program as dispersed water management. It defines the benefits as:

- Ecological improvement projects are enhanced because excess water goes to the lake during the wet season, reducing the volume of discharges to estuaries.
- Retained water reduces nutrient loading to downstream systems by reducing the water volume delivered.
- Detained water reduces nutrient concentrations in runoff as it slowly flows across the landscape.
- Shallow groundwater recharge opportunities are expanded.
- Habitats for native plants and wildlife are improved when wetlands are rehydrated.

Ranchers sell either water retention or phosphorus reduction services to the SFWMD. Projects are chosen through a reverse auction-process, whereby multiple ranchers compete to sell their services. The reverse auction allows ranchers to name their price, which fosters ranch participation, and enables the district to select and fund the most cost-effective environmental services. Ranchers proposing projects must use one of two NE-PES–approved methods to estimate the average annual change in water retention or nutrient removal. The SFWMD and selected ranchers enter into contracts outlining yearly payments based on a load reduction averaged over ten years to ease uncertainty

History of the Program
In 2003, the World Wildlife Foundation (WWF) and six ranchers formed an ad hoc group to identify and explore opportunities to recognize and enhance both the ecological value and the economic viability of cattle ranching, the dominant land use in the Northern Everglades region. The group decided to evaluate the potential for water management projects on ranchlands to provide water and phosphorus retention services in a cost-effective manner to help address the significant water quality and flow problems to Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries.

The program started as a five-year pilot project involving eight selected projects. During the pilot phase, participants were paid a participation fee. These were bilateral agreements for a fixed term. One rancher received an annual payment of $93,333, 5% of overall ranch revenue in 2009. This payment covered operating costs, offset the risk of high water levels that reduced cattle production during wet years, and compensated for the large declines in sod production the ranch experienced due to the housing downturn. The five-year pilot not only provided "proof of concept," but it also allowed for an iterative design process and troubleshooting along the way. With huge public demand for increased water retention and nutrient reduction in the Northern Everglades region, the water management district was keen to pursue a PES model as a financially sound approach, allowing the transition from pilot to program.

Current Status
Eight projects were approved by NE-PES for 2012.

NEW JERSEY WATER SUPPLY AUTHORITY
MANASQUAN RIVER WATERSHED

Location	Monmouth County, New Jersey
Watershed and Acreage	82.4 sq. mi. watershed; townships and boroughs in the watershed: Manalapan, Freehold, Howell, Colts Neck, Brick, and Wall townships, Freehold, Farmingdale, Point Pleasant, Brielle, and Manasquan boroughs.
Population	The Water Supply Authority (NJWSA) operates the Manasquan Reservoir, a 4.7-billion-gallon pumped-storage reservoir fed by the Manasquan River. The reservoir serves a population of 250,000.
Partners	Garden State Preservation Trust and the NJ Department of Environmental Protection, NJ Department of Agriculture, county and municipal open space programs, and local land trusts
Revenue and Rates	Dedicated source water protection component of the regulated rate for water instituted in 2002. The fiscal year 2014 budget allocation to the Source Water Protection fund in the Manasquan Reservoir component was $112,536 out of a total revenue projection of $8.3 million.
Acres Enrolled/Protected	4,000 acres protected

Description of the Program
The NJWSA Watershed Protection Programs Division (WPPD) administers its Source Water Protection Program that develops detailed protection strategies for priority watersheds and implements these strategies through a variety of organizations. Source Water Protection funds are used to leverage state and federal dollars and to finance the acquisition of critical water resource lands through the NJ Environmental Infrastructure Trust financing program. NJWSA forms partnerships with other entities for cost sharing and management of preserved land parcels. The strategy depends on land preservation supported with funding from the Garden State Preservation Trust, the NJ Department of Environmental Protection and its Green Acres program, the NJ Department of Agriculture and its farmland preservation program, county and municipal open space programs, and local land trusts. The local funds are used to match the state funding. Some land is protected through voluntary donations of land or development rights to a land trust or government. Municipal zoning governs development, and some ordinances restrict development on critical areas.

History of the Program
The WPPD protects the water resources in three basins—the Raritan and Manasquan Rivers and the Delaware-Raritan Canal, beginning with the Spruce Run Initiative to protect lands in the vicinity of the Spruce Run Reservoir. The dedicated Source Water Protection Fund was created in 2002. The delineation of critical areas in the Manasquan watershed was completed in 2005.

Current Status
A total of 4,000 acres of critical lands (none so far in the Manasquan watershed) have been preserved through the program, including 316 acres of agricultural lands held as conservation easements. Of the total acquisition cost of $77 million, the authority contributed $15 million. The authority partnered with 26 governmental entities and 10 nonprofits to accomplish and manage these acquisitions.

RHODE ISLAND WATER RESOURCES BOARD – NARRAGANSETT BAY

Location	Rhode Island and the Providence metropolitan area
Watershed and Acreage	Narragansett Bay, 1,650 sq. mi., 60% of the watershed is in Rhode Island
Population	Watershed supplies 1.02 million people with drinking water in Rhode Island
Partners	Local governments and nonprofits
Revenue and Rates	In 1988, the state of Rhode Island contributed $15 million to start the fund. The Rhode Island Water Resources Board receives revenues from a $0.1664/1,000 gallons surcharge on water use that raised $4,289,538 in FY2010.
Acres Enrolled/Protected	2,410 acres protected

Description of the Program
The goal of the Rhode Island Aqua Fund is to remedy existing pollution of Narragansett Bay and to prevent future pollution of the bay. The state finances projects and programs with the proceeds of the Aqua Fund bonds at the direction of the director of the Department of Environmental Management (DEM) with the advice of the Aqua Fund Advisory Council. The fund is divided into five categories: (1) planning and program implementation, (2) pretreatment, (3) sediment and sludge abatement, (4) urban runoff, and (5) water supply to wastewater treatment. Municipalities and other governmental entities are eligible for urban runoff abatement grants. The twenty member Rhode Island Aqua Fund Council advises the director of DEM and is composed of the USEPA, wastewater treatment, Rhode Island League of Cities and Towns, commercial fishermen, local industries, and the public. The Aqua Fund has issued grants to Rhode Island cities and towns, University of Rhode Island, Save The Bay, Narragansett Bay Commission, Southern Rhode Island Conservation District, Brown University, and the New England Interstate Water Pollution Control Commission.

History of the Program
The Rhode Island Aqua Fund was established by voter referendum in 1988 to fund projects aimed at protecting and improving the water quality of Narragansett Bay. Legislation filed under RIGL 42-106 designated $15 million and a twenty-member Aqua Fund Council to advise the director of DEM in granting funds within four categories including planning, project implementation, wastewater treatment, and nonpoint source pollution.

Current Status
Since 1991, the Water Resources Board and Board Corporate have jointly administered a state surcharge levied on customers located in major water supply districts. The surcharge levied on every gallon of water used by customers (with the exception of senior citizens and commercial agricultural users) is collected by the state and deposited into the general fund and a corporate trust account. The money is used to offset costs of new infrastructure, pay down debt service on bonds, and cover a proportion of agency operations associated with supply functions. By law, a percentage of the surcharge is retained by the water suppliers to administer the water supply systems management planning program—36.1% for watershed protection and 57% for the state general fund-debt service.

