Conowingo Watershed Implementation Plan

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Prepared by the Center for Watershed Protection, Inc.

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Revision November 2023 – Updated Table 1, Table 2 and Appendix E to reflect revised CAST modeling of New York load reduction for the Primary CWIP Strategy.

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List of Acronyms

BMP	Best Management Practice
CAP	Countywide Action Plan
CAST	Chesapeake Assessment Scenario Tool
CBC	Chesapeake Bay Commission
CBP	Chesapeake Bay Program
CIT	Conowingo Implementation Team
CWIP	Conowingo Watershed Implementation Plan
CWP	Center for Watershed Protection, Inc.
DO	Dissolved Oxygen
EOT	Edge-of-Tide
EPA	United States Environmental Protection Agency
GIS	Geographic Information System(s)
LRS(s)	Land-River Segment(s)
M	Million
MDE	Maryland Department of the Environment
MPA	Mid-point Assessment
MS4	Municipal Separate Storm Sewer System
N	Nitrogen
NEIEN	National Environmental Information Exchange Network
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
P	Phosphorus
PA DEP	Pennsylvania Department of Environmental Protection
PBC	Performance-Based Contracting
PES	Payment for Ecosystem Services
PFP	Pay for Performance
PFS	Pay for Success
PSC	Principals' Staff Committee
QAPP	Quality Assurance Project Plan
RFA	Request for Application(s)
RFP	Request for Proposal(s)
SRF	State Revolving Fund
STAC	Scientific and Technical Advisory Committee
TMDL	Total Maximum Daily Load
VIMS	Virginia Institute of Marine Science
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency
WIP	Watershed Implementation Plan

Executive Summary

Established in 1983 with the signing of the first Chesapeake Bay Agreement, the Chesapeake Bay Program (CBP) partnership—currently consisting of the seven jurisdictions in the Chesapeake Bay watershed (Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), the U.S. Environmental Protection Agency (EPA), and the Chesapeake Bay Commission (CBC)—has set a goal to have the practices in place by 2025 to meet the modeled nutrient and sediment load reduction targets necessary to restore the Chesapeake Bay. This restoration framework is driven by federal Clean Water Act requirements and a 2010 Total Maximum Daily Load (TMDL) that sets pollution reduction targets for each Bay jurisdiction in order to achieve their respective water quality standards.

Appendix T of the 2010 TMDL recognized that the Conowingo Reservoir was filling with sediments and nutrients, resulting in increased pollution flowing over the dam into the Chesapeake Bay. The TMDL also recognized that the reservoir's ability to capture sediment and nutrients (i.e., its trapping capacity) is affected by sediment transport into the reservoir, scour removal events, and sediment trapping efficiency. Due to the uncertainty with these factors, the TMDL assumed that the Conowingo Reservoir would continue to trap nutrients and sediment through 2025. The TMDL also stated that "if future monitoring shows the trapping capacity of the dam is reduced, then EPA would consider adjusting the Pennsylvania, Maryland, and New York two-year milestone loads based on the new delivered loads" (US EPA, 2010; Appendix T, p. T-5).

In 2017, as part of the CBP partnership's phased planning process, there was a Mid-point Assessment (MPA) to evaluate jurisdictions' progress in achieving 60% of the necessary 2025 pollution reductions. The MPA also adopted the latest science and monitoring information in an updated Phase 6 suite of modeling tools used to measure restoration progress. This new science demonstrated that the Conowingo Reservoir was effectively full, reducing dissolved oxygen (DO) concentrations in the Bay due to an additional 6 million pounds of nitrogen and 260,000 pounds of phosphorus pollution. The Principals' Staff Committee (PSC) agreed to address these Conowingo pollution loads through a separate Conowingo Watershed Implementation Plan (CWIP) that all jurisdictions would work collectively to achieve by pooling partnership resources and by reducing implementation costs through targeting pollution reduction practices in the most effective areas. The PSC also agreed the CWIP must incorporate innovations in financing that leverage both private capital and market forces to reduce restoration costs.

The CWIP provides the PSC, CWIP Steering Committee members, EPA, and stakeholders with a first phase adaptive strategy that will build upon CWIP implementation successes, challenges, and innovations. The CWIP realizes the PSC's vision as a collaborative approach that complements jurisdictions' WIPs by accelerating the pace of restoration, recognizing water quality and ecosystem protection as cost-effective, setting the stage for financing innovations that can help reduce costs and stimulate investments in clean water, and fostering healthy competition in ecosystem restoration markets to achieve Chesapeake Bay implementation goals by 2025.[1]

The CWIP presents a best management practice (BMP) implementation strategy and offers an opportunity to advance the implementation of landscape-scale restoration strategies in the Susquehanna River basin using BMPs that can integrate into existing land management strategies—particularly in the agricultural community where socioeconomic demands must be addressed to ensure both the practices and individual farm businesses are sustainable over the long term. To address efficiency and cost-effectiveness, BMP implementation is targeted to the Land-River Segments (LRSs) within the Susquehanna River basin that are most effective at delivering nitrogen to the Chesapeake Bay and, therefore, offer the best opportunity to improve conditions in the Bay by reducing nitrogen loads. More specifically, implementation is targeted to those areas where actions to reduce nitrogen locally have the greatest impact on increasing DO in the deep water/deep channel areas of the Bay (i.e., the areas where achievement of water quality standards is most difficult).

Since the CWIP strategy specifically targets nitrogen, implementation of the recommended suite of BMPs will approach but not achieve the phosphorus goal, reducing phosphorus by 0.16 million pounds per year rather than the target 0.26 million pounds. The jurisdictions are on track to exceed the 2025 phosphorus target, therefore the phosphorus target for the Conowingo is not a priority. The additional phosphorus load reductions for the Conowingo could come from a nitrogen-phosphorus nutrient exchange process or basin-to-basin exchange if approved by EPA. Consistent with the jurisdictional WIPs, sediment is assumed to be met; for additional information on sediment targets, please see Appendix J.

The implementation strategy presented here targets a specific geography but is not site-specific; the CWIP implementation will rely upon a cooperative multi-jurisdictional effort that includes further assessments to identify specific locations for implementation. The CWIP serves as a starting point for outreach and coordination with local stakeholders on an implementation framework that begins with web-based outreach to reach the widest audience, followed by more targeted outreach in the selected geographies that are aligned with the jurisdictions' outreach strategies for the WIP III.

The CWIP also lays out the initial process for developing and launching a financing strategy. A central focus of the CWIP is to promote flexible, cost-effective, and innovative approaches to address both CWIP load reductions and financing needs, as well as to accelerate the implementation of practices that maximize co-benefits, particularly climate change adaptation and resilience, and mitigation and restoration benefits. The CWIP also recognizes that in-water practices—such as reservoir dredging and reuse, submerged aquatic vegetation, and a restored aquatic ecosystem—have pollution reduction benefits that should be further explored and possibly utilized. Such

[1] Please see Appendix I for results of a scenario run to evaluate land cover changes proposed through 2035.

BMPs may be explored in subsequent versions of the CWIP and are not included here, as additional information is needed to fully evaluate these innovative practices.

The CWIP identifies opportunities and contingencies for reducing Conowingo loads that are either underway or should be further explored, including:

1. Identifying, leveraging, or expanding market mechanisms (e.g., nutrient credit trading) that can be scaled up to accelerate restoration progress;
2. Using in-water practices like dredging and reuse of dredged material for beneficial uses such as living shorelines or other innovative end products and developing nutrient reduction crediting science and frameworks for restored aquatic ecosystems (e.g., submerged aquatic vegetation, oysters, and other filter feeders like shad, menhaden, and freshwater mussels);
3. Implementing other cost-effective BMP opportunities across all sectors (wastewater, agriculture, developed, air) with additional pollution reduction capacity.

In addition, a set of alternate BMP strategies are provided that offer opportunities to expand the geographic scope of the CWIP as well as the type and extent of BMP implementation. These strategies provide the starting point for contingency planning and adaptive management. A complete overview of these alternate strategies can be found in Appendix F.

The CWIP has been developed pursuant to discussion with the CWIP Steering Committee and stakeholders, who provided feedback on the direction of the strategy, and guidance on adjustments and modifications as the CBP partnership initiates the implementation process. As implementation advances, the CWIP will utilize annual progress evaluations, two-year milestones, and continued public engagement to manage this collaborative effort in an adaptive way that complements and adds value to the watershed-wide restoration effort.

Introduction

The Conowingo Watershed Implementation Plan (CWIP) is developed to address the additional nutrient loads entering the Chesapeake Bay that were not previously accounted for by the 2010 Chesapeake Bay Total Maximum Daily Load (TMDL). When the Chesapeake Bay TMDL was established in 2010, it was estimated that the Conowingo Dam would be trapping sediment and associated nutrients through 2025. New information has discovered that this is not the case and the reservoir behind Conowingo Dam has now reached dynamic equilibrium (USACE & MDE, 2015), whereby more nitrogen and phosphorus are now entering the Chesapeake Bay than was estimated when the TMDL was established.

No jurisdictions were assigned the responsibility to achieve these additional reductions when the TMDL allocations were finalized in 2010. Even with full implementation of the seven Bay jurisdictions' Watershed Implementation Plans (WIPs), this additional pollutant loading will contribute to water quality standard exceedances in the Chesapeake Bay. The U.S. Environmental Protection Agency (EPA) documented that adjustments to sediment and associated nutrient load reduction obligations would be needed if monitoring showed the trapping capacity of the reservoir behind the dam was reduced (US EPA, 2010, Appendix T).

On January 31, 2019, the CBP Principals' Staff Committee (PSC) finalized a framework for developing the CWIP (CBP, 2019a, Appendix C), and the CWIP Steering Committee more recently identified nitrogen load reductions (CBP, 2019b) as the primary goal since most of the jurisdictions within the Chesapeake Bay watershed are projected to exceed their phosphorus goals. Central to this CBP partnership framework is the premise that additional Conowingo load reductions are not allocated or subdivided among each jurisdiction, but rather will be achieved collectively by the jurisdictions working together through a flexible, adaptive, and innovative CWIP approach.

The purpose of the CWIP is to present a plan for best management practice (BMP) implementation to achieve the desired pollution load reductions and to articulate the programmatic commitments needed to implement the BMPs. It also outlines the process by which climate change impacts will be addressed. Estimates of BMP types, geographic extent, nitrogen reductions achieved, and total cost of the CWIP scenario are also presented to approximate the extent, location, and resources associated with pollution reduction practices that would address the additional loads passing through the Conowingo Dam. The implementation strategies presented within are not spatially explicit; CWIP implementation will rely upon a cooperative multi-jurisdictional effort that includes additional assessments to identify the types of BMPs and their specific locations. The Programmatic and Numeric Implementation Commitments section of the CWIP describes potential approaches to implement the CWIP given available resources, current programs, and a market-driven approach.

Finally, the CWIP provides the framework for a scalable, efficient, and effective financing system that will ensure long-term investment in restoration activities and projects.

Background

The Conowingo Reservoir is located in the lower portion of the Susquehanna River basin. The Susquehanna River basin has a 27,500 square mile drainage area that is largely (77%) in Pennsylvania with 22% of its area in New York and 1% (281 square miles) in Maryland. The Susquehanna River itself is 444 miles long, originating in Cooperstown, New York, and flowing through Pennsylvania and Maryland before emptying into the Chesapeake Bay near Havre De Grace, Maryland. The reservoir was constructed in 1928 and is owned and operated by Exelon Corporation with a design capacity of 30,000 acre-feet. It is the most downstream of the four hydroelectric dams and their reservoirs located on the lower Susquehanna River (Figure *1*).

The dams in the lower Susquehanna River have historically trapped and stored sediment and associated nutrients transported from the watershed, preventing these pollutants from reaching the Chesapeake Bay. Decades prior to the establishment of the 2010 Chesapeake Bay TMDL, scientists had concern over impacts to the Chesapeake Bay from the lower Susquehanna River reservoirs filling and reaching their capacity. In 1995, it was determined that two of the three reservoirs, Safe Harbor and Holtwood, had reached their sediment trapping capacity. The 2010 Chesapeake Bay TMDL (EPA, 2010, Appendix T) also recognized that TMDL allocations may need to be reevaluated with Conowingo Reservoir infill. Comparison of bathymetric data from the Conowingo Reservoir (1996 to 2011) showed a 33% decrease in reservoir sedimentation, equating to a 10% increase in sediment load to the Chesapeake Bay (20.3 – 22.3 million tons) (USACE & MDE, 2015). The inability of these reservoirs to trap sediment results in pollutants being transported downstream where nutrients associated with the sediments adversely impact DO levels in the Chesapeake Bay.

Analyses of the sources of sediment being transported from the lower Susquehanna River reservoirs finds that most of the load entering the Chesapeake Bay during storm events originates from the watershed, with smaller contributions from reservoir scour (USACE & MDE, 2015). Analyses find the three reservoirs are no longer trapping sediment and associated nutrients over the long term, causing accumulated sediment to be released episodically during high-flow storm events. USACE & MDE (2015) concluded that the dams have reached a state of dynamic equilibrium where there is no appreciable change in sediment transport through the Conowingo Reservoir over the periods of years to decades; rather, there are periodic releases of sediment during high-flow events temporarily increasing the capacity of the reservoir, which subsequently continues to accumulate sediment until the next high-flow event.

Figure 1. Geographic location of the Conowingo Reservoir within the lower Susquehanna River basin.

The CBP partnership estimates that, after fully implementing the Chesapeake Bay TMDL and the Phase III WIPs, an additional reduction of 6 million pounds of nitrogen and 0.26 million pounds of phosphorus is needed in order to mitigate the water quality impacts of Conowingo Reservoir infill (Appendix C). Nitrogen is the primary pollutant of concern in the CWIP because of its impact on dissolved oxygen levels in the Chesapeake Bay and that the jurisdictions are on track to meet or exceed sediment and phosphorus goals. The CWIP framework states that pollutant reductions to meet the Conowingo targets should come from the most effective areas within Bay watershed jurisdictions—that is, the geographic areas with the greatest influence on Chesapeake Bay water quality. If implementation were directed watershed-wide, or not targeted in the most-effective sub-basins, the total pollution reduction needed would increase. For example, it is estimated using the Phase 6 suite of modeling tools, that 7.28 million pounds of nitrogen would need to be reduced if implementation was distributed watershed-wide, rather than in the most effective areas (US EPA, 2018).

The decision by the PSC to develop a CWIP is based on the studies indicating that conditions in the watershed have changed since 2010 and that additional load reductions of nutrients are now needed to mitigate the water quality impacts of the Conowingo Reservoir infill on the Chesapeake Bay (USACE & MDE, 2015; Easton et al., 2017). This decision by the PSC was reached based on the following:

- At the December 2017 PSC Meeting, the PSC agreed to assign the total pollutant reductions attributed to the Conowingo Reservoir infill to a separate Conowingo Planning Target and to collectively develop a separate CWIP (US EPA, 2018).
- At the December 2017 PSC Meeting, all PSC jurisdictional members agreed to pool resources and to identify a process to fund and implement the CWIP (e.g., the allocation of future EPA Chesapeake Bay Implementation and Regulatory and Accountability Program grant funding to the seven Bay watershed jurisdictions; US EPA, 2018).
- At the March 2018 PSC Meeting, the PSC agreed with EPA's request that the agency not have a member on the CWIP Steering Committee due to EPA's oversight role for the implementation of all the jurisdictions' WIPs, including the CWIP (US EPA, 2018).
- At the January 31, 2019 PSC Meeting, the PSC approved final revisions to a Framework for developing the CWIP (CBP, 2019a). The Framework is included as Appendix C.

CWIP Framework

The CWIP is not a jurisdictional WIP. The CWIP encompasses an adaptive management approach consistent with other jurisdictional WIPs. The CWIP is based on the best available information and supporting analyses to achieve the designated nutrient reductions. The CWIP acknowledges the need to adapt its approach as new information becomes available throughout the implementation phase, while putting in place a process to monitor outcomes, transparently assess progress, and reallocate and redirect resources as necessary. In support of this adaptive management process, ten additional CWIP strategies were developed exploring the impact of alternative BMP approaches as well as alternative geographies (Appendix F).

The framework represents an agreement amongst all Chesapeake Bay jurisdictions that recognizes:

A. Trapping of pollutants by the Conowingo reservoir over the past 80+ years has benefited the water quality of the Bay, and it has also benefitted jurisdictions to varying degrees by lessening load reduction responsibilities. However, those benefits are greatly diminished.
B. No reservoir maintenance to restore trapping capacity has occurred over the life of the dam and the reservoir is now near full capacity.
C. A potentially cost-effective approach to mitigate current adverse water quality impacts of the Conowingo reservoir that is in a state of dynamic equilibrium are realized by pooling resources to pay for pollutant reduction practices in the most effective locations (i.e., the locations with the most influence on Bay water quality). Pollutant reduction practices placed in the most effective areas will limit the overall load reductions needed. It is recognized that a jurisdiction may opt for an alternative, more individualized, approach based on its unique circumstances.

Geography of the CWIP

The CWIP framework document (Appendix C) identifies four geographic options for assigning pollutant load reduction responsibilities. After considering these options, the CWIP Steering Committee agreed at its September 23, 2019 meeting to use the "Susquehanna + Most Effective Basins" option as the basis for the CWIP (CBP, 2109b). However, after reviewing 11 potential implementation strategies, the PSC at its July 16th, 2020 meeting voted to present a draft primary BMP strategy for evaluation that focuses solely on the Susquehanna River basin as it is the source of nutrient loads to the dam. Ten alternate strategies and geographies are presented in Appendix F to be called upon as needed as part of the contingency plan and adaptive management approach.

Within the Susquehanna River basin and across the alternative strategy geographic scales, BMP implementation is targeted to the most effective sub-basins (referred to as Land-River Segments, or LRSs) to achieve an additional reduction of six million pounds of nitrogen and mitigate the water quality impacts of Conowingo Reservoir infill on the Chesapeake Bay. Relative effectiveness values were provided by CBP staff based on modeling that follows methodologies developed and implemented during TMDL allocations in 2009 (US EPA, 2010; Section 6.3.1). This modeling reflects the impacts of geography on nitrogen loading to the Bay and identifies geographies where a practice would have more direct impact on the dissolved oxygen of the deep channels of the Chesapeake Bay, and in turn its overall health (citation). The data used in this exercise utilized the land river segment scale, to best identify actionable areas to target implementation.

The relative effectiveness accounts for the amount of nutrients produced locally, and the transport of these nutrients through the watershed into the tidal areas and to the Bay, this therefore, reflects multiple watershed and estuary delivery factors (including the impact of dams and impoundments) affecting DO levels in the Chesapeake Bay. As a result, the most-effective LRSs are primarily those within the upland drainage area of the Conowingo Dam. Further, delivery to the Bay from the estuary considers the Bay's circulation and bathymetry (depth), as well as other factors. Figure *2A* and *Figure 2B* present the relative effectiveness maps for nitrogen and phosphorus, respectively, for the entire Bay watershed.