SAUGATUCK RIVER WATERSHED PARTNERSHIP

Location	Fairfield County, Connecticut; outflows into Long Island Sound near Westport
Watershed and Acreage	Saugatuck River, 89 sq. mi.
Population	Drinking water supply for 300,000 people, mostly outside watershed (Aquarion Water Company, Bridgeport); residents within the watershed get water supply from private groundwater wells
Partners	Eleven municipalities; state, local and federal agencies; The Nature Conservancy; and other conservation partners
Revenue and Rates	Started with $71,000 in funding from federal grants, town contributions, private donations, and foundation support; agreement that four large towns would contribute $5,000/year, smaller towns would contribute $1,000/year; from 2005 to 2010, the partnership received $306,624.50 in donations from individuals and foundations and $243,849.47 in federal grants.
Acres Enrolled/Protected	Seven river miles opened to fish passage

Description of the Program
The partnership's mission is to protect and enhance the health of the watershed. The partnership will work collaboratively to link, maintain, and restore habitats that support healthy populations of diverse species and work to ensure the long-term social, economic, and environmental health and vitality of the communities in the watershed. The goals include:

- Promoting education and understanding of the watershed's natural resources.
- Protecting and restoring water quality in the watershed.
- Protecting and enhancing stream flow.
- Encouraging sound land use and management practices.
- Controlling invasive species.
- Restoring migratory fish passage.
- Working to establish protective development guidelines.
- Facilitating communication and collaboration among individuals, governments, and communities.
- Promoting research and distributing information about the watershed's management and health.

The partnership developed a conservation action plan (CAP) that identified the following threats: development, dams, land management, reservoir management/water withdrawal, and invasive species. The CAP includes a general focus on diadromous fish and a more specific focus on native brook trout.

History of the Program
Due to indications of stress to freshwater systems and at the request of a local official, TNC convened 80 representatives to develop a CAP. The Saugatuck River Watershed Partnership was established in April 2006 when the chief elected officials from the 11 towns within the Saugatuck River watershed signed a conservation compact recognizing the value of regional planning and a healthy watershed.

Current Status
Since the signing of the conservation compact, the partnership and its volunteers have conducted stream walk surveys that have assessed more than 60 miles of stream and riparian conditions within the watershed, undertaken fish passage projects that have opened up access to seven miles of river for migratory fish, and co-sponsored with the Norwalk River Watershed Initiative a sediment and erosion control workshop attended by 80 municipal representatives from 19 Connecticut towns.

Because of changing program structures within TNC, the work of the partnership is now coordinated by the South Western Regional Planning Agency and the Saugatuck River Watershed Based Plan. The partners convene on a quarterly basis to review project status and project development.

TRUCKEE RIVER FUND

Location	Lake Tahoe, California and Nevada and Reno, Nevada
Watershed and Acreage	Truckee River, 3,060 sq. mi.
Population	Watershed supplies 700,000 people with drinking water in Lake Tahoe and Reno, Nevada.
Partners	The Truckee River Fund's nonprofit partners include the Desert Research Institute, The Nature Conservancy, Keep Truckee Meadows Beautiful, Nevada Land Conservancy, Washoe County Sheriff's Office, Nevada System of Higher Education, Truckee River Watershed Council, Friends of Nevada Wilderness, City of Reno, City of Sparks, Nevada Department of Wildlife, Pyramid Lake Paiute Tribe, and Tahoe Regional Planning Authority.
Revenue and Rates	The fund was established by an initial $340,000 contribution by the Truckee Meadows Water Authority (TMWA) and is replenished by a contribution of 2% of the annual budget. To date, the Truckee River Fund has raised $9,200,000 and funded 101 watershed restoration projects.
Acres Enrolled/Protected	101 watershed projects completed

Description of the Program
The Truckee River Fund was created to fund projects that protect and enhance water quality and the watershed. The Truckee River's source is Lake Tahoe and is the primary water supply for many communities including Reno-Sparks. The river is increasingly threatened by aquatic invasive species, stormwater runoff, nonpoint source pollution, and erosion from recent wildfires. The river is an important recreational asset for northern Nevada for kayaking, fishing, rafting, and swimming.

The fund "shall be used exclusively for projects that enhance water quality and water resources of the Truckee River, or its watershed." The fund provides TMWA with a vehicle to respond to outside groups and organizations involved in improving the health of the Truckee River System and watershed, thus benefiting the primary water source for the community and TMWA customers. The fund is held at the Community Foundation of Western Nevada, a 501(c)3 nonprofit organization.

History of the Program
The Truckee Meadows Water Authority (TMWA) established the Truckee River Fund in 2004. Until then, no coordinated regional effort existed to foster ideas, research, educational outreach, and projects that would protect the Truckee River and water quality. When TMWA was formed in 2001 as a public utility, an opportunity arose to create a program to respond to this need. The TMWA Board of Directors created a nonprofit, tax exempt 501(c)3 program to fund projects to improve or protect Truckee River water quality. In 2005, the Nevada attorney general concluded that TMWA could legally make "charitable contributions" to the Truckee River Fund as long as the money would be spent on projects within the utility's jurisdiction, such as protecting its water source. A 2005 audit by the Nevada Bureau of Consumer Protection stated the creation of the fund was "Appropriate to ensure the continued access and use of TMWA's primary water supply commodity."

Current Status
TMWA is charged with the task of supplying customers with water that is safe and clean and meets all USEPA standards. All fund advisor and TMWA board meetings are publicized in advance and open to the public. The fund gives TMWA a mechanism to secure matching funds to complete projects at a much lower cost than if TMWA was paying the entire amount. All projects are recommended for funding by the Truckee River Fund advisors through an open and competitive request for proposal process and reviewed by the TMWA Board of Directors at a public meeting for final approval. The Truckee River Fund utilizes a nine-member advisory committee that equally represents and is appointed by the three political entities in the area: Washoe County, City of Reno, and City of Sparks.

APPENDIX D – STAKEHOLDER INTERVIEW SUMMARIES

STAKEHOLDER INTERVIEW – CITY OF NEWARK

August 27, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- Tom Coleman, Director of Public Works and Water Resources
- Tim Filasky, Assistant Director of Public Works

GENERAL TAKEAWAYS
- The city has set aside money for water quality monitoring in the White Clay.
- Partnerships are important with groups like the City of Wilmington, DNREC, etc.
- The City of Newark cannot go out for bonds without a referendum, therefore they can't efficiently access state revolving funds. (The Clean Water Initiative wouldn't work for them.)
- The Newark system is both surface- and groundwater-based, approximately 40% of its supply comes from wells. There is a lot of concern with the contamination with its wells, but they are dependent on them. The wells are cheaper to treat.
- The City of Newark is actively working on an alternate water supply pumping system due to the dam removal project.
- Newark's stormwater utility funds will initially focus on addressing flooding issues.
- Infrastructure improvements are a major focus for funding.
- If there work is being done in Pennsylvania, it is critical that there is equity between Pennsylvania and Delaware.

QUESTIONS
Who are the top water users? Do any water users have special requirements or sensitivities to water quality?
- University of Delaware
- Computer Science Corporation (CSC)
- DuPont
- Dow Chemical Co. (water sensitivities when flushing)
- McDonald's (water sensitivities when flushing)
- GE Aviation (water sensitivities when flushing)

What is the average volume of water delivered?
- Average volume in 2013 was 920 mg.
- Average daily demand is 3.4 mgd.
- Capacity is 6–7 mgd, 40% from wells.
- 10,000 service connections.

What considerations went into the discussion about the planned rate increases?
- The impetus was deferred maintenance, little investment in infrastructure. There has been more in the past five years.