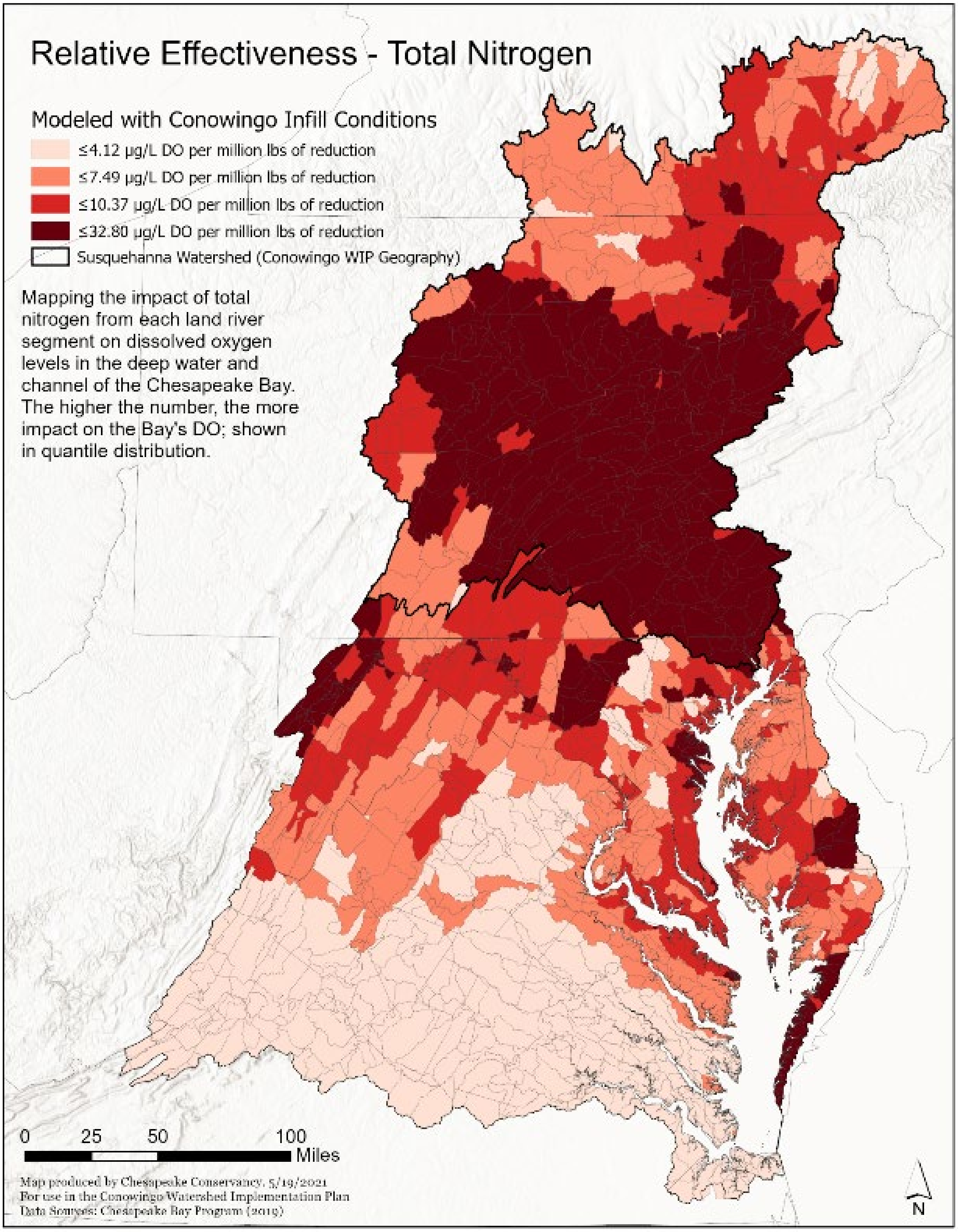


Figure 2A. Relative effectiveness of reducing nitrogen in each Chesapeake Bay land-river segment (LRS) on improving dissolved oxygen (DO) in the Chesapeake Bay.

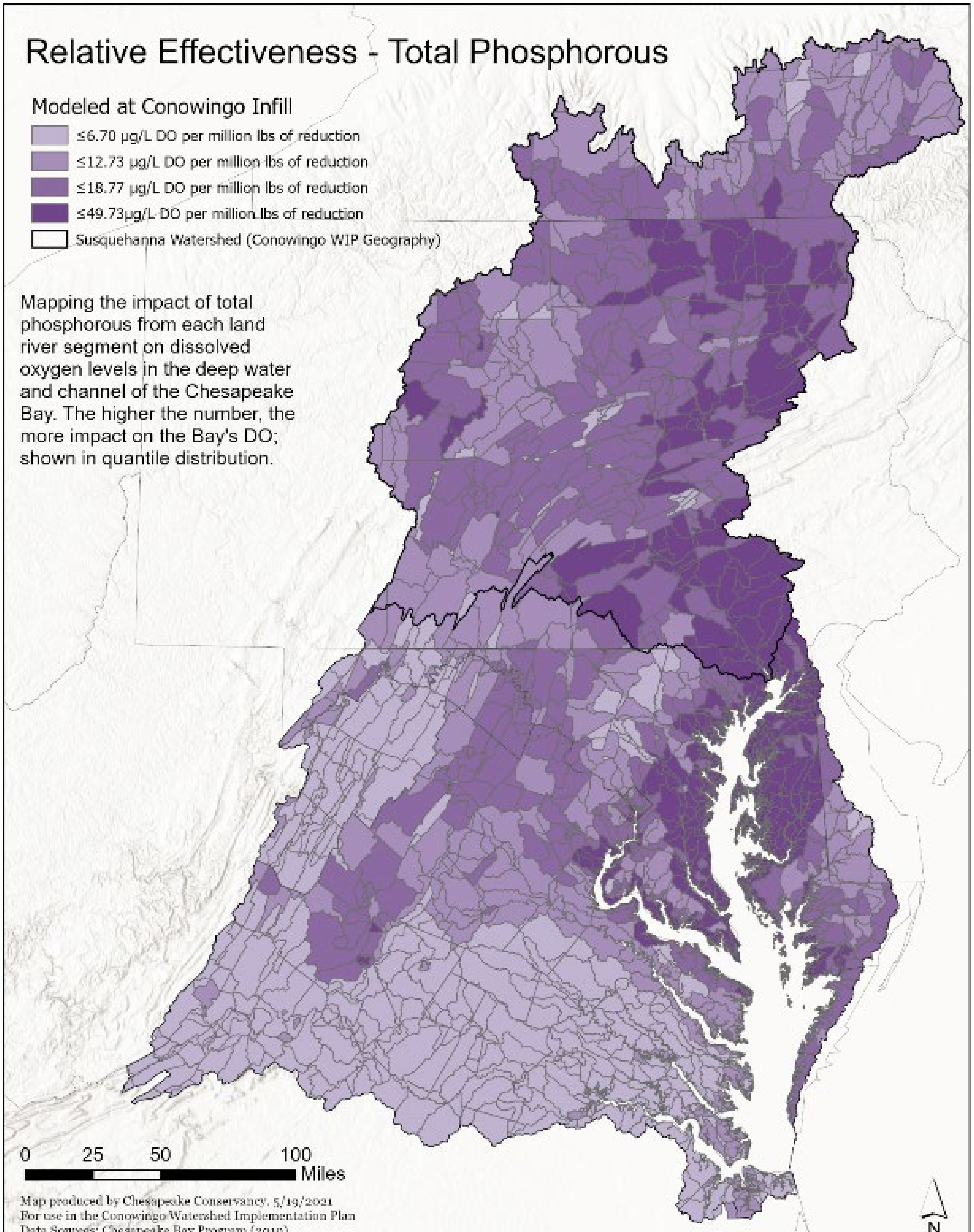


Figure 2B. Relative effectiveness of reducing phosphorus in each Chesapeake Bay land -river segment (LRS) on improving dissolved oxygen (DO) in the Chesapeake Bay.

Roles & Responsibilities

The CWIP was developed through the guidance and recommendations of a CWIP Steering Committee, a subcommittee of the PSC. The CWIP Steering Committee is composed of a representative from each Bay jurisdiction and the Chesapeake Bay Commission (CBC). The membership of this committee is provided in Appendix A. The EPA is not a formal member of this committee due to its oversight role as part of the Chesapeake Bay TMDL accountability framework. The decisions of the committee follow a list of guiding principles identified in Appendix A of the CWIP Framework document (Appendix C).

The roles and responsibilities of the EPA, CWIP Steering Committee, PSC, and third-party grantees are defined in the CWIP Framework document (Appendix C) and the cooperative agreements between EPA and the third-party grantees. Each of their roles as it pertains to the development and implementation of the CWIP are summarized below.

EPA will:

a. Evaluate the draft and final CWIP and provide biennial evaluations of the progress toward attaining the goals of the CWIP. EPA's evaluations, in consultation with the PSC, and any needed improvement will be used to determine if corrections or adjustments are necessary to attain the goals of the CWIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).
b. Issue a Request for Applications (RFA) for the third-party grantees and administer the subsequently awarded cooperative agreements. Since EPA will be issuing the RFA, it cannot act as a third party.
c. Provide technical staff and contractor support such as modeling or GIS analysis to the CWIP Steering Committee.

Guiding Principles

Fairness Principle: Strive for fairness, equity, and feasibility among state, local, and federal and other partners participating in the CWIP regarding level of effort, financing, tracking, resource sharing, and third -party access.

Governance Principle: Operate as an Action Team as defined in the document "Governance and Management Framework for the Chesapeake Bay Program Partnership". Strive for consensus using the Chesapeake Bay Program Partnership Consensus Continuum as described in the document. When consensus cannot be reached, the issue will be deferred to the PSC with a summary of the issue and the different options and opinions expressed by the members.

Consistency Principle: Ensure consistency with the EPA Phase III WIP expectations and CWIP framework documents.

Transparency Principle: Establish clear tracking, accountability and verification consistent with expectations for jurisdictions and to transparently demonstrate which practices are planned for, implemented and maintained in the CWIP vs state WIPs in order to avoid double-counting.

Efficiency in Innovation Principle: Implement the CWIP building on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. At the same time, strive for innovation, leverage new technologies, and, where appropriate, develop new implementation approaches.

**From the "Framework for the Conowingo Watershed Implementation Plan Appendix A. 10/12/2018 Final"*

The CWIP Steering Committee will:

a. Consist of a representative from each Bay jurisdiction and the CBC. Each Bay jurisdiction and the CBC may also solicit comments on the CWIP Framework from key stakeholders as part of its determination on whether and how to participate in the CWIP or an alternative path forward..
b. Develop the CWIP with EPA staff and grantee support.
c. Guide the development of a financing strategy and implementation timeframe – which has not been resolved and is recognized as essential elements of any final CWIP. Guide implementation of the CWIP, working with the third party.

The PSC will:

a. Approve the final draft CWIP for submittal to EPA and the CBP partnership for review and comment, subject to a determination by any jurisdiction to opt for an alternative path forward.
b. Approve the final CWIP before posting on the CBP partnership website.
c. Review the progress of the CWIP Steering Committee in the development and implementation of the CWIP, or a jurisdiction's alternative path forward, on a regular basis.

The third-party grantees, herein referred to as the CWIP Implementation Team (CIT) will, pursuant to EPA cooperative agreements:

a. Work with the CWIP Steering Committee to establish a timeline to implement the CWIP.
b. Develop draft and final CWIP documents, to include two-year milestones every two years, following the release of the final CWIP, that will articulate the programmatic, implementation, and numeric commitments to achieve the necessary load reductions due to the Conowingo Reservoir infill.
c. Document approaches and strategies to select and implement BMPs to cost-effectively and efficiently achieve the necessary load reductions and create a BMP Opportunity Analysis that identifies project-scale locations of high-priority opportunities for the load reductions. These approaches and strategies will include equity considerations, including prioritized implementation in underserved and underrepresented communities.
d. Facilitate the implementation of projects funded specifically in pursuit of CWIP goals or as identified through the financing framework.

> The BMP Opportunity Analysis will guide outreach and accelerate CWIP milestone planning by identifying project-scale opportunities for BMP implementation.
>
> This opportunity analysis will utilize best available data and innovative GIS-based methods for remote identification of suitable locations for specific BMP implementation efforts.

e. Develop and implement protocols and tools to readily track, verify, and report creditable practices for the CWIP.
f. Work with the jurisdictions to develop and implement engagement strategies with local communities in the priority geographies to advise the CWIP Steering Committee on locally relevant and actionable load reduction strategies.
g. Develop a draft and final financial strategy and implementation timeframe that are essential components of the CWIP, and to provide the administrative and financial resources to implement load reduction strategies.

The CWIP Implementation Team (CIT) is currently divided into three EPA funded activities:

Activity #1: Develop and implement the CWIP (Center for Watershed Protection lead)
Activity #2: Develop a Conowingo implementation financing strategy (Chesapeake Bay Trust lead)
Activity #3: Track, verify, and report progress made in the implementation of the CWIP and report to EPA on an annual basis (Chesapeake Conservancy lead)

Accounting for the Impacts of Climate Change

Climate change conditions and resulting increases in pollution loads have been incorporated into the jurisdictions' Phase III WIPs through 2025. The CBP partnership will reconvene closer to 2025 to reassess the science and mechanisms (jurisdictional WIPs, CWIP, etc.) for incorporating any additional change in climate pollution loads out to 2035.

A central tenet of the CWIP is to significantly scale-up implementation of BMPs in the most effective areas to reduce nitrogen loads to the Bay. Some of these BMPs (i.e., wetlands and reforestation) can reduce the vulnerability of communities to the effects of climate change, making communities more resilient, healthier, and less susceptible to urban heat island effects while helping restore water quality and ecosystem functions. Some of the key features of these "green infrastructure" practices are that they: 1) provide enhanced storage capacity for flood mitigation of more intense and larger precipitation events, 2) reduce greenhouse gases through carbon sequestration, and, 3) lower temperatures through shading and evapotranspiration. Focusing CWIP resources and funding to these practices may stimulate the development of versatile designs that provide multiple benefits to local communities. Additionally, they can provide vital habitat to priority species in the Chesapeake Bay.

As project implementation moves forward, two-year milestones and investment decisions on individual projects will be refined using the most up-to-date and available climate modeling data and assessment framework. The CWIP will function in concert with the overall jurisdictions' WIPs, which allows CWIP implementation to adjust to the impacts of climate change as the science evolves and advances.

Accounting for the Impacts of Growth

The geography of the CWIP extends across both local and state political lines. As a result, there is no organized or centralized entity responsible for growth management. Consequently, it is expected that the change in load reductions due to growth will be accounted for through the jurisdiction-specific Phase III WIPs' accounting processes. As such, the CWIP does not need additional measures to address growth.

Comprehensive Local, Regional, & Federal Engagement Strategies & Commitments

Since Implementation of the CWIP is not the responsibility of any one state, the CIT, consisting of third-party grantees (specifically the Center for Watershed Protection, the Chesapeake Bay Trust, and the Chesapeake Conservancy), will initiate the implementation process in those jurisdictions that decide that the path forward is the CWIP. The CIT will oversee both outreach and technical tasks in support of CWIP implementation and these tasks are discussed in further detail in subsequent sections of this plan. During the initial two-year milestone process, the CIT will facilitate the cooperative approach to implement programs and practices with the available resources. The CIT will report to and consult with:

- EPA representative(s)
- CWIP Steering Committee or specific designees
- Finance partners/representatives
- Stakeholders and the public through outreach and engagement processes

Consistent with the Framework for the CWIP, the engagement strategy adopts a Bay-wide effort to ensure that additional nutrient and sediment load reductions needed for a healthy Chesapeake Bay are achieved. The CWIP does not require the development of plans specific to local sites within the priority geography, rather an aggregation of targeted implementation of priority practices that together will achieve the necessary load reductions. The engagement strategy will be carried out in concert with the CBP partnership and jurisdictions' governments and will engage with federal agencies, regional and local governments, quasi- and non-governmental organizations, private sector for-profits, and individual citizens. Overall, the strategies identified in the CWIP build upon the efforts by the Bay jurisdictions to develop the jurisdiction-specific Phase III WIPs. This ensures consistency in messaging and efficiency in the delivery of important communications to a variety of stakeholders. For example, a Frequently Asked Questions (FAQ) document has been completed and is provided in Appendix B. While the aforementioned approach is necessary for the successful implementation of this collaborative WIP, more in-depth stakeholder outreach has and will be conducted in the targeted geographies of the Susquehanna River basin which are the focus of the primary CWIP strategy selected by the PSC.

There are three phases for local and regional stakeholder outreach developed by the CIT. Consistent with the adaptive management approach, there will be a review and evaluation of the strategies and their effectiveness to achieve the desired level of engagement with the completion of each phase.

- Phase 1 (2020 – 2021): Planning phase for stakeholder outreach, development of general materials, and web-based outreach to solicit input on the draft CWIP.
- Phase 2 (2021 – 2022): Outreach will focus on delivering the CWIP, developing draft two-year milestones, collecting data on specific projects that will be implemented to achieve the two-year milestones, and providing training to local stakeholders on the data tools produced as part of the CWIP to support project planning for implementation.
- Phase 3 (2022 – 2025): This phase includes Years 3 through 6 where outreach will focus on reconvening stakeholders annually to review and evaluate progress and make recommendations on the next set of two-year milestones. The development of additional training and guidance documents may be pursued based on feedback from stakeholders to include input from the CWIP Steering Committee. Stakeholders will be notified of proposed amendments to the CWIP.

Federal and CBP partnership engagement will be achieved through the continuation of the CWIP Steering Committee. The success of CWIP implementation will require continuous input from CWIP Steering Committee members to provide guidance on adaptive management strategies and adjust strategies to reflect future changes in standards, policy, and Phase III WIP strategies. CWIP Steering Committee meetings may occur quarterly or monthly based on the needs of the CWIP.

Engagement & Communication Goals

The success of the CWIP requires fulfillment of the EPA expectation for all WIPs to include a comprehensive strategy to engage local, regional, and federal partners in WIP implementation. The measures taken to adopt and implement nutrient load reduction strategies need to be representative of the available local capacity, and technical and financial resources to achieve the desired outcomes. This requires broad-based local community support that is guided and coordinated by jurisdictional agencies.

The CIT will provide outreach support for the CWIP. The CIT will work with EPA, state agencies, local governments, and implementation partners to provide information, tools, and resources that facilitate the implementation of the CWIP recommendations and help to identify locally relevant and actionable steps. As such, the engagement and communication goals for the CWIP are to:

1. sustain communication and engagement of federal, state, and local stakeholders involved in the development phase throughout its implementation. This will include both the public and private sector.
2. effectively communicate and provide timely information about financing options to implement nutrient-reducing strategies.
3. develop broad-based support for implementation by addressing the needs and capacity of specific sectors, communities, and organizations that are directly involved in implementation, tracking, and reporting.

At the time of this CWIP release, the entire Chesapeake Bay watershed community along with the rest of the world is battling the COVID-19 pandemic. Therefore, Phase I outreach was entirely web-based. Phase 1 outreach included a hybrid web-based and in-person outreach approach in accordance with state, local, and federal guidelines.

Strategies

To communicate and interact with stakeholders and partners in all the Bay jurisdictions, the CIT has and will utilize web-based strategies including webcasts and online workshops. These web-based platforms provide the ability to communicate with stakeholders and partners spread across a large geographic area and the flexibility to communicate when in-person meetings are otherwise not possible. The CIT provides ongoing support to the Bay Program and the CWIP Steering Committee to develop communications materials for distribution throughout the CWIP process. With 90% of the cost for BMP implementation in Pennsylvania and 90% for implementation in the agricultural sector (See Table 3, p.38), emphasis will be placed on engaging agricultural professionals in Pennsylvania with the capacity to implement the priority BMPs. During the milestone planning phase, technical tools created by the CIT like the BMP Opportunity Analysis (see p.35) will help local stakeholders identify new opportunities to implement the CWIP priority BMPs and set feasible implementation targets.

Phase I: Draft CWIP (2020 – 2021)

The release of the Draft WIP for public comment triggered a series of notifications to a Bay-wide audience. The Bay Program issued a press release on October 14, 2020 opening the public comment period on the draft CWIP, and delivered a web-based Communications Toolkit to CWIP Steering Committee members, customized to each jurisdiction. The CBP press release included a link to a pre-recorded general information webcast, fact sheets, and an FAQ document housed on the CBP website. These materials focused on 1) the background need for the CWIP, and 2) the process of developing the draft CWIP and the implementation goals.

The public comment period was initially scheduled for October 14, 2020 – December 21, 2020 but at the request of local stakeholders was extended through January 21, 2021. Public comment was collected via email at CWIP@ChesapeakeBay.net and comments in the chat box during the outreach webinars were included as part of the public comment record.

During the public comment period, CIT members engaged key stakeholders familiar with developing local and jurisdiction WIPs include:

- state and local agency representatives,
- local and county staff involved with Phase III WIP development and in Pennsylvania, Countywide Action Plan (CAP) coordinators and team members
- other individuals in the jurisdictions where implementation is expected to be a priority—Pennsylvania, New York, and Maryland.

Outreach Webinars

The CIT coordinated a series of online webcasts with CWIP Steering Committee members and local leaders providing an opportunity for questions and comments. The CBP website was regularly updated with registration information for webinars as they were scheduled. The team held 17 outreach webinars to provide key stakeholders with an opportunity to ask questions and provide feedback on the draft CWIP. The table below provides a summary of the outreach webinars. Recordings of the webinars (where available) can be found on the CBP website.

Webinar Date	Outreach Target for Webinar
November 18, 2020	Cecil County, Maryland
November 19, 2020	Bedford County, Pennsylvania
November 20, 2020	Harford County, Maryland
November 20, 2020	York County, Pennsylvania
November 24, 2020	Chesapeake Bay watershed
November 30, 2020	New York
November 30, 2020	Pennsylvania Agricultural Advisory Board/Nutrient Management Advisory Board (AAB/NMAB)
December 1, 2020	Baltimore County, Maryland
December 7, 2020	Centre County, Pennsylvania Cumberland County, Pennsylvania
December 8, 2020	Maryland
December 10, 2020	Franklin County, Pennsylvania Adams County, Pennsylvania
December 14, 2020	Pennsylvania
January 6, 2021	Pennsylvania Agricultural Community
January 7, 2021	New York
January 13, 2021	Maryland
January 13, 2021	Lancaster County, Pennsylvania
January 15, 2021	Lebanon County, Pennsylvania

The goal was to get feedback from those familiar with WIPs related to the draft CWIP strategy. The format was the same for all online workshops:

- CWIP Steering Committee members from the relevant jurisdictions were invited to participate in the online workshops and provide introductions. The CIT, led by Chesapeake Conservancy in Pennsylvania and New York, and by the Harry R. Hughes Center and MD Sea Grant Extension in Maryland, with support from the Center for Watershed Protection introduced the CIT, the history of and need for a CWIP, and the meeting objectives.
- The Center for Watershed Protection and Chesapeake Conservancy provided a technical overview regarding the BMP identification and selection process along with the implementation opportunity maps that resulted from this process.
- The lead CIT member facilitated discussions to and get feedback on initial concerns, potential for proposed BMPs, areas that are missing, constraints, and ongoing activities, which have been used to inform revisions to the CWIP.
- The CIT compiled feedback from all the online workshops and from comments submitted to the CWIP email address provided it to the CWIP Steering Committee through the Center for Watershed Protection in its report.

December 2019 – August 2020	Front-load *Constant Contact* database email addresses.
Summer 2020 – Fall 2020	Integrate with PA DEP WIP outreach activities and identify key stakeholders in Maryland and New York for online workshops.
Fall 2020 – Winter 2021	Hold seventeen (17) online workshops.
Early 2021	Provide workshop feedback to EPA and the CWIP Steering Committee.
Spring 2021	Roll out the BMP Opportunity Analysis with support to local stakeholders on the data tools produced to support project planning to implement the CWIP.
Summer 2021-Winter 2022	Upon finalization of the CWIP and draft two-year milestones, the CIT will focus on delivering the CWIP and collecting data on specific projects that will be implemented to achieve two-year milestones. The Harry R. Hughes Center (a CIT member) works closely with MDE on WIP III and will coordinate regular communication related to the WIP III and CWIP in Maryland, which will better align the WIP III and CWIP programs.

Overview of Public Comments Received

In total, we received 239 unique comments on the draft Conowingo Implementation Plan (CWIP) from 33 individuals/entities during the public comment period. The public comment period lasted 90 days, from October 14, 2020 to January 21, 2021.

- 159 comments (67%) were written comments formally submitted to the CWIP@chesapeakebay.net email address.
- 80 comments (33%) were comments informally submitted via the Chat Box in outreach webinars.

Comments were received from the following organizations within the below categories:

- State government agencies
- Local government agencies
- Groups, associations, clubs, organizations, and other organized entities
- Individuals without an affiliated organization

U.S. EPA submitted an evaluation of the draft CWIP to CWIP Steering Committee members and the CIT via email on May 5, 2021.

Public Comment Categorization

Comments and questions were imported into a tracking spreadsheet with fields for categorization. Upon entry, both comments and questions were assigned a unique identifier and all logistical details (like the name, affiliation, and contact information of the submitter) were recorded. Questions were addressed at the time they were received, whether by email or via webinar, and were omitted from the comments. Comments were then copy-edited (both the original and edited versions were kept in the spreadsheet) and categorized as follows:

Field Name	Question Version of Field	Field Type	Options
Topic Area(s)	Which of the following topic area(s) does this comment address?	Checkboxes (allows multiple selections)	Bay Model BMP Type Exelon Financing Geography Implementation Capacity Implementation Programs Outreach & Education Timeline Tracking & Reporting Other
Source Sector	Does this comment address concerns that are specific to a source sector?	Checkboxes (allows multiple selections)	Agriculture Urban/Developed Natural Other/Not Specified
Comment or Question	Does this submission include a comment, question, or both?	Checkboxes (allows multiple selections)	Comment Question
Comment Jurisdiction	Does this comment address concerns that are specific to a certain jurisdiction?	Checkboxes (allows multiple selections)	Delaware District of Columbia Maryland New York Pennsylvania Virginia Chesapeake Bay Not Specified
Comment Affiliation	What organization was this comment submitted on	Open-ended	N/A

	behalf of or in association with?		

Response to Public Comments

The CIT delivered a report to the CWIP Steering Committee summarizing the substantive issues raised by the public's comments and the suggested responses. The CWIP Steering Committee reviewed and finalized the responses and recommended edits to the CWIP following the public comment period.

Phase 2: Milestone Planning (2021 – 2022)

Pennsylvania

The CIT will perform the milestone planning and reporting and coordinate efforts with Pennsylvania Department of Environmental Protection (PA DEP) as part of the engagement process, inclusive of the CAP process. Schedules for CWIP milestone planning and final delivery are to be coordinated with jurisdictional Phase III WIP two-year milestone targets.

The PA DEP developed a phased approach[2] to implement the Phase III WIP through their CAPs. The CAPs assign each of the 43 counties within the Chesapeake Bay watershed to one of four tiers (Tiers 1 – 4), where each tier represents 25% of the pollutant load reduction for the Phase III WIP (*Table 1.*). Two "Tier 1" counties (Lancaster, York), one Tier 2 county (Franklin), and one Tier 3 county (Adams) participated in a pilot CAP process with plans completed in 2019. These counties have established CAP members and teams and the CIT will integrate with the existing CAP team structure to provide outreach. The engagement strategy for the Pennsylvania portion of the CWIP aligns development of the "Tier 2" CAPs for the Phase III WIP with the CWIP outreach. The ongoing "Tier 2" CAP process allows the CIT to interact directly with local stakeholders and state agency staff in the development of integrated strategies. This will allow the CIT to integrate the engagement strategy into the Phase III WIP strategy, creating efficiencies for all participants and ensuring consistent communication and fostering collaboration. Together, the CIT and PA DEP will use the Phase III WIP two-year milestone process to align the CWIP implementation timeline with the "Tiers 3 and 4" CAP process in the identified priority geographies.

[1]This phased approach to implementing Pennsylvania's Phase III WIP is described at: https://www.dep.pa.gov/Business/Water/Pennsylvania's%20Chesapeake%20Bay%20Program%20Office/WIP3/GetInvolved/Pages/Local-Government.aspx;

Pennsylvania counties and their tiers for CAPs. Counties with an asterisk (*) next to them were part of the initial PA DEP pilot for CAP development.

Tier 1	Tier 2	Tier 3		Tier 4	
Lancaster* York*	Franklin* Lebanon Cumberland Center Bedford	Adams* Northumberland Perry Snyder Huntingdon Columbia Mifflin Lycoming	Schuylkill Bradford Juniata Clinton Tioga Susquehanna Clearfield Fulton	Union Chester Dauphin Berks Blair Lackawanna Luzerne Montour Cambria Sullivan	Potter Somerset Wyoming Elk Indiana Cameron Wayne McKean Jefferson Carbon

Audience (for Stakeholder Engagement Workshops)

Emphasis will be placed on reaching out to targeted groups currently working on and/or familiar with local CAP development and implementation. This includes agriculture representatives, cooperative extensions, the United States Department of Agriculture (USDA), conservation districts, county and municipal staff, land trusts, environmental and engineering consultants, watershed groups, state agencies, water authorities, and local community leaders. These groups of people are specifically identified in the Community Clean Water Planning Guide[3] and will: 1) have relevant specialized knowledge, 2) be able to speak on behalf of impacted landowners and industries, 3) have connections to relevant groups, and, 4) have shown a willingness to engage. These groups will also be engaged during future outreach activities to share feedback on milestones and BMP implementation levels and strategies.

Communications & Timing

The CIT, specifically the Chesapeake Conservancy with assistance from the Center for Watershed Protection, will lead the CWIP local area engagement in Pennsylvania. Information will be provided to PA DEP to share with local stakeholders as part of the County Clean Water Technical Toolbox[4] for the CAPs. The CIT will join PA DEP staff at select CAP meetings (web or in-person) to discuss the complementarity of CWIP with Phase III Chesapeake Bay WIP.

Active CAP Counties

Beginning Winter 2021: The CIT will integrate outreach to Tier 3 and 4 counties through the CAP process by coordinating with PA DEP and participating in CAP meetings and phone calls with CAP Coordinators.

Other Counties

[3] https://www.ccpa.net/DocumentCenter/View/35039/WIP3-Community-Clean-Water-Guide

[4] http://files.dep.state.pa.us/Water/ChesapeakeBayOffice/WIPIII/FinalPlan/County-Specific%20Clean%20Water%20Technical%20Toolbox.pdf

Beginning Spring 2021: CIT outreach to counties who are not currently going through the CAP process with PA DEP will focus on providing the stakeholders with an understanding of how the CWIP is structured and how the development of CWIP two-year milestones will integrate with the CAP process. Outreach in these locations will include webcasts, participation in regional partnership meetings, and phone calls and in-person meetings with key stakeholders.

Maryland

A Maryland-specific outreach strategy has been developed, which recognizes that Maryland has specific areas identified in the CWIP target geography within the Counties of Baltimore, Harford, and Cecil, and they have completed county-based strategy development as part of the Maryland Phase III WIP. The outreach strategy for the priority geographies in Maryland follows a process similar to the strategy developed for the Phase III WIPs. The primary stakeholders identified for the Maryland WIP and CWIP engagement strategies are the same and county, municipal, federal, and soil conservation district staff directly involved with stormwater, agriculture, wastewater, septic, and federal facility BMP implementation. The CIT will communicate with Maryland Department of Environment (MDE) and Maryland Department of Agriculture (MDA) to ensure that communication efforts regarding the CWIP and the Phase III WIP complement each other.

Audience (for Stakeholder Engagement Workshops)

Emphasis will be placed on reaching out to targeted groups currently working on and/or familiar with local WIP implementation. For the first round of stakeholder engagement workshops, invitees will be organizations and local government agencies actively working on WIP-related projects in the watersheds identified in the CWIP. These groups were selected because they have been or are currently engaged in WIP projects and reporting and because they have a strong understanding of the watersheds. These groups will also be engaged during future outreach activities to share feedback on milestones and BMPs. Invitees are to include:

- County soil conservation district, NRCS, MDA, public works, and planning staff currently doing WIP work.
- Key Maryland Department of Natural Resources (MD DNR) staff that deal with land management or are doing WIP work.
- Local and regional watershed groups that are actively doing projects in cooperation with counties to meet WIP goals such as Octoraro Watershed Association, Friends of the Bohemia, Elk & North East River Watershed Association, and ShoreRivers.

Communications

The CIT members will continue to utilize a database of contacts developed during the Phase III WIP process to send out initial workshop notices and includes the ability for respondents to ask questions that can be passed along to the CIT.

CWIP Finalization: Summer 2021

During this timeframe, the CIT will focus on identifying project opportunities to reduce loads associated with the CWIP. Upon finalizing the CWIP the CIT will focus on delivering the CWIP and collecting data on specific projects that will be implemented to achieve the two-year milestones. CIT member the Harry R. Hughes Center also organizes regular statewide WIP meetings in Maryland and will allow for alignment of WIP III and CWIP meetings.

Within 1 month of CWIP finalization	Conduct a webinar to share the final CWIP
CWIP Finalization – January 2022	In-person (or web-based) regional engagement meetings to solicit input on draft two-year milestones due to EPA by January 15, 2022.
Three (3) months after CWIP finalization	Roll out of the BMP Opportunity Analysis with support to local stakeholders on the data tools produced to support planning of projects to implement the CWIP

New York

The initial outreach strategy for New York has been developed in recognition that this state is included in the primary CWIP implementation scenario. However, the most-effective sub-basins (LRSs) are very specific and have limited targeted areas primarily within Broome, Cortland, and Tioga Counties.

Audience (for Stakeholder Engagement Workshops)

The primary stakeholders identified in New York included state agency staff and those that have a central role in project implementation in the specific watersheds identified in the final CWIP (e.g., conservation district staff, Upper Susquehanna Coalition).

Communications

Because implementation is limited and narrowly targeted in New York, the CIT will focus primarily on direct communication with the audience via conference calls and web-meetings.

Phase 3: Implementation (2022 – 2025)

During this timeframe, the CIT will focus on providing technical assistance to local stakeholders to support implementation and the tracking, verifying, and reporting of projects toward meeting the two-year milestones by providing access to partner-led and external training opportunities. Should the Steering Committee consider making amendments to the CWIP, the CIT will work with Steering Committee members to develop a strategy for notifying local stakeholders and consider opportunities to collect public comment. The CIT will also reconvene stakeholders through webinars and virtual meetings platforms at the conclusion of each two-year milestone deadline to evaluate progress, adjust strategies in response to any CWIP amendments, and make recommendations on the next set of two-year milestones due to EPA by January 15 each even numbered year, and final milestones provided within 60 days of receiving EPA's comments on the draft milestones. The CIT will also engage local stakeholders to help compile milestone progress reporting by January 15 of each year, contingent upon funding available through the financing strategy or other sources to support implementation efforts.

Programmatic & Numeric Implementation Commitments

Partner Commitments

The Steering Committee is committed to achieve the collaborative vision behind the Conowingo WIP (CWIP) and recognizes the importance of each member's continued participation in related conversations. We want to keep each member of the Steering Committee and their respective organization active and engaged on this important effort. The final version of the CWIP and its implementation is dependent on funding availability, a financial plan and timeframe for implementation. Jurisdictions may be unable to effectively gain stakeholder support without knowing how much funding will be available.

We also recognize and affirm that the geographical focus of the CWIP at this time is the Susquehanna River basin, that the phased financing strategy is also targeted in the Susquehanna River basin, and that as a practical matter, Delaware, West Virginia, Virginia, and the District of Columbia are not currently involved in any related implementation, though alternative geographies may be selected in the future and will be selected by the Partnership. No jurisdictional funding commitments have been made to the Conowingo WIP at this time outside of what EPA has withheld from CBRAP grants. Additionally, as a non-jurisdictional member, the Chesapeake Bay Commission does not have any regulatory obligations related to the TMDL, although it works to achieve policy and budgetary outcomes, at both the state and federal levels to assist the jurisdictions in achieving their goals. Appendix T of the 2010 Chesapeake Bay TMDL, as quoted in the CWIP Executive Summary, also envisioned primary responsibility for Conowingo implementation by Maryland, Pennsylvania, and New York. Although several scenarios were run that include Delaware, West Virginia, Virginia, and/or the District of Columbia, as indicated in the CWIP Appendices, and for full transparency it is important to retain these in the final CWIP, the CWIP does not include or plan for any implementation within Delaware, West Virginia, Virginia, and the District of Columbia.

Conowingo Implementation Program Structure

The implementation program of the CWIP is structured to dovetail and work in tandem with financing institutions and existing state or grant programs to maximize capacity and deploy implementation funds in the most efficient way possible while providing thorough review and oversight of project implementation. Ultimately, the approach used to fund project implementation is a critical aspect of the CWIP and will be informed by and adapted to the financing strategy.