What are the current expenses for the stormwater program (for above activities without salaries)?
- It includes all stormwater expenses and all utility expenses.
- The stormwater utility will fund infrastructure, not the MS4.
- Sediment and stormwater regulations – fee in lieu of money will be brought in and goes back to the state.
- The set aside for MS4 is $40,000/year; had an extra $13,000 from the previous year that got added to the budget.
- The stormwater utility will be based on impervious cover, and it is estimated to be effective sometime in 2015.

What are the city's priorities with respect to the water utility?
- Plant maintenance is a priority.
- There is a focus on pipes-in-ground infrastructure. The cost is approximately $1 million/mile, and the goal is to complete 1–1 ½ miles/year.
- Another priority is remote monitoring of facilities and automation.
- Dam removal (at the White Clay intake) is another priority. This requires redesigning the intake on the White Clay. The city had looked into horizontal drilling near the intake on the raceway, but this approach had many hurdles. We are now looking at a direct intake adjacent to the plant. The project will begin with a small pilot then expand. The estimated timing is as follows: design in 2015 and construction in 2016; the project will cost approximately $2.8 million. The design is still being developed.

What are the water quality problems in the White Clay that most affect the City of Newark?
- Nutrients
- Turbidity
- Cryptosporidium
- Contaminants in the wells (Potomac wells offline due to contamination, high VOC levels)
- Algae issues in reservoir

What are the water quality problems within the next ten years?
- Industrial contaminants in well area
- Replacing old pipes
- Emerging contaminants (USEPA's plan for PCPs and pharmaceuticals)

How big of a change in turbidity would you have to see in the main stem to make a difference in O&M? At what level NTU do you switch to the reservoir?
- Start closely monitoring at 10 NTU. Problems start at 15 NTU, so move to reservoir. Reservoir water is a lower water quality. Treatment costs are higher when reservoir water is used.

What do you believe are the causes of the water quality problems?
- Instream bank erosion (also puts sewer lines in jeopardy)

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- Stream bank restoration (to decrease loss of property and scouring, NOT flood control)
- Reforestation
- Vegetation
- Reestablishing riparian buffers
- Fencing out livestock

How much do you currently spend on an annual basis to address water quality? Permit compliance? Operation and maintenance? Monitoring?
- Operations and maintenance is $5.3 million, including:
- Stormwater ($0.5 million)
- Water utility (chemicals, pumping, etc.; approx. $150,000)
- Testing ($92,000)
- Other charges ($1.85 million in debt service [loans as result of referendum] to build physical infrastructure)
- Does not include capital investment.

Aside from the CB PCS, has the city developed or participated in the development of plans, reports or analyses associated with improving water quality in the Brandywine-Christina?
- None

Who else would you like to see involved in the water fund?
- Wilmington
- United Water Delaware
- Conservation districts
- DNREC
- If there work is being done in Pennsylvania, it is critical that there is equity between Pennsylvania and Delaware.

Do you have any thoughts about the initial scope of a water fund? Should it include the entire watershed?
- Spending money outside White Clay would be a hard sell for Newark.
- There needs to be a clear idea of how money is spent—a list of projects so city council knows where the money is being spent.

What is the most important consideration among these three in terms of the city's preferences: cost reduction, regulatory compliance, or economic development?
- The city is fiscally sound. Members of city council are focused on the costs staying the same (efficiency) as well as doing what needs to be done, so we need to balance these two different perspectives.
- It is important for an expert to present the idea/water fund to city council.
- The City of Newark will want the City of Wilmington involved as a partner, but don't compare the City of Newark to the City of Wilmington.

What kind of results would you need to see from watershed restoration?
- Need to show results of projects. Baseline analysis to prove there is a need and the benefit.
- Council and the city need to know someone is looking at the results, and there is a structure that is part of the process. The city needs to know it is not throwing money into a black hole.

What factors would favorably influence the city to invest more in watershed restoration?
- Need proof of a problem.
- Maps, charts, red streams/blue; visuals are critical.
- Showing the differences in costs (agriculture versus urban, etc.).

How does the city mitigate risk to source water? Short term? Long term? Does the city view watershed stewardship as a way to mitigate risk?
- Quantitative analysis of risk.
- The city's well-head regulations are stronger than the county. The city would like to see stronger regulations in the county because it's affecting their wells. The city is planning to move south with its wells.
- Most concerns with wells are legacy.
- The city is planning to put $100,000 in its budget for source water protection.

Other
- There was some discussion on the city's need for and/or participation in a notification system.
- In 2008 improvements were made to the south wellfield due to contamination.

***ACTION ITEMS/FOLLOW-UP**
- Other people to interview should include Jon Husband in New Castle County and towns in Pennsylvania on the White Clay Creek.
- Spray irrigation/septic regulations in Pennsylvania, how they are regulated.

STAKEHOLDER INTERVIEW – CITY OF WILMINGTON

August 28, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- Jeffrey Starkey, Public Works Commissioner
- Sean Duffy, Water Division Director
- Matt Miller, Assistant Water Division Director
- Christiana Oh, Water Quality Manager
- Kelly Williams, Special Assistant to the Commissioner

GENERAL TAKEAWAYS
- The City of Wilmington fully understands the importance of its source water and the need to spend money in Pennsylvania to ensure a clean source of drinking water. The city is committed to a sustainable source of water, water supply for the long term.
- As it relates to this project, partners play an important role in leveraging funds.
- Wilmington's biggest concerns related to water quality are extreme events (e.g., storms, droughts, big changes in weather) affecting the management of their water system.
- It is necessary to have periodic updates with city council to educate them and have them aware of this initiative prior to bringing it before council for a vote.

QUESTIONS
Who are the top water users?
- DuPont
- JP Morgan Data Center
- AstraZeneca
- Need more large water users

Do any water users have special requirements or sensitivities to water quality?
- Noramco
- Citrosuco
- Clean out tanks at the Port
- Wilmington is in contact with some of its water users that require a specific level of water quality relatively frequently (not only on an annual basis when flushing is occurring).

What are the city's priorities with respect to its water utility/what are the highest priorities for the system?

- One priority is the sustainability of the water supply.
- Most of the city's water supply is located in a drainage area outside of the city boundary.
- For water quality and supply purposes, improvement in the basin is more important than combined sewer overflow (CSO) remediation, as most CSOs are downstream from the water intakes. The one CSO upstream of intake is being addressed through a sewer separation project.
- Treatment facility upgrades.
- Water distribution upgrades.

What would make a water fund work in the City of Wilmington?

- Get in front of city council regularly, they are already investing. The funding request can't be a significant increase.

What are the water quality problems in the Brandywine that most affect the City of Wilmington right now?

- Extreme events, storm events, droughts
- Land use upstream
- Drastic swings in water quality on stream (bacteria, organics, chlorides [winter], pH)

What are the water quality problems within the next ten years?

- Replacing old pipes
- Emerging contaminants (tighter regulations coming soon, unregulated now). At this time, science is ahead of the regulation and treatment solutions.

How big of a change in turbidity would you have to see in the main stem to make a difference in O&M? At what level NTU do you switch to the reservoir?

- The city makes changes based on flow, not turbidity; 840 cfs @ Chadds Ford – start to look at when to switch. Switching to the reservoir is sometimes more economical from a pumping standpoint, although Hoopes tends to cause treatment challenges related to filterability.
- It's most beneficial if you can reduce the impact of smaller storm events.

What do you believe are the causes of the water quality problems?

- Pesticides and farms
- Chemicals
- Sediment
- Land use
- Frequent intense storms or periods of drought
- Erosion (Hoopes Reservoir, landowners removing trees)

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?