Implementation of projects funded for the purpose of reducing nutrient loads associated with the CWIP could occur through three primary pathways:

1. Existing cost-share programs
2. In partnership with existing organizations who currently have the ability to finance projects
3. Directly using performance-based (or similar) contracting

Existing State Cost-Share Programs

To prevent the development of duplicative or redundant programs, implementation of the CWIP should take advantage of implementation programs identified in the jurisdictions' WIPs. The jurisdictional WIPs provide a complete list of programs currently in place with information on implementation activities each program covers. Each Bay jurisdiction has a network of programs that could be utilized based on the selected BMP strategy, while this CWIP limits discussion to a few key programs in each jurisdiction that are in line with the CWIP implementation goals. Most of these programs are at being fully utilized to meet Chesapeake Bay goals, and additional Conowingo funding would be required to increase capacity for CWIP implementation. Projects implemented with Conowingo funding through these programs will be tracked and accounted for as part of CWIP milestone reporting. The programs identified in the CWIP are not intended to be a full catalog of cost-share programs; a complete listing of potential state cost share programs from an array of state agencies can be found in each of the WIPs. The programs referenced here are intended to serve as examples which could be utilized for CWIP implementation; however, the appropriateness of each program will be further informed and influenced by the financing strategy.

Pennsylvania

Conservation Excellence Program: The Conservation Excellence Program is a grant program administered by the State Conservation Commission and provides technical assistance and project funding through a mix of grants, low-interest loans, and tax credits to help farmers and landowners implement conservation BMPs.

Environmental Stewardship Fund: The Environmental Stewardship Fund is a dedicated fund used for environmental restoration, conservation, and community revitalization projects. Funds from the Environmental Stewardship Fund are directed to the Department of Agriculture, PA DEP, the Department of Conservation and Natural Resources, and the Pennsylvania Infrastructure Investment Authority (PennVEST) for water and wastewater treatment facilities, and grants to local governments and nonprofits.

Maryland

Maryland Agricultural Water Quality Cost-Share (MACS) Program: The MACS program is administered by the MDA and provides farmers with grants to cover up to 87.5% of the cost to install BMPs on their farms to prevent soil erosion, manage nutrients, and safeguard water quality in streams, rivers, and the Chesapeake Bay. The MACS program provides implementation cost-share funding and support for more than 30 BMPs currently, such as grassed waterways, streamside buffers, and animal manure management systems.

New York

New York Agricultural Non-Point Source Abatement and Control Program: This is a cost-share grant program that provides funding to address and prevent potential water quality issues that stem from farming activities. Financial and technical assistance supports the planning and implementation of on-farm projects with the goal of improving water quality in New York's waterways. The program seeks to support New York's efforts to implement BMPs that improve water quality and environmental stewardship. The program prioritizes water quality protection projects including nutrient management through manure storage, vegetative buffers along streams, and conservation cover crops. The program is a competitive grant program, with funds applied for and awarded through county soil and water conservation districts.

Program Support

Most of the jurisdictional implementation programs utilize soil conservation districts, local governments, and/or local partners to deliver technical support and/or funding. As a result, the local programs have the technical and administrative ability to implement, track, and verify BMPs and management plans in a manner that is consistent with CBP partnership requirements and specifications. While the technical and administrative ability to implement these BMPs are, for the most part, already in place to implement projects, the capital and human resources to increase the rate of implementation to meet CWIP goals are not in place. Based on discussions with State agency staff, a ramp up of implementation above WIP III goals will require additional communication, outreach, and/or incentives to allow implementation of the CWIP to move forward.

Since the CWIP requires additional implementation beyond WIP III, costs associated with outreach and education will likely increase. This will require a significant ramp-up of technical service providers and outreach specialists to expand relationships with private landowners and assist agricultural landowners in particular with the implementation of approved practices. The Pennsylvania Phase III WIP estimates approximately $52,148,734 annually is needed for new and existing resources to support the implementation efforts necessary to achieve modeled nitrogen load reductions of 24,806,000 pounds. A proportional estimate based on this information indicates local programs would need an estimated additional $12,515,696 annually to support the additional technical and administrative requirements to achieve the Conowingo nitrogen reductions. The cost of the CWIP implementation ramp-up will likely vary across Bay jurisdictions and BMP type, however, this initial analysis focuses on Pennsylvania State WIP III resource estimate broadly where the majority of the nitrogen reductions are targeted.

Existing Organizations with Financing Capacity

There are several existing organizations across the region that have the potential to finance water quality improvement projects at scale. These organizations have a track-record of providing grants and funding for projects that achieve specific environmental goals (e.g., water quality, habitat, etc.) in the Chesapeake Bay watershed. These organizations include but are not limited to:

- Chesapeake Bay Trust (CBT);
- National Fish and Wildlife Foundation (NFWF);
- Susquehanna River Basin Commission (SRBC); and,
- Pennsylvania Finance Authority (PennVest).

The University of Maryland conducted a review of institutions across the region to identify those that have the geographic reach, scope of services, and ability to finance projects to serve as a financing entity for the CWIP. This report was released in December 2020 as part of the financing strategy and the information from that report will be used to identify which organizations have the capacity to lead a pilot financing effort.

Performance-Based Contracting

The CWIP Implementation can address the PSC's Efficiency in Innovation Principle by using Performance based contracting or payment for ecosystem services (PES) contracts to deploy implementation funding directly to the highest performing projects. This approach focuses on developing strategic performance metrics such as nutrient emissions reductions and then directly coupling contracting payment to performance against these metrics. In other words, private contractors are paid based on the delivery of ecosystem services and nutrient reductions. The goal of this approach is to reduce the cost of securing pollution reductions and incentivize the private sector to develop and demonstrate new implementation approaches that achieve additional efficiencies by assigning risk and adjustment factors to a variety of project opportunities.

To allow for this flexibility and innovation, funding decisions would be informed through the use of "Project Tiers" to evaluate a level of risk associated with a variety of specific BMPs. This tier-based system would allow stakeholders and project offerors the flexibility to innovate, optimize, and incorporate efficiencies into a variety of restoration strategies that are proven to offer nitrogen load reduction performance while taking risk factors into consideration. Figure 3 shows how specific BMPs are categorized into these project tiers.

Tier I. Low Relative Risk

Tier I projects are considered priority BMPs in the CWIP that are mostly land-based, and therefore easier to track and verify over time. They have established and approved CBP partnership protocols and credit calculations. They are currently being widely implemented and likely have habitat and other co-benefits. These projects offer the lowest relative risk due to the ability to provide clear guidance on project specifications and credit and ease of tracking and verifying.

Tier II. Moderate Relative Risk

Tier II projects are either not land-based or more difficult to track, verify, and credit. They have or will soon have an approved CBP partnership protocols and credit calculations. Currently, some are not widely implemented or the technical and site-specific requirements to identify and develop load reduction estimates for a specific project in the CWIP are not feasible at this time. These projects offer a moderate level of risk due to the ability to provide clear guidance on project specifications and credit but are more difficult to track and verify.

Tier III. High Relative Risk

Tier III is designed to provide a pathway for innovation and may or may not be land-based BMPs but do not have an approved CBP partnership protocol or credit at the time of this CWIP. However, these practices may be approved at some future point based on current research (STAC workshop recommendations) or an activity under study such as dredging. These practices may have significant potential for load reduction, but additional research and development will be required to document water quality improvement metrics and these practices would not receive credit towards the planning targets without additional evaluation by the CBP partnership. These projects offer the highest risk because there are no specifications or credit at this time, but pilot projects (such as the Maryland Dredging Pilot Project) could generate data to support a specification and credit in the future.

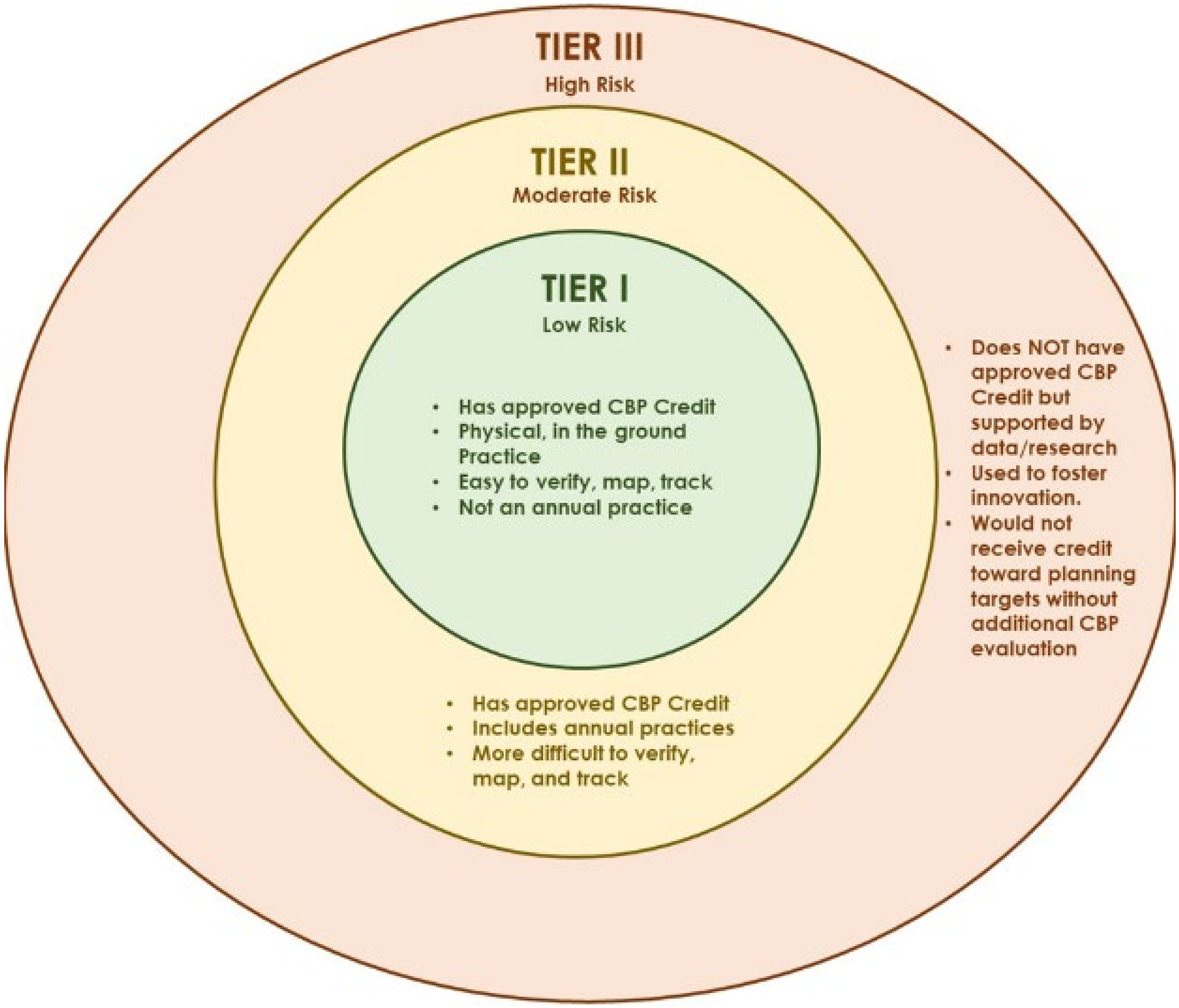


Figure 3. BMP project tiers matrix.

Performance-Based Contracting: Technical Review

The financing process must include a technical review of proposed projects that implement approved BMPs at scale or innovative approaches to BMP implementation that utilize detailed credit calculations. The technical review process will ensure that only technically sound projects with clear and accurate credit calculations will be considered for funding. To accomplish this, the technical review process must:

- Evaluate project offers on a technical basis;
- Evaluate project offers on a cost basis;
- Confirm, verify, and track completed contracted projects; and,
- Ensure the practices funded by the contract are tracked as CWIP projects and are not double-counted.

The technical review process may require support from qualified contractors who have specific knowledge and skills in key areas. The financing process will require that project offers utilize CBP partnership protocols and specifications in the responses and FieldDoc or jurisdictional-specific databases as part of the submittal process which will be evaluated for technical merit. The practices reported through FieldDoc or jurisdictional-specific databases as a part of the CWIP will be reviewed by Chesapeake Conservancy and reported to the jurisdictions and the EPA separately from other programs and funding sources. A list of metrics is set up in FieldDoc or jurisdictional-specific databases separately for each reporting program, and the data will be assigned a unique identifier that will tie the practice to the CWIP. Through this process in FieldDoc or jurisdictional-specific databases, project bids will document the location of the project which will allow the CWIP credit calculation to apply Edge of Tide and/or the Exchange ratios. These are described as follows:

- Exchange ratio is the adjustment factor applied to all projects located outside of the Susquehanna watershed to compensate for the adjusted level of effort required to achieve comparable results in the Susquehanna River basin.
- Edge-of-Tide ratio is the adjustment factor applied to all projects to normalize loads based on delivery to the mainstem of the Chesapeake Bay. The appropriate factor shall be calculated using assessment tools consistent with the CBP partnership modeling tools and accepted by the CBP partnership (Davis-Martin, 2017).

The technical review will also take into account project location when evaluating the credit. The technical review approach could be adapted to the Pennsylvania Nutrient Trading Program and the Chesapeake Bay Nutrient Trading Tool (CBNTT) once it reaches completion or the Maryland Water Quality Trading Program, which utilizes uncertainty ratios and Edge-of-Tide ratios to adjust for specific project types and locations. This analysis—which is consistent with methods used to define the priority basins—provides stakeholders and interested parties the ability to identify project locations within the selected CWIP geography that have the capacity to deliver the largest nitrogen reductions.

This approach supports the PSC's stated goal of developing a process by which preferred practices, targeted geographic locations, and implementation projects will be selected and deployed. It also supports the PSC's Transparency Principle by providing a financing mechanism for project implementation that can transparently document practices that are funded by and implemented for credit towards achieving CWIP goals.

Financing System Implementation Strategy

Introduction

In July 2019, the Center for Global Sustainability located at the University of Maryland, in partnership with Throwe Environmental and E3 International, was awarded an EPA grant administered by the Chesapeake Bay Trust to develop and implement a financing system designed to advance the Conowingo Watershed Implementation Planning (CWIP) process. The project team worked in close collaboration with the Center for Watershed Protection staff to incorporate proposed financing processes into the CWIP. This part of the CWIP project is being implemented in three phases:

- **Phase 1: Evaluation & Due Diligence**
  During this first project phase, the project team is evaluating existing financing capacities across the watershed, identifying innovative financing processes from other parts of the country, and drafting the structure of a new CWIP financing system and process. The primary project output will be a proposed financing strategy, which will be complete and ready for implementation by the end of December 2020.
- **Phase 2: Initial Program Launch & Implementation**
  The second phase of the project, occurring in 2020–2021, will launch the implementation and investment process at scale, thereby providing an opportunity to identify the strengths and weaknesses of the proposed system.
- **Phase 3: Complete Financing System Implementation**
  Finally, the third phase of the project occurring in 2021–2022, will be designed to enable course adjustments and establish the permanent Conowingo financing system.

The Financing Challenge

The obligation for mitigating the pollution loads attributed to the Conowingo Dam rests with the Bay jurisdictions with the budgetary assistance of the federal government; therefore, the obligation to finance mitigation is in addition to the already challenging obligation to finance the existing state-based watershed implementation plans. In other words, the financing obligation facing the Bay jurisdictions is now increased by 6 million pounds of nitrogen annually. Compounding the financing challenge facing the Bay jurisdictions is the fact that the additional financing obligation associated with the CWIP must be addressed in the midst of an economic recession. As a result, limited public revenue will become even more scarce as water quality restoration obligations increase.

The CWIP process created an additional unique challenge. Specifically, the Bay jurisdictions made a collective decision in December 2017 to address the Conowingo pollution loads collectively rather than allocating pollution responsibility through the existing state-based WIPs where BMPs are implemented, funded, and credited entirely through the auspices of the jurisdictions' WIPs. While this collective approach to the

CWIP has the potential to create very real efficiencies over time, success will not occur without a collective approach to funding and financing. The CWIP is also facing a very significant time constraint. The challenge to the financing team and the Bay States is to develop and implement a financing strategy and system within these constraints.

To be successful, the strategy must be designed around three key outcomes and conditions:

- The financing system must incentivize capital investment at scale in a very short amount of time;
- The system must support the most cost effective and efficient BMPs; and,
- The system must secure and leverage sustainable, long-term revenues to support restoration investments.

These three desired outcomes provide the structure or framework for the financing strategy itself.

The Financing Strategy

The proposed joint CWIP financing system must be founded on three key outcomes or conditions. First and most importantly, the financing system must be **efficient**. Reducing the costs associated with pollution reductions is essential to the entire financing process. However, a more important measurement of program effectiveness is efficiency and achieving this means gaining more pollution reductions per dollar invested. Therefore, the project team's primary goal is to identify the most efficient approaches for achieving the CWIP goals. There are any number of ways to improve efficiency of the restoration financing process, but the project team's primary focus is to identify options for reducing overall costs. Potential options for reducing relative costs include:

- <u>Reducing administrative costs</u>: this includes improving program or project performance; establishing innovative procurement procedures; establishing efficient institutions; and, maximizing financing and implementation scale.
- <u>Reducing implementation costs:</u> this includes reducing capital or aggregate costs, which can be accomplished by: incentivizing investment and funding in those places where project costs are inherently less expensive; funding practices that are less expensive, specifically in the long-term; and, reducing long-term operations and maintenance costs.

Second, the financing system must have the **scale** necessary to adequately address the restoration challenge, primarily in the form of revenue. Regardless of actual implementation costs, there must be a firm commitment to ensure there is enough revenue to support the CWIP. The scale of revenue flows is an issue that has received much attention in regard to the Chesapeake restoration process, and the CWIP is no exception. It is beyond the scope of this project to make recommendations on specific funding and revenue obligations. Rather, the goal is to identify opportunities and options for generating revenue flows from multiple public and private sources.

Finally, the financing system must ensure **long-term** water quality restoration success. This requires long-term dedicated revenue flows as well as access to credit, borrowed capital, and financing. At its core, financing is the process by which up front capital is allocated and invested in support of restoration activities whereas funding is the capital that is used in support of those financing activities. Effectively connecting the two is what ensures implementation success over the long-term. Ensuring that financing and funding continue throughout the duration of the project will include:

- <u>Leveraging:</u> high upfront costs associated with many structural practices can create an implementation disincentive, thereby shifting capital to short-term practices that may be less efficient in the long-term. Debt or leveraging spreads out upfront implementation costs over time, thereby making project implementation and financing more palatable to the public sector.
- <u>Transfer risk to the private sector:</u> By transferring risk to the private sector, or at least some the risk, private capital can provide upfront funding while the public sector funds the implementation over time. This can be a very effective way of reducing upfront capital costs.
- <u>Target long-term structural practices:</u> long-term practices may often be more efficient than short-term practices even though the upfront costs are dramatically higher. This is due to both implementation and administrative costs over time. Therefore, targeting long-term practices, especially in combination with project financing, may be a highly efficient financing/funding approach. Some interventions, such as targeting structural practices, will impact more than one enabling condition.

These conditions are the metrics by which the performance of the entire restoration financing system is gauged, and therefore, serves as the structure of a proposed financing system.

The draft financing strategy was completed at the end of 2020. The singular CWIP financing focus through 2021 will be to coordinate the opportunities and resources necessary to make this implementation timeline a reality. Given the political realities of allocating revenues at scale, the financing process will require a relatively conservative approach of approximately one to two years of collective restoration investment that can provide enough scale to effectively launch the system through an adaptive management process.

The initial focus of the financing effort will be on structural practices only because of the opportunities to engage the private sector and leverage private capital. This approach will allow several things to happen simultaneously. First, it will enable private capital to be deployed very quickly through the use of long-term contracts, financing processes, and innovative procurement systems. If implemented properly, this payment for ecosystem services (PES) approach will require little to no public funding responsibilities or commitments for the first five years of the implementation process. This is critically important as state and local governments work to address the economic and budget realities associated with the COVID-19 pandemic.

Financing Strategy Summary

Each of the questions and issues raised in regard to the CWIP financing process are being addressed in the Phase 1 CWIP financing/implementation plan. The Phase 1 plan will be delivered to the Bay Partnership later this summer, and that plan will address the key issues associated with the restoration investment process, including: revenue flows; institutional capacity; investment timelines; cost analysis; interaction with the state Phase 3 WIPS, and, efforts to effectively engage the private sector. The Center for Global Sustainability remains on track and ahead of schedule in regard to its contract and stipulated deliverables.

Private investment: All private investment occurs when there is a clear understanding of the potential return on investment that is balanced with the risk that investors are taking. Private capital would invest in the CWIP if it is an opportunity to make money. The balance between public and private benefit defines the entire public sector financing system.

Public funding: The only way that private investors will make money, at least in the near future, is if the public sector is compelled, for whatever reason, to pay them back for their investments. Basically, this means that the states are required to meet restoration goals and therefore are willing to pay the private sector for helping them do so. The financing strategy will not determine which jurisdictions are responsible for assuming the costs of achieving the CWIP (and therefore paying back any private investments into restoration). However, once it is determined who will ultimately pay for the CWIP implementation, investment can and will happen.

Pilot implementation: The financing strategy includes a proposed process for incentivizing investment as part of a pilot or initial launch process. The ultimate scale and timing of pilot investments depends entirely on when the funding supporting those investments is identified.

Primary CWIP Strategy: Nitrogen-Effective Practices Including Urban Forestry in the Susquehanna River Basin

This primary CWIP strategy was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen. In the CWIP, "strategy" refers to a geographic extent and a combination of restoration practices and BMPs. This primary goal of this strategy is to minimize the cost per pound of nitrogen reduction. The strategy geography is entirely within the Susquehanna River basin, which has the greatest relative influence on DO in the Bay.

Primary CWIP Strategy	
Geographic Extent	Above-the-median, nitrogen-effective LRSs within the Susquehanna watershed
BMP Sector(s)	Agricultural + Urban
States Involved	Maryland, Pennsylvania, New York
N Reduction	6,7 million pounds/year
Total Annualized Cost	$53.3 million/year
Unit Cost for N Reduction	$8/pound

At its core, this CWIP strategy offers opportunities to realize landscape-scale restoration in the Susquehanna River basin. This approach centers on a landscape-scale definition, which includes improving and rebuilding the ecological integrity of the landscape and enhancing people's lives by supporting the development of sustainable farm-scale efficiencies, creating income-earning opportunities, and improving the quality of life for residents. Landscape-scale restoration requires a balance between landscape functions that support communities and the economy as well as the ecological integrity and biodiversity of the area. Therefore, landscape-scale restoration must include strategies that can integrate into existing land management strategies—particularly in the agricultural community where socioeconomic demands must be addressed to ensure both the practices and individual farm businesses are sustainable over the long term.

To address this goal, the primary CWIP strategy supports restoration efforts in three core areas:

1. Natural Filters (wetland restoration and riparian forest buffers)
2. Sustainable Farm Practices (prescribed grazing and conservation tillage)
3. Nutrient Reduction Practices (nutrient management and manure Incorporation)

Natural filter projects directly relate to existing landscape restoration programs like those supported by the U.S. Forest Service which direct funding to the restoration of priority forest landscapes and State Forest Action Plans. Although the CWIP goals are specifically focused on nutrients, the BMP strategy also serves to meet other land conservation objectives such as improving wildlife habitat by increasing wetland and forest areas. The implementation strategy for the CWIP, discussed later in this document, relies on considering the practices comprehensively. This approach will allow for a variety of financing strategies, where risk can be managed across a portfolio of practices via performance-based contracts over long-term multiple multi-year timespans.

Unlike the natural filters, which are typically implemented as a single project, the management-based practices like nutrient management and conservation tillage support sustainable farms without reducing tillable land. They accomplish this goal by reducing nutrients at the source. Unlike structural practices, which function over multiple years with periodic maintenance requirements, annual and management-based practices require consistent effort (i.e., maintenance and ongoing implementation) from the farmer or land manager to maintain their effectiveness.

Geography of the Primary CWIP Strategy[5]

This scenario targets those LRSs in the top two quartiles for relative effectiveness (based on nitrogen reduction) within the Susquehanna River basin (*Figure 4*). According to the relative effectiveness model, actions taken to reduce nitrogen loading in this geography will result in greater nitrogen reduction to the Bay when compared to the same level of effort applied elsewhere on the landscape. See "Geography of the CWIP" on p.5 for more explanation on relative effectiveness. To further target local outreach and implementation efforts, Steering Committee members from each jurisdiction within the priority geography have and will guide the CIT to direct outreach to stakeholders and geographies that have the greatest capacity to implement the CWIP.

Implementation targets and strategies will be established in partnership with local stakeholders as described in Comprehensive Local, Regional, & Federal Engagement Strategies & Commitments; Phase II: Milestone Planning (p.17). Should the two-year milestone progress reports indicate that the primary CWIP scenario is not sufficient to meet the stated goals in advance of the CWIP timeline, the CIT will work with the CWIP Steering Committee to further evaluate necessary actions, including expanding the geographic scope of the CWIP. More explanation on Contingency Plans can be found on p.45 under "Contingency Plans & Opportunities).

[5] The scenario presented was based on 1995 Modeling and will be refined to reflect the Conowingo Infill N-effective basins reflected in Figure 4.

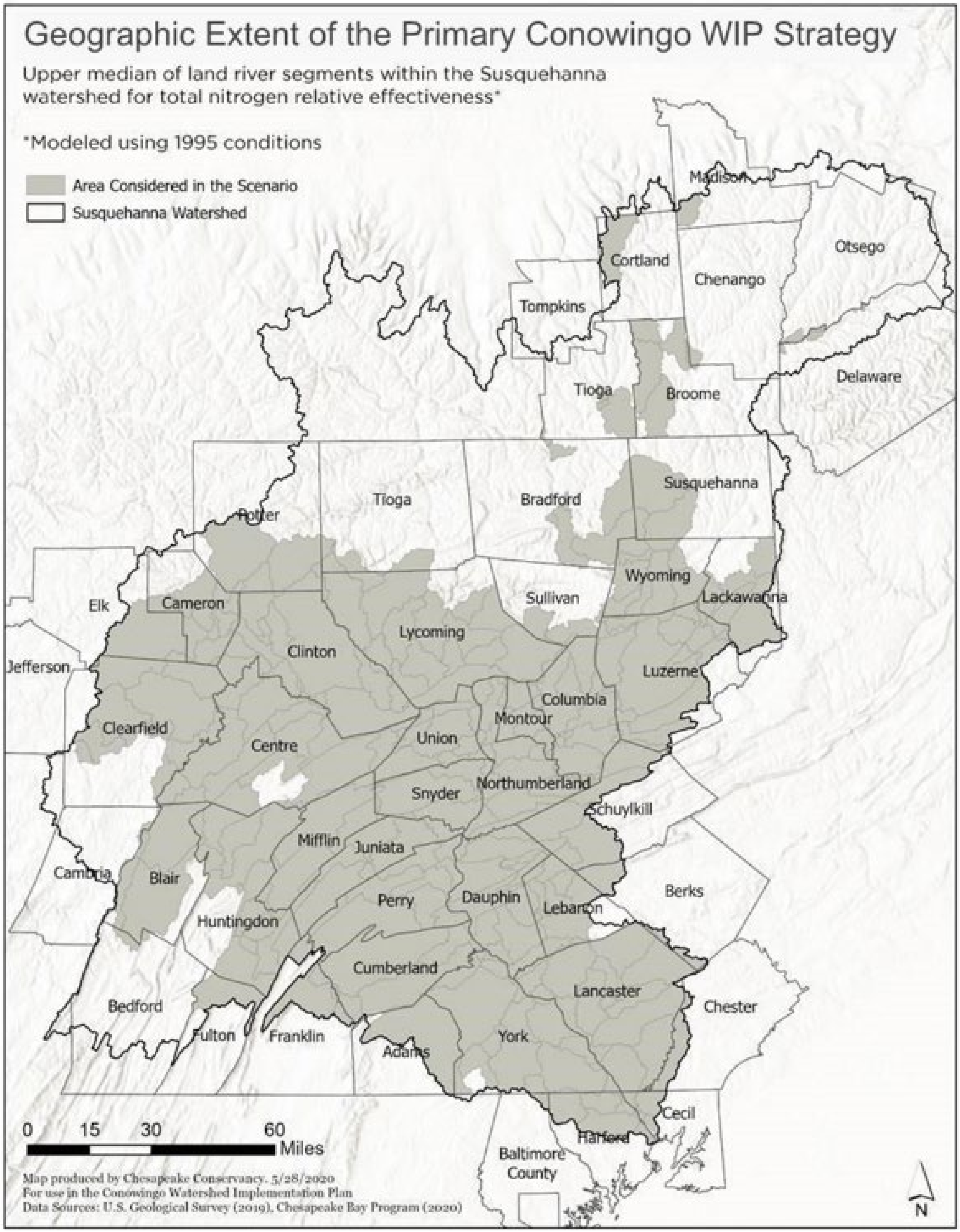


Figure 4. Geographic extent of the primary CWIP strategy.

BMPs in the Primary CWIP Strategy

The BMPs in the primary CWIP strategy address both developed and agricultural load sources and are accepted BMPs by the CBP partnership (Table *1*). The urban BMPs include the aggressive use of urban forest planting and urban forest buffers, and they could be expanded to include a broader suite of urban BMPs which may impact cost. However, urban land, and in particular urban land that is not regulated by the MS4 program, represents a very small fraction of the total area under consideration. Regulated MS4 land is specifically not included in this strategy under the assumption that the most-cost effective projects in these areas will be implemented and reported towards the Chesapeake Bay WIP goals. By targeting areas outside regulated MS4 lands, the CWIP avoids competing for projects or load reduction credits with local governments who are simultaneously working to achieve local MS4 and Chesapeake Bay WIP goals.

Table 1. Summary of acres of BMP implementation for the primary CWIP strategy.

BMPs Implemented in the Primary CWIP Scenario			
Practice	**Duration**	**Unit**	**Amount (Thousands)**
Agricultural Practices			
Nutrient Application Management Core Nitrogen	annual	Acres	185
Nutrient Application Management Rate Nitrogen	annual	Acres	602
Nutrient Application Management Placement Nitrogen	annual	Acres	201
Nutrient Application Management Timing Nitrogen	annual	Acres	603
Conservation Tillage	annual	Acres	217
High Residue Tillage	annual	Acres	50
Low Residue Tillage	annual	Acres	10
Prescribed Grazing	cumulative	Acres	67
Forest Buffers	cumulative	Acres in Buffers	23
Wetland Restoration	cumulative	Acres	11
Grass Buffers	cumulative	Acres in Buffers	20
Soil and Water Conservation Plan	cumulative	Acres	74
Manure Incorporation	annual	Acres	183
Barnyard Runoff Control	cumulative	Acres	0.6
Urban Practices			
Urban Forest Planting	cumulative	Acres	50
Urban Forest Buffers	cumulative	Acres	17

Coarse BMP Opportunity Analysis

As this CWIP strategy serves as a starting point for outreach and coordination with local stakeholders, the CIT developed a Coarse BMP Opportunity Analysis that identifies the potential implementation opportunities associated with in-the-ground BMPs for the Susquehanna as well as other "most effective basins" used in some of the alternative strategies. The Coarse BMP Opportunity Analysis helped quantify the available land for BMP implementation and illustrate local capacity to implement the CWIP. Ultimately, it aided in the selection of the geographic extent of the Primary CWIP Strategy. The specific location and type of BMPs will be further refined in the BMP Opportunity Analysis, which will be completed in subsequent phases of CWIP implementation as described in the Programmatic and Numeric Implementation Commitments section. The BMPs considered in this initial analysis were selected in consultation with the CWIP Steering Committee, as they address both developed and agricultural load sources, are accepted BMPs by the CBP partnership and data is available to map the extent of available area for future implementation. The BMPs included wetland restoration and forested buffers. The Coarse BMP Opportunity Analysis included the identification of areas where there is: 1) suitable watershed and land cover characteristics to implement wetlands and forested buffers within the counties, 2) area within a specific landscape for the BMPs to have the greatest corresponding load reductions in the Chesapeake Bay, and 3) additional opportunities for nitrogen load reductions over and above the jurisdictions' Phase III WIP goals as estimated from the difference between the "E3" and Phase III WIP scenarios. The E3, or "Everything, Everyone, Everywhere," scenario was completed by the Chesapeake Bay Program in 2010 as a part of the TMDL development process to reflect the best possible nutrient reductions. The data sources and methods used to derive the BMP opportunities are included in Appendix C.

Figure 5 and *Figure 6* illustrate the extent to which these BMPs can be implemented.

The specific location and type of BMPs will be further refined in the BMP Opportunity Analysis, which will be completed in subsequent phases of CWIP implementation as described in the Programmatic and Numeric Implementation Commitments section. The CIT will provide the BMP Opportunity Analysis and other technical tools to local stakeholders to enhance nutrient reduction planning efforts currently underway. These tools will be created at a scale that is locally relevant, which in many cases is at the county-scale as illustrated in the figures below.

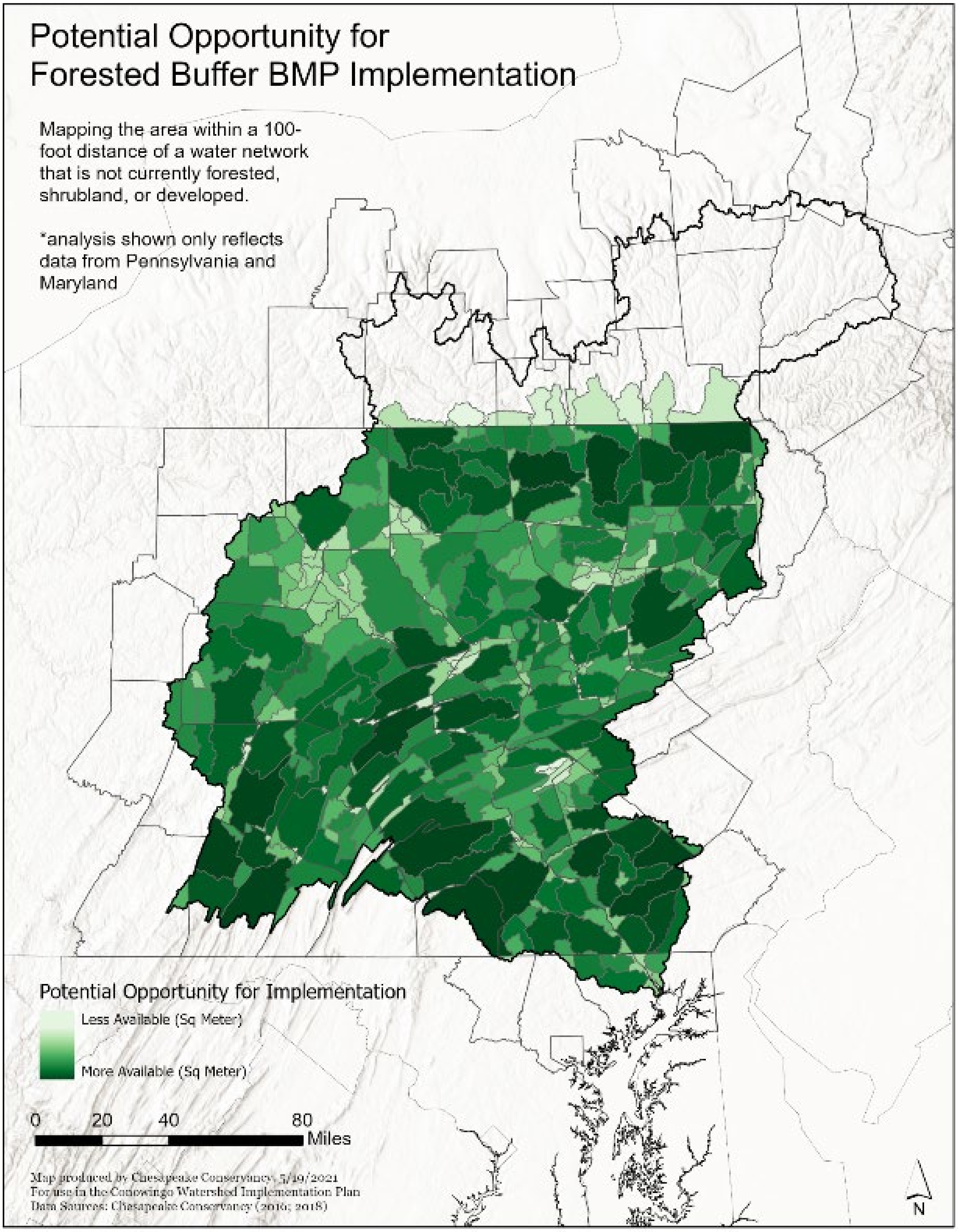


Figure 5. Opportunity to implement forest buffers within the Susquehanna and other effective basins.