- The city's next priority is to focus on the Route 30 corridor.
- The water supply crosses lines yet the city has no authority in the jurisdictions causing the problems.
- Fencing out livestock
- Implementing buffers
- Purchasing development rights/easements
- Funding BMPs
- Investing upstream

Aside from the COWSWPP, has the city developed or participated in the development of plans, reports or analyses associated with improving water quality in the Brandywine-Christina?

- The city funded a USGS bacteria source tracking study ($90,000). This is available.
- The city has recently been funded through DNREC to conduct a study on the feasibility of using the Wilmington quarry in its CSO remediation.

Who else would you like to see involved in the water fund?

- Pennsylvania municipalities upstream
- Aqua Pennsylvania
- PA American
- CTIP
- The city suggested getting large water users to participate (pharmaceutical companies that need high-quality water).

Other

- There was some discussion on the city's need for a notification system and if they were currently part of an existing Delaware River notification system.

***ACTION ITEMS/FOLLOW-UP**

- How many meters are in the City of Wilmington, what is the population served/average flow rate, daily demand?
- What considerations went into the discussions about the planned rate increase?
- Is the water quality of the untreated water in the reservoir worse than the surface water? Overall is it more expensive to treat reservoir water than surface water?
- How much do you currently spend on an annual basis to address water quality? Permit compliance? Operation and maintenance? Monitoring?

STAKEHOLDER INTERVIEW – PENNSYLVANIA AMERICAN

September 24, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- James Gable, Operations Superintendent, Coatesville District

QUESTIONS

Who are the top three water users? What is the average volume of water delivered?
- ArcelorMittal, Valley Township
- Customer usage on average is going down, estimated from 300 to 200 gallons/customer/day decrease.
- Victory Brewery Company is coming to Parkesburg, so they will be a big user in the future. Moved here a year ago, production started one year ago, planned expansion will require more water. In the future, they will be one of our top users.

Does anyone have special requirements or sensitivities to water quality?
- Victory Brewing Company's new facility in Parkesburg

What are the company's priorities with respect to its water utility? What investments are the highest priorities for the system?
- Safe, clean drinking water is the highest priority; controlling for leaks (non-revenue producing water); they invest about $3 million into the system.

What are the water quality problems in the Brandywine that most affect PA American right now? What about within the next ten years?
- Rock Run reservoir is a different animal; iron and manganese issues; nitrates from farms; Octararo plant was shut down in 2005/2006 because of nitrates.

What do you believe are the causes of these problems?
- Iron and manganese (occur naturally)
- Nitrates associated with farming; believe causes to be livestock, fertilizer, field maintenance

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- Better ground rules for land management

How much do you currently spend on an annual basis to address water quality? Permit compliance? Operation and maintenance? Monitoring?
- 25% of budget

Has the company developed or participated in the development of plans, reports, or analyses associated with improving water quality in the Brandywine-Christina? Would you be willing to share them?

- Source water protection plan in 2013; provided access online; stakeholder meeting on Monday, October 20 at 10:00 a.m.

Can you tell us about the watershed projects the company has engaged in?

- PA American's grant program: generally one grant/year in service area; approximately $30,000.

Who else would you like to see involved? (i.e., other utilities, other cities, corporations)? How many other partners?

- County, wastewater, local municipalities; Caln Township is very active in stormwater management. Anyone involved with drinking water and wastewater.

Do you have any thoughts about the initial scope of a water fund? Should it include the entire watershed?

- Aqua Pennsylvania is doing a source water plan, they invest too/similar stewardship. PA American sees watershed protection as protecting our interests.

What is most important consideration among these three in terms of the company's preferences: cost reduction, regulatory compliance, or economic return?

- All

What kind of results would you need to see from watershed restoration?

- Need to demonstrate reduction of loads.

What factors would favorably influence the company to invest more in watershed restoration?

- American Water involved in impacts from West Virginia spill; company began work on source water protection plan after that. Focus on managing potential contaminants; revisit all flows into the source water; develop personal contacts with managers within the watershed; improve emergency management with the county; and build trust.

How does the PA American mitigate risk to source water? Short term? Long term? Does the company view watershed stewardship as a way to mitigate risk?

- See above. PA American has become more involved with local and county emergency management.

What other organizations should we be sure to interview at this early stage in the project?

- PA American is interested in continuing the conversation, but not sure who the correct person would be. Need to identify the individuals to include, possibly the water quality manager. They also do water quality modeling, and these people may need to be involved.

STAKEHOLDER INTERVIEW – NEW CASTLE COUNTY/DELDOT

October 23, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- Mike Harris, Special Services, New Castle County
- Ellie Mortazavi, Special Services, New Castle County
- Marianne Walch, DelDOT

GENERAL TAKEAWAYS
- The pipes don't follow watershed boundaries and may cross them.
- Most of the system is under DelDOT's jurisdiction.
- The first two WQIPs are being developed for the Christina River and Dragon Run watersheds.
- Costs savings, economic development, regulatory compliance, and protection of the environment are critical considerations for New Castle County (NCC) and DelDOT.

QUESTIONS
How old are the systems/pipes?
- The oldest pipes are probably about 40–50 years old (for DelDOT), its pipes are typically not that old. NCC has little infrastructure; the majority of the pipes are DelDOT's, and there are numerous private systems.

Who are some of the largest stormwater contributors by total impervious cover?
- Refinery
- Christiana Mall
- Auto plants (Boxwood Road, not functioning but has a lot of impervious cover). Note: These are some of the locations with the most impervious cover in the county. There are not necessarily the largest "contributors." For example, the Christiana Mall has many BMPs and treats most of its runoff.

What are your current priorities for stormwater management?
- The biggest financial priority is going to be the implementation for the WQIP for the Christina River. It will cost millions, and it will require partnering, grants, cost-share, etc.
- There is discussion underway between DelDOT and DNREC regarding fee in lieu and whether this money can go to retrofits for the WQIP. It's a priority to keep the fee in lieu of money within the watershed and not to move it around the state. There have also been discussions about stormwater banking.

What is being used to pay for the MS4 program?
- NCC: general fund and wastewater fund
- DelDOT: state operating funds, $2.7 million/year goes to the MS4 program and an additional $1 million is set aside for retrofits
- The consultant has been asked to address the financial piece in the WQIPs so there is some ballpark for the cost of implementation in these plans.

What is the timeline for the WQIPs?
- Two per permit cycle (typically permits are for five years)

Watershed overlay permit, is this something that would be appealing? This would base the reductions on a watershed basis or by pollutant rather than a piece-meal approach.
- There was discussion whether this would easily achievable considering the current organization at DNREC with responsibility falling under many different sections.

What is the priority with stormwater?
- Trying to raise the attention on the need to address stormwater. The culture is changing, but this has typically not been the biggest priority. DelDOT has begun to look at stormwater and watersheds in the initial planning stages, and this helps to address water quality/stormwater problems. DelDOT has also begun to look at excess properties for stormwater retrofit potential before selling them.

Has green infrastructure been implemented or a priority?
- NCC has spent approximately $11 million over 6–7 years on stormwater retrofits on both public and private lands. NCC performs major maintenance for residential maintenance corporation facilities in exchange for the maintenance corporation performing and documenting minor maintenance. DelDOT, in accordance with state regulations, prioritizes green technology designs whenever feasible. DelDOT annually inspects all BMPs and maintains them as needed.
- Most DelDOT maintenance facilities have had their stormwater infrastructure upgraded. DelDOT's
- BMPs and storm sewer systems are mapped for the entire state.
- NCC funds to do this came from the general and wastewater funds. NCC pays Wilmington $19 million for wastewater. DelDOT funds are from the MS4 funds (line item in budget).