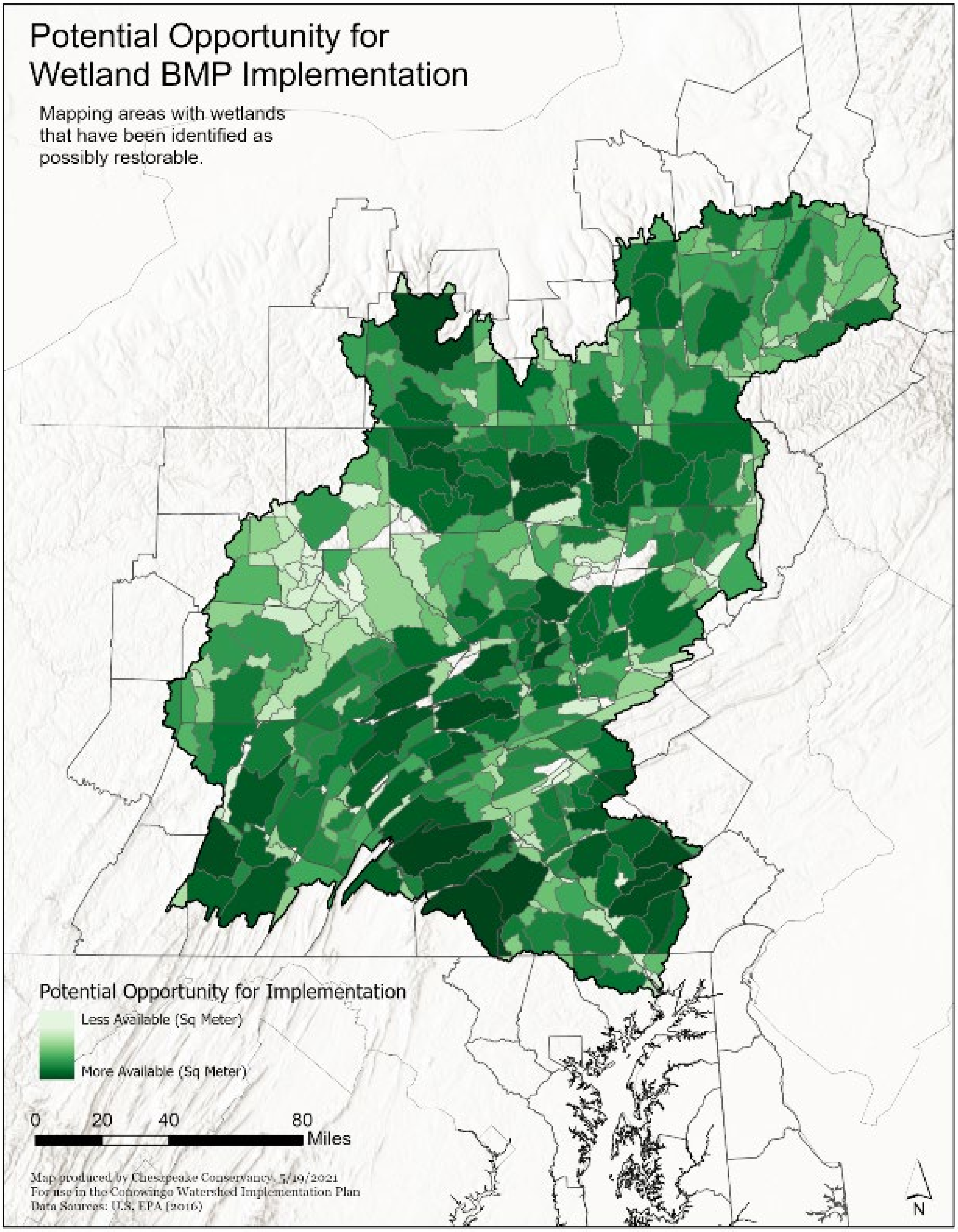


Figure 6. Opportunity to implement wetland restoration within the Susquehanna and other effective basins.

Load Reductions for the Primary CWIP Strategy

The primary CWIP strategy exceeds the nitrogen reduction target by over 700,000 pounds (Table 2), with 95% of the load reduction coming from Pennsylvania, and 89% from the agricultural sector. The nitrogen load reductions are determined from WIP III baseline, meaning the loads achieved after the BMPs identified in the Phase III WIPs have been implemented (MDE et al., 2019; NYS DEC, 2021; PA DEP, 2019). Although the BMPs implemented in the Phase III WIPs have not been implemented, they cannot be used to meet the CWIP goals, since they have already been proposed to meet Chesapeake Bay TMDL nutrient targets.

Table 2. Summary of nitrogen load reductions in primary CWIP strategy.

Load Reduction (Millions of Pounds) for the Primary CWIP Strategy										
		Nitrogen			Phosphorus			Sediment		
STATE	**Sector**	**Baseline**	**CWIP**	**Reduction**	**Baseline**	**CWIP**	**Reduction**	**Baseline**	**CWIP**	**Reduction**
MD	Agriculture	0.85	0.68	0.17	0.010	0.008	0.002	16	11	5
	Developed	0.35	0.35	0.00	0.020	0.020	0.000	17	17	0
	Natural	0.26	0.26	0.01	0.024	0.023	0.001	75	71	3
	Septic	0.19	0.19	0.00	0.000	0.000	0.000	0	0	0
	Wastewater	0.01	0.01	0.00	0.002	0.002	0.000	0	0	0
	MD Total	**1.67**	**1.49**	**0.18**	**0.057**	**0.054**	**0.003**	**108**	**100**	**8**
NY	Agriculture	5.59	5.52	0.07	0.151	0.150	0.001	131	129	2
	Developed	1.52	1.51	0.01	0.052	0.051	0.000	74	74	0
	Natural	2.93	2.93	0.00	0.222	0.221	0.000	323	320	3
	Septic	0.19	0.19	0.00	0.000	0.000	0.000	0	0	0
	Wastewater	1.41	1.41	0.00	0.070	0.070	0.000	2	2	0
	NY Total	**11.64**	**11.56**	**0.08**	**0.495**	**0.494**	**0.002**	**530**	**524**	**5**
PA	Agriculture	39.20	33.51	5.69	0.796	0.688	0.108	365	278	87
	Developed	13.98	13.34	0.64	0.367	0.348	0.020	423	407	16
	Natural	16.52	16.43	0.09	0.836	0.810	0.026	1,120	1,051	69
	Septic	1.66	1.66	0.00	0.000	0.000	0.000	0	0	0
	Wastewater	8.20	8.20	0.00	0.634	0.634	0.000	8	8	0
	PA Total	**79.55**	**73.13**	**6.41**	**2.632**	**2.479**	**0.153**	**1,916**	**1,744**	**172**
TOTAL		**92.86**	**86.19**	**6.67**	**3.184**	**3.027**	**0.158**	**2,554**	**2,368**	**185**

Cost of Primary CWIP Strategy

The total cost of the primary CWIP strategy is estimated to be $53.3 million/year (Table 3), with 93% of the cost for BMPs implementation in Pennsylvania, and 90% for implementation in the agricultural sector. The costs reported in Table 3 were calculated using state-specific cost profiles in the CAST model, based on newly updated costs in 2018 dollars.

Table 3. Summary of costs for BMPs implemented in primary CWIP strategy.

Annualized Costs (in Millions of $) by State and Sector for Primary CWIP Scenario			
	Agriculture	**Developed**	**Total**
MD	1.28	0.00	1.28
NY	1.39	0.07	1.47
PA	45.44	5.08	50.52
Total	48.11	5.15	53.27

The costs presented in Table 3 were developed using state-specific unit costs included in the 2019 Update to the CAST model (CAST-19). These costs are in 2018 dollars, and they are referred to as CAST 2018. In the previous version of CAST, costs were represented in 2010 dollars (CAST 2010), but the update also included some changes to the underlying cost assumptions, based on new cost data and studies. To present the potential variability in costs based on the data source, this section estimates the costs of both the entire primary CWIP strategy using all four cost profiles (Table 4), and summarizes the annual unit costs for each source.

As indicated in Table 4, the cost varies widely depending on the source of the unit costs ("cost profile") used to estimate the total annual cost of implementation. For example, if the cost was estimated using a Chesapeake-Bay-wide unit cost rather than the state-specific data used to estimate the strategy's cost, the estimate would drop by about $7 million per year, or approximately 14%. Surprisingly, the overall strategy cost using the 2010 watershed average costs is higher than the watershed-average costs using the CAST 2018 costs, while the cost estimates using the UMCES data are much higher (nearly five times) the CAST estimates.

Table 4. Primary CWIP strategy costs using different cost profiles.

Cost Profile	Estimated Total Cost Annual Cost ($ millions)	Description
CAST 2018 – State Specific	53.3	Cost estimate using CAST 2018 costs, with different unit costs for Maryland, New York and Pennsylvania. This profile was used to estimate costs presented in Table 4.
CAST 2018 Watershed Average	46.0	Cost estimate using Chesapeake Bay Watershed-Wide CAST 2018 costs.
CAST 2010 Watershed Average	51.3	Cost estimate using Chesapeake Bay Watershed-Wide CAST 2010 costs.
UMCES	253	Estimate using a hybrid of UMCES report data, combined with CAST 2018 watershed average unit costs when UMCES data were unavailable.

The wide range in cost estimates can be explained by the unit costs of specific BMPs (Table 5). In the update to CAST 2018 costs (from CAST 2010), the cost of most practices increased, but nutrient management was less expensive. This difference likely explains the decrease in cost between CAST 2010 and CAST 2018 watershed-wide estimates. The relatively high UMCES cost estimates are explained at least partially by the much higher cost of urban forest planting, combined with higher costs for most agricultural practices. The component costs used to estimate these annualized costs are provided in detail in Appendix G.

This discrepancy indicates that the costs presented in this document should be interpreted as a broad estimate; the costs may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. The costs presented in this plan do not include associated costs for financial services or technical assistance provided at the local level to facilitate implementation of CWIP-specific BMPs. Therefore, these cost estimates are likely low and will be refined during the outreach phase and with input from the financing strategy.

Table 5. Summary of the annualized BMP costs for the primary CWIP strategy.

Sector	BMP	Unit	Total Annualized Cost ($/unit/year)			Change from CAST 2010 (%):	
			Watershed Average CAST 2010	Watershed Average CAST 2018	UMCES Median	Watershed Average CAST 2018	UMCES Median
Ag	Barnyard Runoff Control	acre	559.4	579.90	942.43	4%	68%
Ag	Forest Buffer	acre	99.53	299.33	361.71	201%	263%
Ag	Grass Buffer	acre	43.6	181.27	141.48	316%	224%
Ag	Manure Incorporation	acre	17.34	20.23	56.67	17%	227%
Ag	Manure Injection	acre	85.28	85.28	n/a	0%	n/a
Ag	Nutrient Management Core N	acre	16.63	6.06	n/a	-64%	n/a
Ag	Nutrient Management N Placement and Timing	acre	17.13	9.24	n/a	-46%	n/a
Ag	Nutrient Management N Rate	acre	22.36	9.24	n/a	-59%	n/a
Ag	Precision Intensive Rotational/Prescribed Grazing	acre	18.83	47.13	245.30	150%	1203%
Ag	Soil Conservation and Water Quality Plans	acre	1.94	26.55	49.29	1269%	2441%
Ag	Tillage Management	acre	0	0	22.94	0%	n/a
Ag	Wetland Restoration - Floodplain	acre	95.27	442.59	n/a	365%	n/a
Ag	Wetland Restoration - Headwater	acre	294.57	477.67	602.30	62%	104%
Dev.	Forest Buffer	acre	86.17	178.46	n/a	107%	n/a
Dev.	Forest Planting	acre	82.57	42.54	3715.08	-48%	4399%
Total Average Annualized Cost Estimates By BMP Type			1440.62	2405.49	6137.20	67%	326%

Moving from Costs to Financing & Implementation

The CAST model is an important planning tool that enables state officials to better understand the scale of the financing challenge. There are, however, factors outside the model itself that will impact actual implementation costs, and these factors were also considered in the CWIP.

Forecasting Uncertainty

The CAST scenarios and corresponding cost estimates are statistical forecasts, which means that data are used to look for patterns that will continue into the future. However, the past may not be as accurate a predictor of the future. This is extremely important as it relates to financing. It is impossible to know exactly where practices will be installed, and how much they will cost at this stage of the planning effort.

Financing vs. Costs

An important part of the CAST model is its capacity to convert aggregate costs to annual costs. Annualizing costs this way allows planners to more effectively compare the relative cost-effectiveness of practices and scenarios. In addition, determining annualized costs is necessary when modeling annual practices because these costs exist in perpetuity. Without a predetermined end date, there is no way to calculate aggregate costs. It is important to note that annualized costs are based on modeled BMP lifespan, not on the cost of financing; nor do the estimated costs represent the realities of cost-share programs and the human capital needed to deploy program funding. Therefore, the CAST estimates can be best described as accounting or planning cost estimates as opposed to cash flow projections.

Achieving Goals

Pollution reductions are the priority goals related to Bay restoration in general and the Conowingo restoration effort specifically. There are, however, additional goals that are part of the Chesapeake Bay Agreement, including stream, wetland, forest buffers, and oyster restoration. These goals have been quantified and progress towards achieving those goals is tracked and reported by the Bay jurisdictions. These practices have been identified collectively as an integral part of a restored ecosystem and are therefore the ends that the restoration effort is designed to achieve. These practices also provide nutrient and sediment reduction benefits, which means they are a means to the water quality restoration end while generating multiple ecosystem service benefits.

Under-Counting Costs

CAST cost estimates are based on a pre-existing public financing system. Basically, the cost estimates are determined by the government-based system that funds projects. Though many of these funding programs are effective, they do not necessarily capture unique features of the broader financing system.

Revenue Risk

There is value in ongoing public investment in activities that are necessary for ensuring long-term community well-being; public safety, education, and transportation to name a few. However, adding water quality restoration and protection to this list comes with the long-term risks that are inherently part of the public financing process. Finally, this risk is compounded as a result of the multi-state nature of the CWIP effort. Achieving nutrient reductions in the most cost-effective and efficient way possible will require addressing the aforementioned exogenous factors and risks. Therefore, the CWIP financing system must be developed and implemented within the framework of broader community needs and priorities, which means the CWIP financing process must be structured as an optimization exercise when pollution reductions and their associated costs are weighed against exogenous risks and community priorities.

Recognizing this need for innovations in financing, the PSC has directed that a key component of the CWIP implementation is to develop a financing strategy that complements jurisdictional WIPs, accelerates Bay restoration overall, and provides healthy competition in the marketplace that will stimulate innovation and science while lowering costs. The University of Maryland is leading the effort to develop the CWIP financing strategy, which will be provided as a separate document when completed in March 2021.

Recognizing that the CWIP BMP implementation strategy will need to evolve with time and the completion of a comprehensive financing strategy, adjustments may need to be considered to better align with the innovative financing tools and ideas contained within the financing strategy.

Contingency Plans & Opportunities

A contingency plan for the CWIP provides safeguards to ensure the nitrogen load reductions are achieved in the case that the primary CWIP scenario is not sufficient to meet the stated goals in advance of the CWIP timeline. Through the development of the primary CWIP scenario, ten alternative scenarios were identified that will serve as the starting point for contingency planning and adaptive management (Appendix F). These alternative scenarios include options for expanding the geographic scope of the CWIP as well as the types and levels of BMP implementation. The CIT will work with the CWIP Steering Committee to further evaluate necessary actions given the options described in this CWIP. The annual reports on jurisdiction-specific and Conowingo load reductions, the two-year milestones reporting on progress, and the adaptive management approach provide the necessary checks and balances throughout CWIP implementation to evaluate whether alternative actions need to be taken. Any relevant future outcomes from Maryland's 401 Water Quality Certification for Conowingo Dam will be considered in this process, as appropriate.

The CWIP is developed with the option to introduce to the use of an Authority and a PFP approach to provide the opportunity for private capital to cover initial project implementation costs. This strategy maximizes CWIP resource flexibility by allowing investments in the most cost-effective projects and provides an opportunity for innovative projects while requiring the project offeror to demonstrate the amount of nitrogen load reductions achieved towards CWIP goals.

Alternative Approaches

The following are alternative approaches if CWIP implementation efforts do not meet load reduction targets:

- **Re-evaluate Priority Watersheds**. The CWIP focuses implementation on priority watersheds within the Susquehanna River basin based on their relative influence on Bay water quality as well as efforts to align with existing jurisdictional planning and implementation. If the market to support implementation does not achieve the required level of implementation, or the capacity of the current priority watersheds cannot meet the demand for implementation, the CIT will work with the CWIP Steering Committee, PSC, and EPA to identify additional effective sub-basins identified in the alternative strategies (Appendix F).
- **Other BMPs**. The CIT may utilize an extended list of BMPs that meet the CBP partnership requirements as creditable and reportable practices. Additional BMPs may be desired given the response or direction indicated by a market-driven approach or if there is greater capacity for other BMPs given site-specific geographies.
- **Dredging.** While modeling results from the USACE & MDE (2015) study notes that increasing or recovering the storage volume of the reservoir provides limited and short-lived ecosystem benefits to the Chesapeake Bay at a high cost of dredging, MDE is funding a study and pilot project to evaluate this action further with results expected in late 2021. The results of this study will evaluate the benefits of sediment reuse as a result of dredging and help the CWIP Steering Committee evaluate the cost-effectiveness of this activity. If found viable, the CWIP can be adjusted to incorporate feasible, cost-effective, creditable, and trackable load reduction measures identified in the study and approved by the partnership. The Steering Committee consulted with Bay Program modelers and are recommending several partnership actions to advance the science needed to evaluate Conowingo dredging, including:
    - The science-based modeling tools may already exist to quantify load reductions from any Conowingo dredging scenario. A key model that best represents the reservoir hydrologic and sediment dynamics needed to quantify nutrient load reductions from Conowingo dredging is the Exelon/HDR Conowingo Pond Mass Balance Model (CPMBM). The CWIP Steering Committee recommends the CBP partnership enter into a cooperative agreement with Exelon/HDR for application of the CPMBM to quantify nutrient removal benefits from Conowingo dredging operations.
    - The CWIP Steering Committee recommends the Bay Program Modeling Workgroup explore and, if appropriate, identify additional resources needed to oversee and integrate CPMBM with other appropriate Bay modeling tools.
- **Reassigning Loads.** EPA could decide to assign the required Conowingo reduction back to each of the jurisdictions if the CWIP is not effective at reducing loads. As stated in the October 2018 letter from the EPA to the PSC, "Pursuant to its role and authority under the Bay TMDL's Accountability Framework, EPA can

assign the necessary Conowingo load reductions among the seven Bay Watershed jurisdictions" (Appendix T of the Chesapeake Bay TMDL; U.S. EPA 2010).