What are the priority investments in the system?
- DelDOT: BMP retrofits and stream restoration, BMP and system maintenance, illicit discharges, monitoring.

Why was Christina River watershed chosen for the WQIP?
- Water quality problems but also because there are a lot of publicly owned lands in the watershed, a lot of DelDOT property. A lot of data for the Christina. Lot of parks. Best opportunities to improve this watershed. Impervious cover reduction will be difficult. Bacteria reductions are going to change because DNREC is looking at the wildlife contributions and is going to consider that in the reductions required.

What do you think are the source/causes of the water quality problems?
- Residential fertilizer use, sewer, CSOs in Wilmington, input from Pennsylvania, agriculture, impervious surface.

What are some approaches that show promise to address these problems?

- Stream restoration, riparian buffers, DelDOT puts emphasis on stream restoration in its water quality plans.

Are there any other water quality projects/programs NCC or DelDOT are involved with aside from the MS4 program?

DelDOT:

- Beck's Pond committee in the Christina River watershed. Looking at how to improve the water quality there. Aiming to make it swimmable. Some DelDOT roadways are not treated and run into this pond. Additionally there is a private mobile-home park that is contributing. There may be potential to work with a mobile-home park and DelDOT to find funding to relieve these problems.
- Stream monitoring on Leatherman's Run (drains into the Christina). DelDOT has conducted six years of monitoring in this area and has developed a retrofit plan. Retrofits at the Christiana High School and the I-95 service plaza have been implemented. A stream restoration project is in final design. More monitoring and biological assessment are planned for this site.
  *Marianne will send the information on this project.

NCC:

- Working with Partnership for the Delaware Estuary (PDE) to install rain gardens in parks.
- When new parks go in the designs, go through special services for review. Park maintenance and operation are under a different section of Special Services, while planning and engineering for parks are part of the department that addresses the MS4 program.

Any tree plantings or similar initiatives?

- Looking at this for WQIPs and also tree plantings are currently happening piecemeal. For example, tree planting at Middle Run and the Leatherman's Run project is targeting NCC parks.

How will you fund the restoration work?

- It's on the radar, already trying to figure out where to find the funds. Will require partnering. A WQIP timeline will be proposed when the WQIP plan is done (2016) and then the implementation timeline will be included in the plan (with funding estimates).

Is it appealing to get involved with the water fund?

- Yes. Although DelDOT has limited, if any, ability to contribute to work done outside Delaware.

Who else do you want to see at the table if you were involved?
- City of Wilmington, City of Newark, PDE, Delaware Nature Society, Homebuilders Association of Delaware; unsure about whether Pennsylvania should be involved.
- For this to work, it has to make economic sense for NCC and DelDOT. Need to meet the waste load allocation (WLA) so these would have to change for NCC to be involved.
- Only new construction plans require stormwater controls. Older sites may have predated stormwater regulations and don't have BMPs in place. Additionally, there are sites such as mobile-home parks and shopping centers that are directly connected to surface waters and not the MS4. These sites should have their own NPDES individual permits.
- Getting private groups to partner would be important or can make a big difference. Create an incentive for big shopping malls and properties with big parking lots.

What is most important for consideration for these projects?
- DelDOT and NCC: regulatory compliance is the biggest driver. If it's not required, it is more challenging to perform because the budgets are already stretched so far there is not much room to do extra without a requirement.

What factors influence DelDOT/NCC to invest more?
DelDOT:
- Projects facilitated by other groups; it's easy for DelDOT to contribute cost-share or finance a piece of a project, but it is difficult for DelDOT to manage grants.

NCC:
- We are able to apply for grants but some of the most important things for the county right now are creating jobs and economic development.

Are you managing long-term risk?
DelDOT:
- It's becoming a priority – infrastructure, resiliency (i.e., climate change). Will be issue with stormwater BMPs if they are put in floodzones, etc. DelDOT is spending a lot of money on saving washed-out bridges, so resiliency is a big deal for them.

NCC:
- The executive office is better to answer; Mike and Ellie only address stormwater.

Are you interested in staying involved?
- Yes, both groups are interested in being involved in conversations in the future.

STAKEHOLDER INTERVIEW – DOWNINGTOWN MUNICIPAL WATER AUTHROITY

October 6, 2014
Interviewers – Ellen Kohler and Jerry Kauffman
Meeting Attendees:
- Fred Bopp, Executive Director

QUESTIONS

What is the average volume of water delivered?
- Capacity is 2.5 mgd; average use is 1.6 mgd.

How many customers do you have? (meters)
- 3,600 meters
- Just under 10,000 population

Who are the top three water users?
- Pepperidge Farm
- Victory Restaurant and specialty brewing facility (although most of Victory moved to Parkesburg)

Anyone have special requirements or sensitivities to water quality?
- No

PRIORITIES AND CONCERNS

What are the authority's priorities with respect to its water utility?
- Water quality is highest priority, invested about $3.3M in inclined plate settler to enhance water treatability. Looking toward installing a UV/peroxide treatment step to ensure against biological and organic contaminants.

What investments are the highest priorities for the system?
- Wells as back up to Brandywine surface intake; one well cost about $900,000, in order to preserve continuity of production for customers.
- Infrastructure maintenance – 30 miles of pipe and costs $1 million/mile to replace.

What are the water quality problems in the Brandywine that most affect Downingtown right now? What about within the next ten years?
- Turbidity/sediments and color
- Installed a plate settler that treats turbidity up to 50 NTU; cost $3 million; grant from Chester County paid for $1.7 million of costs; maintenance of filters and settler require a lot of water so working on doing maintenance only when needed as opposed to regular schedule (94 mg/yr wastewater derived from maintenance of plate settler and filters).
- Water from Marsh Creek reservoir can be poor quality during hot weather, with the result that biologicals such as Cryptosporidium and giardia are growing problems.

What do you believe are the causes of these problems?

- Development – land surface modifications and increasing population density.

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?

- Not a regulatory approach, because we are becoming overburdened with overbearing regulations that cost excessively for compliance, while often not achieving the expected goal. Industry/local government partnerships, I believe, have a better chance of success.

PREFERENCES

What is most important consideration among these three in terms of the authority's preferences: cost reduction, regulatory compliance, or economic development/return?

- Cost reduction is most important.

How does the authority mitigate risk to source water? Short term? Long term? Does the authority view watershed stewardship as a way to mitigate risk?

- Second water supply. (I must not have understood the question, since the answer does not fit the question.) I do not believe that DMWA can do anything to mitigate risks to its own source water, only to waters further downstream, which serve as source waters for others. With that in mind, first, the DMWA works very hard to comply with all relevant regulatory requirements (for example, maintaining our "waste water" in such a good water quality condition that disposal of "waste water" through our NPDES Discharge Point, will not impinge upon the source waters of others with any undesirable characteristics our "waste water" may contain. And, second, we are very careful to ensure that we are not wasting water, the throughput of which past our intakes would normally be part of the source waters for others downstream.

STAKEHOLDER INTERVIEW – HONEY BROOK MUNICIPAL WATER AUTHORITY

October 9, 2014
Interviewers – Ellen Kohler and Andrew Homsey
Meeting Attendees:
- Mike Shuler, Manager
- Dennis Patterson, Chief Operator

QUESTIONS

What is the average volume of water delivered?
- Capacity is 800,000 gd; usage is 175,000 gd.
- Four active wells, one inactive well.