Accountability, Tracking, & Crediting

The CIT will work with the jurisdictions, the CBP partnership and the CWIP Steering Committee to ensure all implemented practices are tracked, verified, and reported along with their associated load reductions for the CWIP. This process will also ensure the CWIP reported practices are not also being reported and credited toward State WIP implementation progress. The intent is to use the existing reporting and tracking tools to create efficiencies and reduce redundancy or unnecessary bureaucracies given the well-established and familiar protocols available to the CBP partnership and restoration practitioners (e.g., project implementers). The protocols provide assurance and accountability that load reductions associated with practices implemented in the selected geographies are credited towards the CWIP while the tools will help streamline the process across multiple geographic scales that align with the Chesapeake Bay TMDL.

There are three levels, or tiers, for reporting to track practice implementation—from the site-specific scale of implementation to the Chesapeake-Bay-wide modeling scale. The tools used for each tier include Chesapeake Commons' FieldDoc, jurisdiction-specific databases, and the National Environmental Information Exchange Network (NEIEN). New York, in particular, will utilize the Upper Susquehanna Coalition's Agricultural Environmental Management (AEM) database to track and report implementation toward the Conowingo WIP. Each of these reporting tools will include common fields or metrics to track and report projects that meet CBP partnership requirements and are credited towards the CWIP, rather than Phase III WIPs. The CIT is responsible for reviewing the accuracy and validity of the information given the steps described in the Quality Assurance Project Plan (QAPP), annually. Reports may also be provided to the jurisdictions based on their progress.

When a practitioner implements a project that will be tracked towards CWIP progress, they will be required to report the project through Chesapeake Commons' FieldDoc platform. This web-based tracking platform will allow the user to track practice implementation and assign it to both the CWIP program and other funding programs for reporting purposes. When a practitioner is done editing the project details and metrics, there will be a submission allowing them to report their practice to all attached programs. For a practice to be considered complete for CWIP reporting, a set of required metrics must be completed, including the information needed for a practice to be reported to NEIEN, as well as a spatial footprint and photograph of the practice. These data will be utilized for a data validation check as outlined by the Activity 3 Team in a QAPP and approved by EPA. An intermediate step may be taken at the jurisdictional level, where projects reported in FieldDoc are input to a jurisdiction-specific database that is then uploaded to NEIEN. The team may work with the various agencies to ensure the projects designated for the Conowingo are translated effectively.

Adaptive Management, Milestones, & Progress Reporting

The EPA will evaluate the draft and final CWIP and provide biennial evaluations of the progress toward attaining the goals in the CWIP. The EPA's evaluations, in consultation with the PSC, will be used to determine if corrections or adjustments are necessary to attain the goals of the CWIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).

Development of the 2022–2023 set of two-year milestones will be based on anticipated levels of funding both prior to and after the implementation of the Conowingo financing strategy. Two-year milestone goals can be developed with additional information from the CBP partnership related to anticipated funding levels for CWIP implementation prior to the implementation of the financing framework, and goals may be integrated into future drafts of this plan and/or future two-year milestones. However, the results of the financing strategy will largely determine the rate and scale of annual implementation.

For the initial set of two-year milestones, the CIT will work with the relevant jurisdictions to submit draft milestones to EPA by January 15, 2022, and final milestones provided within 60 days of receiving EPA's comments on the draft milestones. Milestone, due on January 15 each year, is contingent upon funding available through the financing strategy or other sources to support implementation efforts. An intermediate step may be taken at the jurisdictional level, where projects reported in FieldDoc are input to a jurisdiction-specific database that are then uploaded to NEIEN. In this case, the CIT will work with the jurisdictions to ensure the projects designated for the Conowingo are translated effectively. This process will be done in a timely manner to ensure adequate time for review and submission by the jurisdictions before December 1 of each year. A unique identifier in NEIEN will denote the project is credited towards the CWIP, rather than the jurisdictions' Phase III WIPs, to ensure that proper crediting can be completed.

Timeline & Next Steps

The development of the CWIP is arranged to occur in phases, with the plan completed in 2021 followed by a financing strategy . The focus of the CWIP is on which BMPs and where in the watershed they should be located to achieve the additive load reductions. The timeline is established to complement Phase III WIPs such that the CWIP identifies priority BMPs in local geographies to achieve the required nitrogen load reductions, which would ensure the health of the Chesapeake Bay remains on track.

In regard to the deadline for implementation, the CWIP is generally consistent with the jurisdictional WIPs. The EC committed in the 2014 Chesapeake Bay Watershed

Agreement to 'By 2025, have all practices and controls installed to achieve the Bay's dissolved oxygen, water clarity/submerged aquatic vegetation and chlorophyll a standards as articulated in the Chesapeake Bay TMDL document.'.

The draft timeline shown in Table 6 identifies key periods of CWIP development and its implementation. Annual CWIP implementation funding levels will impact the overall CWIP timeline and could result in implementation occurring after 2025 if funding is limited or delayed.

Table 6. CWIP development and implementation timeline.

Year	Key Decisions and Outcomes
2018	• October 28, 2018: the CBP PSC approved a Framework for developing the CWIP • Formation of the CWIP Steering Committee
2019	• Begin development of the CWIP (September) • Begin Stakeholder Outreach
2020	• CWIP approved with updated timeline • Finalized tracking and reporting protocols and tools (March/April) • Stakeholder Outreach • Draft financing framework • Begin design of the financing framework
2021	• Stakeholder Outreach • Complete financial strategy • Complete economic development investment plan • Draft plan for the financing framework • Project-specific BMP opportunity blueprint for priority geographies
2022	• Submit draft two-year milestones for 2022–2023 (January 15, 2022) • Submit final two-year milestones for 2022–2023, incorporating climate change by January 15 • Stakeholder Outreach • Launch the financing framework • Implementation of investment activities (Winter) • Milestone progress reporting due on January 15, contingent upon funding available through the financing strategy or other sources to support implementation efforts
2023	• Continued implementation of investment activities •
2024 – 2025	• Submit two-year milestone for 2024–2025 by January 15 • Continued implementation of investment activities • Submit two-year milestone for 2026–2027 by January 15 • Milestone progress reporting due on January 15, contingent upon funding available through the financing strategy or other sources to support implementation efforts

References

Chesapeake Bay Program (CBP). 2018. Framework for the Conowingo Watershed Implementation Plan. October 12, 2018 Final version.

Chesapeake Bay Program (CBP). (2019a, January 31). *Chesapeake Bay Program Principals' Staff Committee Meeting, Final Actions and Decisions*. Retrieved from: https://www.chesapeakebay.net/channel_files/36881/psc_actions-decisions_01-31-19_final.pdf

Chesapeake Bay Program (CBP). (2019b, September 23). *Conowingo WIP Steering Committee Meeting, Face to Face*. Retrieved from: https://www.chesapeakebay.net/channel_files/39794/conowingo_wip_actions_and_decisions_23.9.19_(1).pdf

Chesapeake Bay Program (CBP). (2019c, August 12). *Chesapeake Bay Program Principals' Staff Committee Conference Call, Final Actions and Decisions*. Retrieved from: https://www.chesapeakebay.net/channel_files/40423/i._psc_actions-decisions_8-12-19_final.pdf

Chesapeake Bay Program (CBP). (2020, January 24). *Chesapeake Bay Program Principals' Staff Committee, Program Update*. Retrieved from: https://www.chesapeakebay.net/what/event/principals_staff_committee_meeting_january_2020

Davis-Martin, J. (2017, December 4). Chesapeake Bay 2017 Midpoint Assessment – Policy Issues for Partnership Decisions: Water Quality Goal Implementation Team Meeting, December 4–5, 2017. Retrieved from: https://www.chesapeakebay.net/channel_files/25782/wqgit_dec_4-5_2017_mpa_policy_decisions_briefing_presentation_story_board-12.3.17_jsadd.pdf

Easton, Z., Scavia, D., Alexander, R., Band, L., Boomer, K., Kleinman, P., Martin, J., Miller, A., Pizzuto, J., Smith, D., & C. Welty. 2017. Scientific and Technical Advisory Committee Review of the Phase 6 Chesapeake Bay Watershed Model. STAC Publication Number 17-007. Edgewater, MD. Retrieved from: http://www.chesapeake.org/pubs/379_Easton2017.pdf

Praul, C. (n.d.). Technical Brief: Pay for Performance Contract Mechanisms for Stormwater Management. Prepared by: Environmental Incentives, LLC. South Lake Tahoe, CA. Retrieved from: https://www.enviroaccounting.com/payforperformance/FileResource/GetFileResourceForProgram/8c4d7d33-faba-4481-a642-49fba7ff83eb

U.S. Army Corps of Engineers, Baltimore District (USACE), & Maryland Department of the Environment (MDE). 2015. Lower Susquehanna River Watershed Assessment, Maryland and Pennsylvania. Prepared for: U.S. Geological Survey (USGS), Maryland Department of Natural Resources (MD DNR), the Susquehanna River Basin Commission (SRBC), USACE's Engineer Research & Development Center, U.S. Environmental Protection Agency (US EPA), & the Nature Conservancy.

U.S. Environmental Protection Agency (US EPA). 2010. Section 6: Establishing the Allocations for the Basin-Jurisdictions. Retrieved from: https://www.epa.gov/sites/production/files/2014-2/documents/cbay_final_tmdl_section_6_final_0.pdf

U.S. Environmental Protection Agency (US EPA). 2010. Chesapeake Bay TMDL. Appendix T: Sediments Behind the Susquehanna Dams Technical Documentation – Assessment of the Susquehanna River Reservoir Trapping Capacity and the Potential Effect on the Chesapeake Bay. Prepared by: Tetra Tech, Inc.

U.S. Environmental Protection Agency (US EPA). (2018, October 26). *Letter from United States Environmental Protection Agency, Region III, to the Principals' Staff Committee*.

Appendix A. Membership of the CWIP Steering Committee

Jurisdictional Representative	Jurisdiction/Affiliation
John Maleri Katherine Antos	District of Columbia
Brittany Sturgis	Delaware
Matthew Rowe* Dave Goshorn	Maryland
Lauren Townley	New York
Jill Whitcomb*	Pennsylvania
Ann Jennings	Virginia
Teresa Koon	West Virginia
Mark Hoffman Ann Swanson (Alternate)	Chesapeake Bay Commission
* Co-chair	

Appendix B. CWIP Steering Committee Meeting, Draft CWIP Outreach FAQ Document

October 2020

FREQUENTLY ASKED QUESTIONS

CONOWINGO WATERSHED IMPLEMENTATION PLAN (WIP)

The Chesapeake Bay Watershed

Why Do We Need To Reduce Pollution In The Chesapeake Bay?

The Chesapeake Bay is in poor health due to pollution from a variety of sources, including stormwater runoff, air emissions, wastewater, agriculture, development and more. For many years, pollution that flowed into the streams and rivers of the Chesapeake Bay was not managed to meet water quality standards. At the same time, the population in the 64,000-square mile watershed increased significantly – rising 43% between 1980 and 2017, from 12.7 million people to 18.2 million people. All of this has harmed water quality in the watershed.

In 2010, the U.S. Environmental Protection Agency (EPA) established the Chesapeake Bay Total Maximum Daily Load (Bay TMDL), which set nitrogen, phosphorous and sediment reduction goals so that all practices would be in place by 2025 to meet the Bay's water quality standards. Sediment can smother aquatic life and pollutants such as nitrogen and phosphorus cause algae to grow in local waterways and the Chesapeake Bay that rob the waters of oxygen when they begin to die off and decompose. To meet these goals, the seven jurisdictions (Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia and the District of Columbia) that drain to the Bay developed Watershed Implementation Plans to help guide their Chesapeake Bay clean-up efforts. The entire 27,500-square mile Susquehanna River – the largest single source of freshwater to the Chesapeake Bay – drains to the Conowingo Reservoir.

The Conowingo Dam and reservoir were built in 1928 and are owned and operated by Exelon Corporation. The Conowingo Dam and other dams in the Lower Susquehanna have historically trapped and stored sediment. A 2015 study by U.S. Army Corps of Engineers and the Maryland Department of the Environment concluded the reservoir has reached approximately 92% capacity, no longer trapping sediment and associated nutrients. In December 2017, the Chesapeake Bay Program agreed to a separate Conowingo Planning Target and to collectively develop a separate Conowingo WIP. All Chesapeake Bay Program Principals' Staff Committee (PSC) jurisdictional members agreed to pool resources and to identify a process to fund and implement the Conowingo WIP.

Chesapeake Bay Program
Science. Restoration. Partnership.

Since 1983, the Chesapeake Bay Program has led and directed the restoration of the Chesapeake Bay. Bay Program partners include federal and state agencies, local governments, non-profit organizations and academic institutions. Staff members work at our offices in Annapolis, Maryland, and at partner organizations throughout the watershed.

How Does A Watershed Implementation Plan Work?

Watershed Implementation Plans (WIP) identify pollutant sources and methods to address those pollutants.

This is done across three general tracks:

First: They identify local pollution sources by category, such as urban, agriculture, wastewater treatment plants and septic systems.

Second: They identify the partners and resources that can help reduce pollution.

Third: They identify the best strategies to reduce pollution to meet the 2025 goals.


Photo by Edwin Remsberg
University of Maryland

How Much Additional Nitrogen Coming from the Conowingo Dam Will Need To Be Reduced?

Current estimates are that six million pounds of nitrogen need to be reduced as part of the Conowingo WIP. To meet this target, the Chesapeake Bay Program targeted areas where reducing nitrogen locally will have the greatest impact on increasing dissolved oxygen in the Bay.

Based on the amount of pollutant loads being delivered to the Bay and planned restoration efforts, some watersheds downstream of the dam could offer restoration opportunities that deliver benefits to the Chesapeake Bay comparable to restoration opportunities located upstream of the dam.

These cost-effective downstream restoration opportunities could also be included in the WIP if the cost per pound of nitrogen reduced is similar or better than reductions associated with projects upstream of the dam.

How Will Jurisdictions' WIPs Work in Tandem With the Conowingo WIP?

The Conowingo WIP process is intended to integrate with ongoing efforts to implement best management practices (BMPs) but seeks to go above and beyond what is identified in existing WIPs.

Watershed jurisdictions are NOT being asked to develop a second WIP document for the Conowingo. Instead, EPA has contracted with the Center for Watershed Protection, the Chesapeake Conservancy, the University of Maryland Sea Grant Program and the Harry R. Hughes Center for Agro-Ecology to develop, write and implement the Conowingo WIP or perform outreach.

The Conowingo WIP team will bring additional resources to identify, fund and ultimately implement projects that are identified as part of the Conowingo WIP. Projects identified and funded through the Conowingo WIP will be reported directly to the jurisdiction which will report the project and corresponding Conowingo WIP load reductions to the EPA.

How Were "Priority" Watersheds In The Conowingo WIP Identified?

The priority watersheds are located within the "most effective basins" and were identified based on a combination of modeling, monitoring data, GIS analysis and communication with state agencies.

Criteria used to identify "priority" watersheds include:

• Watershed modeling and monitoring data related to the delivery of nitrogen to the Chesapeake Bay;

• A BMP opportunity analysis using GIS data to determine where there may be opportunity for both Chesapeake Bay WIP and Conowingo WIP projects;

• Input from steering committee members on each jurisdiction's available and needed resources for implementation.

How Will The Conowingo WIP Be Created?

To assist in the development of the Conowingo WIP, the most up-to-date data, modeling and technology will be used to target and track restoration practices where they will have the most strategic impact.

The EPA contracted with the Center for Watershed Protection, Chesapeake Bay Trust and Chesapeake Conservancy to assist in overseeing various tasks including coordination, project identification and developing a financing strategy to reduce the total amount of nitrogen delivered to the Chesapeake Bay.

Is The Conowingo WIP Independent From WIPs Currently In Development In Other Jurisdictions?

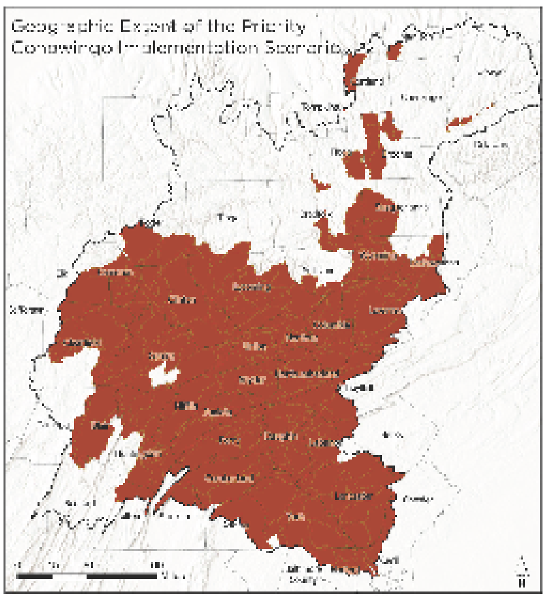
Yes. When complete, the Conowingo WIP will be its own plan, independent of the individual WIPs currently being developed by each of the Bay jurisdictions.

Why Is This WIP Focusing On The Conowingo Dam?

Jurisdictions throughout the Chesapeake Bay watershed have made progress in reducing pollution since the Bay TMDL was established in 2010. However, recent scientific studies have shown that the dam's reservoir is nearing "dynamic equilibrium" which means it will no longer serve as a sufficient sink for sediment and other pollutants, and what flows in above the dam will eventually flow out.

The Phase III WIPs did not account for the Conowingo Dam's reduced ability to trap upstream pollution. To address this problem, the Chesapeake Bay Program has been working since December 2017 to develop a WIP specific to the Conowingo Dam.

Primary Conowingo WIP Geography



Susquehanna Watershed

County Boundaries

Areas Considered in the Scenerio

Map produced by Chesapeake Conservancy. 8/12/2020
For use in the Conowingo Watershed Implementation Plan.
Data sources: U.S. Geological Survey (2019), Chesapeake Bay Program (2020)

How Will Implementation Occur?

The Conowingo WIP proposes to utilize flexible and cost-effective mechanisms to deliver nitrogen reductions. Implementation of the Conowingo WIP is structured to dovetail and work in tandem with financing institutions and existing state or grant programs to maximize capacity and deploy implementation funds in the most efficient way possible while providing thorough review and oversight of the project implementation.

The Conowingo WIP also is set up to utilize performance-based contracting to leverage private sector capacity to develop and propose cost-effective BMPs to reduce the most nitrogen entering the Chesapeake Bay.

Who Will Pay For The Practices In The Conowingo WIP?

New financing methods are being developed that will be designed to help expedite progress toward restoration of the Chesapeake Bay. To accomplish this, a team of financial experts is looking at ways to reduce costs, improve scale and ensure implementation over the long term.

Chesapeake Bay Program
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Project partners include:

Center for Watershed Protection
Chesapeake Conservancy
Chesapeake Commons
Harry R. Hughes Center for Agro-Ecology
University of Maryland Sea Grant Extension
Chesapeake Bay Trust

Appendix C. Framework for the CWIP

October 12, 2018 Final

Framework for the Conowingo Watershed Implementation Plan

Objective: To document PSC approval on the Framework for developing the Conowingo Watershed Implementation Plan.