How many customers do you have? (meters)
- 787 meters; 2500 population

Who are the top three water users?
- Good Food, some light commercial; superfund site nearby has shaped system (1985); most customers are residential.

PRIORITIES AND CONCERNS

What are the authority's priorities with respect to its water utility? What investments are the highest priorities for the system?
- Another well site outside of current drainage.
- Checked whole system for leaks, found some big ones and repaired; will do half the system each year to stay up to date.

What are the water quality problems in the Brandywine that most affect Downingtown right now? What about within the next ten years?
- Iron and manganese from wells an issue.
- See some nitrates but not above WQ standards.
- Could see that being a problem in the future especially with more development that might mean more lawns.
- Sewer authority is having difficulty treating waste water; concern about discharge capacity.

What do you believe are the causes of these problems?
- Iron and manganese are natural causes; farmers used to till in manure, but now it is often a slurry that doesn't get tilled in as rapidly.

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- They have seen the benefits of livestock fencing for stream banks; seeing more fish in streams.

How much do you currently spend on an annual basis to address water quality? Permit compliance? Operation and maintenance? Monitoring?

Spend about 70% of budget on operations, repairs, maintenance of system:

- Main costs: Personnel (3 FTEs), power, material (e.g., Chlorine)
- Treatment costs: ~$4 per K gal., charge ~$6/K gal.
- They are breaking even, and want to keep it a break-even condition.
- Two wells with small treatment pumps. One site with iron and manganese problems, large treatment building (usually offline).
- Nitrates dealt with through blending.
- No power backup, but three-day supply in water tower. Never experienced outage.
- May experience development pressure, but feel capacity within any projected expansion.

Has the authority developed or participated in the development of plans, reports or analyses associated with improving water quality in the Brandywine-Christina? Would you be willing to share them?

- Growing Greener grant six years ago to create a wellhead protection plan (copy received); it includes recommendations for nutrient, pesticide application agreements with farms (Zone 1 & 2 WHPAs); they feel they have good compliance with landowners around wellheads.
- H2O Grant to upgrade stormwater infrastructure in conjunction with "streetscapes" grant, just finishing up.
- They have a progressive board of supervisors who are proactive (e.g., leak detection).
- Large landfill to north is Superfund site. Thirty wells contaminated in 1985. Plume is shrinking, but the houses may come under public water in future.
- Aqua Pennsylvania pipes come up Rt. 322 to near Borough line, but no interconnections. Honey Brook (HB) has few customers outside boundary.

PREFERENCES

What is most important consideration among these three in terms of the authority's preferences: cost reduction, regulatory compliance, or economic development/return?

- Municipality has some interest in economic development – revitalization grants.
- Right now, revenue covers costs; slowing increasing rates to cover maintenance issues.

How does the authority mitigate risk to source water? Short term? Long term? Does the authority view watershed stewardship as a way to mitigate risk?

- Value in public ownership of the system.
- Better control of rate increases, driver for development.
- Better communications across departments.
- Partnering with other community groups.

STAKEHOLDER INTERVIEW – AQUA PENNSYLVANIA

October 20, 2014
Interviewers – Ellen Kohler and Jerry Kauffman
Meeting Attendees:
- Tony Fernandes, Manager, Water Resources Engineering
- Colleen Arnold, Manager, Water Quality and Environmental Compliance

QUESTIONS

Who are the top three water users? What is the average volume of water delivered?
- Ingram's Mill draws water off the E. Branch Brandywine and has a 6 mgd maximum allocation. The plant produced 5 mgd on average in 2013. The plant provides 3.5 mgd to about 9,000 customers and 34,000 people in West Chester, East Bradford, and West Goshen Townships. The other 1.5 mgd is fed via intraconnects to Aqua Pennsylvania – Main System (Westtown Township), Aqua Pennsylvania – Beversrede (Pocopson Township) and Aqua Pennsylvania – Spring Run (West Bradford Township).
- The top water usage customer is West Chester University. The next several large water users are just residential. We were unable to get West Chester usage.

Anyone have special requirements or sensitivities to water quality?
- Hospitals

PRIORITIES AND CONCERNS

What are the company's priorities with respect to its water utility? What investments are the highest priorities for the system?
- Replacement of pipelines; they are replacing 100 miles/year.
- General company priorities are growth and expansion.

What are the water quality problems in the Brandywine that most affect Aqua Pennsylvania right now? What about within the next ten years?
- Sediment biggest issues; ammonia from DMWA.
- Nutrients reaching stream from nonpoint sources (agriculture) help produce algae blooms which in turn produce taste and odor compounds such as MIB and Geosmin.
- Algae during summer months is also temperature-related.

What do you believe are the causes of these problems?
- Sediments coming from instream sources; increased floodwaters resulting from increase development. Streambank scouring is the largest source of sediment.
- However, nutrients are carried to the stream in sediment and runoff from offsite, too, which causes other issues described above.

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?
- Forested buffers
- Education: talking to people upstream; working with watershed associations, leveraging volunteers, partnering with conservation districts on implementation.

How much do you currently spend on an annual basis to address water quality? Permit compliance? Operation and maintenance? Monitoring?

- We spend millions and millions to address "water quality." Below describes only what we spend on SOURCE water quality. Big difference.
- Two field staff; 20% of Tony's time: samples water quality at intake and upstream once per month and reservoirs quarterly.

Any other information?

- We are the major private funder of TreeVitalize. We manage implementation of some TreeVitalize projects along our streams. We do one or more streambank stabilization projects where we see the most need. Our staff maintains previous TreeVitalize project areas to maximize survival rate of green infrastructure. We work with students to teach them about water quality, and we provide presentations on watershed protection to community groups when asked.

Has the company developed or participated in the development of plans, reports, or analyses associated with improving water quality in the Brandywine-Christina? Would you be willing to share them?

- In the wake of the West Virginia spill, working on source water protection plans for all intakes; hope to complete by 2016.
- Also implementing online real-time tool to assess acute risks; GIS-based access to data about potential sources.
- Interested in participating in a Brandywine-Christina early warning system (EWS) subscription with other water purveyors. Aqua Pennsylvania paying about $8,000/yr in Philadelphia EWS.

Can you tell us about the watershed projects the company has engaged in?

- Aqua Pennsylvania supports TreeVitalize, a tree-planting program through Pennsylvania Horticultural Society, started years ago by PA DCNR.
- They are also participate in the Schuylkill River Restoration Fund (on a project basis; needs to be capital investment).
- Participating in streambank restoration about $15,000/yr on project-by-project basis.
- Maintenance is big concern with tree planting projects; municipalities will take care of the trees, but sometimes private land not as robust on maintenance.
- The company CEO has been active in partnering with the City of Philadelphia and the PA DCNR.

PREFERENCES

Who else would you like to see involved (i.e., other utilities, other cities, corporations)? How many other partners?

- Waste water managers, watershed organizations, conservation districts.

What is most important consideration among these three in terms of the company's preferences: cost reduction, regulatory compliance, or economic return?

- Cost reduction

What kind of results would you need to see from watershed restoration?

- Need to demonstrate a measurable reduction of loads, some kind of return on investment.

What factors would favorably influence the company to invest more in watershed restoration?

- Aqua Pennsylvania is investing more and more in green infrastructure.

How does the Aqua Pennsylvania mitigate risk to source water? Short term? Long term? Does the company view watershed stewardship as a way to mitigate risk?

- Aqua Pennsylvania does manage for long-term risk but has not viewed investments in watershed protection/restoration as long-term risk management – This will be the key to get the highest chance of Aqua Pennsylvania (and other partner) participation. To change the thinking from making a return on investment to reducing our risk by investing. If we try to push cost benefit or return on investment, we cannot show good reason to invest.

Is Aqua Pennsylvania willing to continue to participate in discussions about this concept?

- Yes. At some point, they will need to involve Mike Pickel, vice president and chief environmental officer. Although not discussed at the meeting, the fund will have to get over the hurdle of showing Aqua Pennsylvania that providing resources to the fund (and having the fund decide which projects to implement) is better for Aqua Pennsylvania than having Aqua Pennsylvania simply direct its money to fund exactly the projects it wishes. Why should Aqua relinquish that control?

STAKEHOLDER INTERVIEW – CTIP Representatives

October 27, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- Bob Struble, Brandywine Valley Association
- Jan Bowers, Chester County Water Resources Authority
- Chris Strohmaier, Chester County Conservation District

GENERAL TAKEAWAYS
- In general, MS4s are not responsible for the agricultural load or urban load outside of their jurisdiction. Only responsible for what's in their jurisdiction.
- Reparsing has occurred in at least some municipalities in order to improve the accuracy of the load reductions required. Not sure if all municipalities have reparsed.
- It is not appealing at this point for municipalities to work in agricultural areas outside their jurisdictions because Pennsylvania Department of Environmental Protection (DEP) has indicated they will not get credit for this work.
- Agricultural areas don't have a clear obligation to meet water quality standards (or pollution reduction loads). This differs greatly from the MS4 and the NPDES and requires a different approach.
- DEP has made clear that any credit that has been accrued for BMPs put in place since the TMDLs were established must also debit for any increased pollutant loads created (e.g., from new development, etc.) that has been incurred since the TMDLs were established.
- DEP has indicated that if a BMP is not in the drainage way of the MS4 polluted discharge the regulated systems will not get credit.
- DEP provided funding for Barry Evans to work with CCWRA to create the Christina Basin MapShed model.
- CTIP municipalities are still waiting for response back from DEP on their proposed MS4 CTIP plans; expect response after lawsuit (by others) is settled.
- One of DEP's current intents of "offsets" has to be because you can't do something where you are supposed to, not because it's easier to do it elsewhere.

QUESTIONS

What municipalities are contributing the most stormwater?

- There is not a simple answer; some townships are geographically bigger but less urbanized or agriculture so they aren't necessarily contributing the most stormwater, but are the largest. For example, Honeybrook is the biggest geographically, but has the smallest urban area. West Chester has a large urban area, but not all of it is within the Christina Basin watershed. Downingtown and Coatesville have a smaller geography, yet are large stormwater contributors. The Great Valley municipalities (Coatesville to E. Caln) are some of the most urbanized, and thus large contributors yet several don't have TMDL obligations and include some of the poorest municipalities in the county. In the Red Clay watershed Kennett Square is a relatively large contributor based on urban area. In the White Clay watershed, Avondale and West Grove are relatively large contributors. The boroughs and city (e.g., Modena, Avondale, West Grove, West Chester, Coatesville, etc.) have similar contributions due to their development. The area west of West Chester is less developed than the area to the east, and the west side is in the Christina Basin.

What are the biggest priorities for the CTIP municipalities for managing stormwater?

- Volume reduction.
- Cheapest BMPs to get compliance, economically driven (e.g., street sweeping and tree plantings).
- The urbanized area will most likely expand to the 2010 boundary, based on comments from DEP.
- There may be additional pollutants that also need to be addressed in the near future, such as chlorides and pharmaceuticals.

What are some of the approaches to addressing water quality?
- Street sweeping.
- Tree planting.
- Should be talking about volume control.
- In the more rural areas there is tree planting, streambank fencing, and stream restoration.
- The missing link is measuring/monitoring the reductions (e.g., before/after sediment reductions). Currently there is monitoring for biological, chemistry, and habitat, but there is a need for sediment monitoring.
- There is a need for much larger practices to address volume control for urbanized areas (e.g., large storage chambers, etc.), but these controls are very expensive. The amount of urban volume control needed is not likely going to happen through just infiltration, retrofit, and buffers.
- West Chester is looking at implementing a stormwater fee. In progress. Upper Uwchlan Township may be looking to do this, also. The stormwater fees are not just about meeting TMDLs and MS4s; they are also about needing capital to make improvements to the system.
- Within DEP, stream restoration credits are being developed through their work with the Chesapeake Bay Program. DEP is using this approach in Big Springs, and this may be applicable to the Christina Basin due to similar geographies.

Discussion on the CTIP Process
- Each municipality contributed $2,000 to support CTIP plan coordination for the first year.
- Phase 3 is the next phase. It's the implementation phase, identifying what actions will make the biggest impact. This phase is on hold until DEP comments on the MS4 TMDL plans submitted with permit renewal applications.

Are there any other plans/reports that we should look at?
- No.

Has CTIP had any discussion about outcomes/reporting?
- It's important that municipalities are able to show how TMDLs/regulatory responsibilities are being met. Currently we can measure biological activity, and there is monitoring that can be done through the USGS flexible stations. There is a greater need for measuring sediment (pre and post).

What are your thoughts about the York County example?
- The York County example seems to be worth watching to see if it provides any value for the Christina Basin. The York County differs, though, in that they do not have WLAs. DEP is reportedly going to allow them to invest in joint projects. In York County they need to meet state reductions not reductions based on the individual jurisdictions like in the Christina Basin.
- Without certain regulatory flexibilities it is hard to implement a watershed-wide joint program. Looking at potential partners (e.g., small clusters to work together), would need to match needs and interests. For example, Downington and E. Caln may have

similarities of need, but may or may not be willing to partner, and neither have WLAs. Another potential partnership could be the municipalities in the Great Valley. No one is going to partner unless they know they will get credit for work they fund.

There was some discussion at the last Water Fund Regional Advisory Panel meeting about a "watershed overlay" (watershed-based reductions rather than municipal-based reductions), what are your thoughts on this?

- This would provide flexibility and benefits to the CTIP municipalities, but it seems unlikely to happen.
- It would seem that there would need to be a major change in the law to allow this to work, given current understanding. The SDWA (for drinking water providers) and CWA (stormwater/wastewater protections) have separate requirements, and the law would need to be revised in order for a watershed overlay to be effective.

How can we include the agricultural community in Chester County in this conversation/discussion?

- It is important that if the agricultural community is involved, that purveyors bring a good story to the farmer; it is critical to convey how the agricultural community is part of the watershed/drinking water, and that the drinking water purveyors understand the agricultural community's role as well.
- It is important that the right people tell the story and discuss these ideas.
- Remember that there is a fundamental difference between the municipal-owned authorities and the investor-owner purveyors. The municipal-owned are responding to a need and the investor-owned are able to spend money on advertising and messaging. It's a different culture and has more resources available for this type of messaging and outreach.
- Recommend getting the Chester Water Authority (as well as other water suppliers) involved with the agricultural community in Chester County.
- Address that lawns are a source of the problem as well as farms. Make this clear in the beginning.

Are you interested in continuing this conversation?

- Yes, with CTIP this discussion is going to continue.
- The William Penn finance effort shouldn't get out in front of the municipalities.
- CTIP will continue working with DEP, and those next conversations will help to identify a path forward; can't look at considering a new structure until hear regulatory requirements and expectations from DEP.

Other

- If the municipalities work together, they will have a greater influence on DEP.
- Current stormwater ordinances are about not making things worse and not about fixing the past.
- One difficulty with the municipalities is the frequent changeover in their leadership. Sometimes there mistrust within the community of why a municipality may be participating in a committee or partnership. What will be the benefits?
- DEP supports the concept of individual and multi-municipal stormwater authorities. However, with the ability to individually or jointly raise fees is the responsibility to individually or jointly manage the infrastructure that the fees are paying for, and thus, individual versus joint regulatory responsibilities must be determined. A joint permit may (or may not) be useful for multi-municipal scenarios, depending on individual interests and needs. But in some scenarios, applying for a joint permit might allow for greater flexibility for TMDL implementation, but has other implications that would need to be evaluated to determine if it is a good strategy for a multi-municipal stormwater authority.
- Trust among municipalities is critical for a partnership to work.
- There is an existing and historic sense of stewardship within Chester County. There is a long history of work with BVA and CCWRA and other conservation organizations. There is a lot of leadership in this sector, and open space has been a priority among the constituency. West Chester University conducted a survey and water/stormwater scored high among the county residents' priorities. This survey may be found on the "Chester County Commissioners" link (under "Strategic Plan"). The commissioners also prioritize improving stream water quality in their strategic plan goals.
- In considering a partnership between the water suppliers and the municipalities, there needs to be an awareness that there are some existing tensions and historic relationships that must be considered.
- Money talks. If there is money available for the municipalities, this is appealing. For example, the Victory and PA American grant programs have been effective, albeit small.

STAKEHOLDER INTERVIEW – UNITED WATER DELAWARE

December 3, 2014
Interviewers – Ellen Kohler and Martha Narvaez
Meeting Attendees:
- Larry Finnicum, Director of Operations
- Tom Hubbard, Public Relations Manager

GENERAL TAKEAWAYS
- United Water Delaware is already involved in investing upstream through an established agreement with the USEPA.
- The key to success with United Water Delaware's work upstream is collaborating with organizations that have experience and expertise with landowners and farmers and providing financial assistance to these groups in the watershed to help fund projects that need additional funding to get implemented.
- United Water Delaware serves a population of 100,000 in northern Delaware.
- United Water Delaware's customer base has a large industrial component.
- Within the industrial base, quantity over quality is its customers' largest concern at this time.

QUESTIONS
Who are the top water users? Do any water users have special requirements or sensitivities to water quality?
- United Water Delaware's average water usage is 17 mgd.
- Delaware City Oil Refinery (if the water is not consumed the company must pay 35 mg)
- FMC Corporation
- BASF Corporation
- DuPont Edgemoor
- Generally, United Water Delaware serves a large portion of industrial users; 73 industrial users carry the weight of consumption, using 50% of the water they produce.
- United Water Delaware has experienced a reduction in industrial water demand due to shrinking manufacturing bases, but the decline seems to be flat-lining.
- Similar to other water providers in the Delaware River Basin, United Water Delaware has experienced a reduction in residential water demand primarily due to the advent of regulations requiring installation of low water use fixtures.

Does anyone have special requirements/sensitivities to water quality?
- DuPont Stine Haskell Research Center has a chlorine analyzer, sensitive to chlorides.
- Most industrial users are more concerned about quantity/reliability than quality.

What are the company's priorities with respect to the water utility? What investments are the highest priorities?

- Safety.
- Value to customers.
- Efficient cost-effective.
- Compliance/no notice of violations.
- Providing clean, safe, reliable water 24 hours/day, 365 days/year.

What are the water quality problems that most affect United Water Delaware?

- Sustainability.
- Upstream partners.
- United Water Delaware relies on the Red Clay and White Clay Creeks, and these are very flashy streams with variable sediment loads.
- Ensuring supply: United Water Delaware does not have a large unfinished water reservoir to draw from. There is finished storage at the treatment plant and a small reservoir with unfinished storage in Edgemoor (22 mg). United Water Delaware also has storage (75MG) in aquifer storage recovery (ASR) with a capacity of 1 mgd. There is also an agreement with Wilmington to get water from Hoopes through their interconnections.
- No major land use changes, but land use and development are occurring and may create problems.
- No wastewater dischargers upstream in the White Clay like there are in the Brandywine, so United Water Delaware doesn't have to worry about that.

What do you believe are the causes of the water quality problems?

- Water quality concerns are tied to current land use and changes in land use.
- A major concern is more stringent water quality regulations and what will be required.

What are your investments?

- Stanton Water Treatment Plant investments.
- United Water Delaware faces challenges with main replacement.
- $8–9 million capital investments in 2014: 30–35% in the plant, the remainder spent on distribution projects.
- Majority of investments go to meet more stringent regulations.
- Looking at how to address aging infrastructure. For example, there were 22 main breaks in November 2014.
- The system has 15–16% non-revenue water. United Water Delaware is working on a meter change-out program that should benefit the customer and company. Identifies leak detection within 30 days.

What approaches to improving water quality in the Brandywine-Christina do you believe have the most promise?

- Addressing stormwater runoff.
- Keeping livestock out of streams.
- Installing and maintaining riparian buffers.
- LT2 permit is a five-year permit. United Water Delaware is investing in watershed restoration.

What determines how funds are spent for WCP portion of LT2 compliance?

- Working with consultant (Chris Crockett) to identify projects.
- Getting a group of projects in funnel and looking at which ones have the biggest impact (e.g., how many cows can a project get out of stream).
- Projects are prioritized based on crypto loading. For example, calves or younger cows produce more crypto than older cows.
- Work with partners who have existing relationships, collaborative approach to projects with other organizations that have expertise or experience with farmers and upstream landowners such as the Brandywine Conservancy and the Red Clay Valley Association.
- Monitoring is not being done because there is monitoring data available and it is not cost-effective; it takes money away from putting projects in the ground.
- Leveraging dollars to get large projects completed.
- Maintenance is stated in the contract with the farmers and landowners.
- There are currently 25 projects outlined in the agreement with the USEPA, but these change and updates are provided to the USEPA on an annual and quarterly basis through reporting.

Is it possible to expand what United Water Delaware is doing?

- It is being done now yet piece-meal.
- United Water Delaware is the first in USEPA Region 3 to have an agreement with USEPA to do this.
- United Water Delaware has more scrutiny through the Public Service Commission (PSC) because they are investor-owned; there is scrutiny on how/where the money is spent. Municipal-owned utilities do not have this scrutiny.
- United Water Delaware would continue to do these types of projects even if they lose USEPA credit because it's the right thing to do.
- Largest challenge is that they/we are working in two states.

What is the most important consideration among these three in terms of United Water Delaware's preferences: cost reduction, regulatory compliance, or economic development?

- Regulatory compliance is number one, but it is a three-legged stool.
- Long-term risk management is critical and is a consideration but an overly active discussion item. It is part of United Water Delaware's environmental charter to be environmental stewards.

Other

- United Water Delaware's Stanton Water Treatment Plant is a no discharge plant; solids are hauled off and beneficially reused. Lagoons only have a limited capacity. High cost to clean.
- Surface water has a lot of potential to get dirty, but passes quickly so there are benefits and drawbacks to surface water source.
- The filter plant in Stanton is 30 mgd and United Water Delaware produces 17 mgd on average so there is no need for additional capacity. The Christiana Plant (6 mgd) was last operated in 2007. United Water Delaware currently working to determine what they will do with that plant in the future.
- Concern over future of Christiana Plant includes its potentially being needed to provide water to United Water Delaware's south service territory due to a lack of interconnections for additional supply.

***ACTION ITEMS/FOLLOW-UP**

- If possible, Tom will provide a copy of United Water Delaware's agreement with the USEPA.