Background: When the TMDL was established in 2010, it was estimated that Conowingo Dam would be trapping sediment and associated nutrients through 2025. New research has determined this is not the case, and that the reservoir behind Conowingo Dam has now reached dynamic equilibrium. As a result, more sediment, nitrogen, and phosphorus are now entering the Chesapeake Bay than were estimated when the TMDL was established. Even with full implementation of the seven Bay jurisdictions' WIPs, this additional pollutant loading from Conowingo reservoir reaching dynamic equilibrium will cause or contribute to water quality standards exceedances in the upper Bay. This additional pollutant load must be addressed if the Bay's water quality standards, as they are currently written and implemented, are to be met. The Chesapeake Bay Program (CBP) partnership estimates that, after fully implementing the Bay TMDL and Phase I/II WIPs, an additional reduction of 6 million pounds of nitrogen and 0.26 million pounds of phosphorus is needed in order to mitigate the water quality impacts of Conowingo Reservoir infill. Although further analysis may alter the total nitrogen and phosphorus loads needing to be reduced, these current estimates are also based on reductions occurring in the most effective sub-basins of the watershed – that is, the geographic areas with the greatest influence on Chesapeake Bay water quality. If implementation were directed watershed-wide, including less effective areas, the total pollution reduction needed would increase.

It is also important to recognize that the Conowingo Dam, a hydroelectric facility owned and operated by Exelon, is currently undergoing a Federal Energy Regulatory Commission relicensing which requires a water quality certification from the state of Maryland pursuant to Section 401 of the Clean Water Act. Maryland has indicated that it is going to review the May 2017 application from Exelon for consistency with all applicable state water quality standards. Public comments received on the application signal a need for Exelon to be a key partner in addressing the downstream water quality impacts.

The CBP Partnership has identified four options for assigning pollutant load reduction responsibility among the Bay jurisdictions and has also signaled that Exelon should be held responsible for some portion of the reduction. The four geographic options under discussion are listed below and do not yet include an assignment to Exelon, which could be impacted by the outcome of Maryland's 401 Water Quality Certification. The four options are:

1. Susquehanna Basin Only – This option includes the area within the states of New York, Pennsylvania and Maryland that are in the Susquehanna River Basin that drain directly into the Conowingo Reservoir.
2. Susquehanna Basin + Most Effective Basins – This option includes the Susquehanna Basin (i.e. Option 1 above) plus those other basins within the Chesapeake Bay watershed within which best management practices are most effective at improving Chesapeake Bay water quality.

1

3. Susquehanna Basin + All of Maryland and Virginia – This option adds the Partnership states that benefitted most from the original calculation of the TMDL in 2010.
4. The Entire Chesapeake Bay Watershed – This option includes all seven jurisdictions in the Bay watershed.

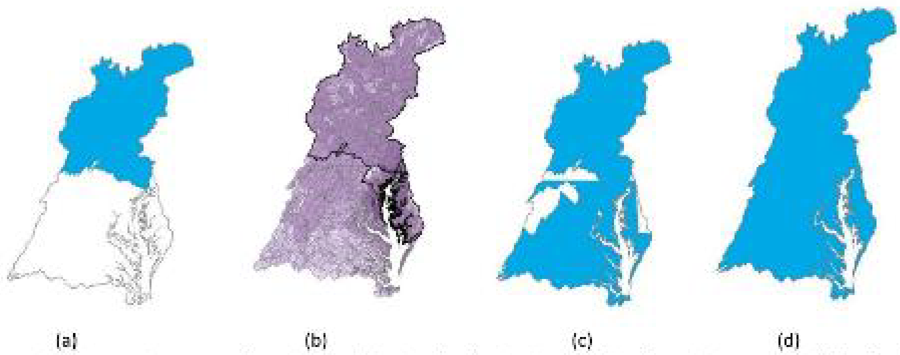


Figure 1 – Four options currently under consideration by the Bay Partnership for assigning responsibility for the additional reduction needed as a result of Conowingo infill. a) Susquehanna Basin, b) Susquehanna Basin + Most-Effective Basins (darker shades of purple = more effective basins within the watershed), c) Susquehanna Basin + All of Maryland and Virginia and d) Entire Chesapeake Bay Watershed.

There are also three options with respect to timing to account for these additional load reductions:

1. Now – The loading is incorporated now into the Phase 3 WIP and must be addressed by 2025.
2. Beyond 2025 – The loading is recognized as something that must begin to be addressed now, but the actual implementation will continue beyond 2025.
3. Post-2025 – The loading is not something that can be addressed now and will be re-visited once implementation of the Phase 3 WIPs is assessed post 2025.

After careful and extensive discussion of these options, the following conceptual approach was offered and agreed to by the CBP Partnership's Principals' Staff Committee (PSC) at its December 2017 meeting.

<u>Conceptual Approach</u>: Develop a separate and collaborative Conowingo Watershed Implementation Plan that provides details on how to reduce adverse water quality impacts to the Chesapeake Bay resulting from Conowingo Reservoir infill and provides a timeline at which it can be accomplished.

The recommended approach is in response to the recognition by all Bay jurisdictions that:

A. Trapping of pollutants by the Conowingo reservoir over the past 80+ years has benefited the water quality of the Bay, and it has also benefitted states to varying degrees by lessening load reduction responsibilities, but now those benefits are greatly diminished; and,
B. No reservoir maintenance to restore trapping capacity has occurred over the life of the dam and the reservoir is now near full capacity; and
C. The most cost-effective approach to mitigate current adverse water quality impacts, of the Conowingo reservoir at dynamic equilibrium, are realized by pooling resources to pay for pollutant reduction practices in the most effective locations (i.e., the locations with the most influence on Bay water quality). Pollutant reduction practices placed in the most effective areas (Figure 2) will limit the overall load reductions needed.

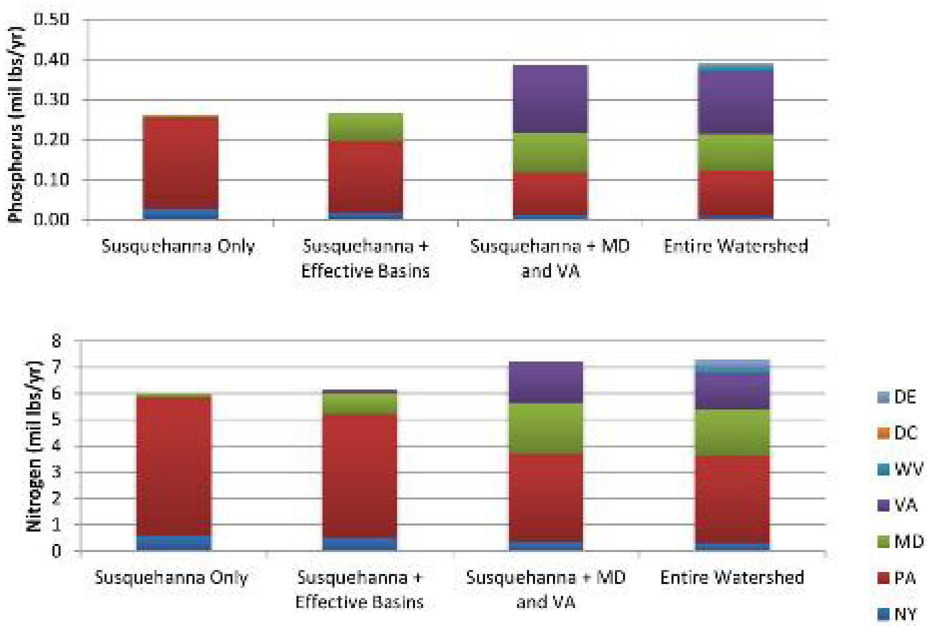


Figure 2 – Basinwide Conowingo targets developed using four different allocation options.

The Conowingo Watershed Implementation Plan (WIP) would include consideration of the following innovative components:

1. Establishing the Conowingo WIP Steering Committee as a subcommittee of the PSC. The

Conowingo WIP Steering Committee is composed of a representative from each Bay jurisdiction and the Chesapeake Bay Commission (CBC). This committee is responsible for developing and implementing the Conowingo WIP with assistance from a third party. The membership of this committee is in Appendix A. A list of guiding principles under which this Action Team will operate is included in Appendix C.

2. Creating a fund that members of the Conowingo WIP Steering Committee can use to work with the third-party awardee and install the most cost-effective practicesin the most effective locations.
3. Incorporating the outcome of the Exelon CWA S. 401 water quality certification.
4. Developing a financing strategy to support development and implementation of the Conowingo WIP.
5. Developing a process by which preferred practices, targeted geographic locations and implementation projects will be selected and deployed.
6. Managing reservoir sediment through dredging and innovative and/or beneficial re-use based upon information from the Maryland pilot project.
7. Determining achievability and in what timeframe the needed load reductions will occur.

Although there are many specifics to this approach that remain to be discussed and agreed-upon, the PSC requested that more detail be provided on the following:

1. <u>Pollutant Load Targets</u>: **The total pollutant load targets attributed to Conowingo Reservoir infill would be assigned to a separate Conowingo Planning Target which all Bay jurisdictions would work collaboratively to achieve.**

   For the reasons described above, rather than adding those individual pollutant reduction targets to jurisdictions' existing Phase III planning targets, the recommendation is that the total pollutant reduction targets for nitrogen and phosphorus be assigned to the Conowingo WIP Steering Committee (i.e., the CBP Partnership will now have eight Targets: the seven Bay jurisdictions + Conowingo) with the latter to be achieved collaboratively by all relevant parties in a separate WIP. In other words, although the PSC may expect that reductions to meet the Conowingo pollutant reduction targets will come from the most effective areas in a subset of Bay jurisdictions, all Bay jurisdictions recognize the benefits of Conowingo's past pollutant trapping and, therefore, all agree to work together in implementing the agreed upon plan.

2. <u>Funding options</u>: **Partners would agree to contribute resources (e.g. funding, technical assistance, in-kind services, etc) into a pool to be managed collaboratively to achieve the necessary pollutant load reductions.**
   The unique and critical component to this proposed Conowingo WIP is pooling resources and the collaborative application of those pooled resources in the most cost-effective manners possible. Pooled resources would be phased in over a period of time. Key sources of initial funding are anticipated to be realized through the Exelon Water Quality Certification (anticipated May 2018) and additional federal funding sources (e.g., USDA , CWA 117 Innovative Nutrient and Sediment and Small Watershed Grants, Army Corps, USFW, NFWF Chesapeake Stewardship Fund, etc.) that can supplement current state WIP efforts. A financial strategy will be developed by the third party awardee and Steering Committee that identifies these initial sources of funding, as well as medium

and longer range funding sources that can be phased in over time as necessary to achieve the Conowingo pollution reduction targets. The strategy will consider leveraging state, local and private dollars and in-kind services or technical resources as well as reallocation of existing federal funds to the jurisdictions (e.g., CBIG, CBRAP, 319, WIP assistance funds) for Chesapeake Bay restoration. EPA will work with the partnership to help ensure that any reallocation of federal funds will not adversely impact state WIP efforts. The Conowingo WIP Steering Committee will also work with a third party (see below) to enlist other federal and non-federal funding sources or voluntary partnerships as well as define associated roles and responsibilities, including consideration of "pay for success" approaches.

3. **Implementing the Plan: Pooled resources would be managed by a third party, following RFP issuance by EPA's CBP Office, with guidance from the WIP Steering Committee to implement pollutant reducing practices in the most cost-effective manners possible independent of jurisdictional boundaries.**
   A third party would be charged with applying the pooled resources in the most cost-effective and pollutant load reduction-efficient locations in order to achieve the required Conowingo pollutant load reductions for the least cost. Reductions would come from existing CBP partnership-approved BMPs and other innovative components such as those listed above. Geographic targeting of BMP locations would be consistent with CBP partnership-approved models and watershed loading rates. Additionally, the third party would be charged with verifying and tracking all reductions following CBP partnership-approved protocols and pursuing or leveraging additional funding sources to implement the Conowingo WIP.

4. **Crediting Implementation**
   Practices funded with pooled dollars are credited to the Conowingo WIP pollutant reduction targets, regardless of where the practices were implemented or where the funding originated. The Conowingo WIP Steering Committee, with technical support from EPA's CBP and the third party, will develop a Conowingo credit calculation and tracking protocol that simultaneously considers opportunities to advance other state WIP efforts.

5. **Plan Development Schedule**
   The schedule is in Appendix B and subject to change. The Conowingo WIP Steering Committee will submit changes to this schedule to the PSC for approval.

6. **Roles and Responsibilities**

   I. EPA will:
      a. Evaluate the Conowingo WIP and provide biennial evaluations of the progress toward attaining the goals in the Conowingo WIP. EPA's evaluations, in consultation with the PSC, and any needed improvement will be used to determine if corrections or adjustments are necessary to attain the goals of the Conowingo WIP (e.g., whether the targets need to be re-evaluated or assigned to specific jurisdictions).
      b. Issue a Request for Proposal (RFP) for the third party and administer the subsequently awarded contract, grant or cooperative agreement. Because EPA will be issuing the RFP, it cannot act as a third party.

c. Provide technical staff and contractor support such as modeling or GIS analysis to the Conowingo WIP Steering Committee.

II. The Conowingo WIP Steering Committee will:
  a. Consist of a representative from each jurisdiction and the Chesapeake Bay Commission (CBC). Each Bay jurisdiction and the CBC may also solicit comments on the Conowingo WIP framework from key stakeholders. EPA will not participate on this committee due to its oversight role as part of the Bay TMDL accountability framework
  b. Develop the Conowingo WIP with EPA staff and contractor support.
  c. Guide the development of a financing strategy and implementation of the Conowingo WIP, working with the third party.

III. The Third Party will:
  a. Provide facilitation, programmatic and technical assistance to the Conowingo WIP Steering Committee in the implementation of the Conowingo WIP.
  b. Develop a financing strategy with guidance from the Steering Committee and act as a fund manager, either using the shared dollars directly and/or awarding the funding to other parties to implement cost-effective pollution reduction technologies in areas having the most impact on Chesapeake Bay's water quality.
  c. Track/ verify progress made in the implementation of the Conowingo WIP and report to EPA on an annual basis.
  d. Pursue additional funding sources to sustain the Conowingo WIP and help meet associated pollution reduction targets.

IV. The PSC will:
  a. Approve the final draft Conowingo WIP for submittal to EPA and the Partnership for review and comment.
  b. Approve the final Conowingo WIP before posting on the CBP Partnership website in June 2019.
  c. Review the progress of the Conowingo WIP Steering Committee in the development and implementation of the Conowingo WIP on a regular basis.

APPENDIX A
Draft Conowingo WIP Guiding Principles for PSC Review
Prepared by: The Conowingo WIP Steering Committee
10/12/18 Version

1. **Fairness Principle**: Strive for fairness, equity, and feasibility among state, local, and federal and other partners participating in the Conowingo WIP regarding level of effort, financing, tracking, resource sharing, and third party access.

2. **Governance Principle**: Operate as an Action Team as defined in the document "Governance and Management Framework for the Chesapeake Bay Program Partnership". Strive for consensus using the Chesapeake Bay Program Partnership Consensus Continuum as described in the document. When consensus cannot be reached, the issue will be deferred to the PSC with a summary of the issue and the different options and opinions expressed by the members.

3. **Consistency Principle**: Ensure consistency with the EPA Phase 3 WIP expectations and Conowingo WIP framework documents.

4. **Transparency Principle**: Establish clear tracking, accountability and verification consistent with expectations for jurisdictions and to transparently demonstrate which practices are planned for, implemented and maintained in the Conowingo WIP vs state WIPs in order to avoid double-counting.

5. **Efficiency in Innovation Principle**: Implement the Conowingo WIP building on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. At the same time, strive for innovation, leverage new technologies, and, where appropriate, develop new implementation approaches.

APPENDIX B – Schedule for Development
Conowingo Phase 3 Watershed Implementation Plan (WIP)

OPTION 1 --- CONCURRENT SUBMITTAL

December 2017	Received PSC Approval on Conowingo WIP framework and the first cut of the Conowingo pollutant reduction targets to address this additional load.
March 2018 - March 2019	The Conowingo WIP Steering Committee, including a representative from each jurisdiction and the Chesapeake Bay Commission work collaboratively to begin development of the Conowingo WIP to include: 1) finalizing the Conowingo WIP framework, pollution reduction target(s), and resource sharing commitments; and, 2) working with EPA, other federal partners, and the third party to develop a financing strategy that leverages technical assistance, in-kind services, and federal, state, local and potential private sector funding sources.
September 2018	EPA prepares a draft RFP for an award of a cooperative agreement or contract to manage and oversee the pooled resources and to facilitate the development and implementation of the Conowingo WIP, as guided by the Conowingo WIP Steering Committee.
Sept. 2018 – March 2019	EPA selects the RFP awardee and, building on the decisions made to date, the Conowingo WIP Steering Committee continues drafting the Conowingo WIP with support of the awardee to include a finance strategy for the Conowingo WIP, additional local government and public engagement strategies, identifying specific reduction practices and a timeline, funding sources, the methodology for addressing any identified gaps and provisions for contingencies.
April 1, 2019	The Conowingo WIP Steering Committee submits a draft Conowingo WIP to the PSC for review and comment.
April 8, 2019	The PSC submits comments to the Conowingo WIP Steering Committee.
April 12, 2019	**States will post their Draft Phase III WIPs on their respective websites for Partnership review and comment.**
April 12, 2019	DRAFT Conowingo WIP posted on the CBP website for a 30-day public comment period ending May 13, 2019.
June 7, 2019	**Partnership Comments Due on States' Draft Phase III WIPs.**
July 5, 2019	The Conowingo WIP Steering Committee addresses all comments and submits a final draft to the PSC for final review and comment.

July 19, 2019	The PSC submits any final comments to the Conowingo WIP Steering Committee.
August 9, 2019	States will post their FINAL Phase III WIPs on their respective websites.
August 9, 2019	**The CBP partnership will post the FINAL Conowingo WIP on its website**
October 1, 2019	The Conowingo Steering Committee and the third party will begin full plan implementation utilizing funding allocated to the plan for federal FY 2020.
??	Determine the role of Exelon in the implementation of the Conowingo WIP based on the outcome of Maryland's decisions regarding 401 certification and the resultant court cases.
Biennially	EPA to evaluate the effectiveness and progress of the Conowingo WIP, pursue additional funding sources to help with implementation, identify additional mitigation options and recommend options to the PSC, as necessary.
Summer 2023	The PSC will reevaluate and make any necessary corrections based on EPA's biennial evaluations of the Conowingo WIP implementation, recommendations from the Conowingo WIP Steering Committee and any other factors.
2025	Consistent with the 2014 Watershed Agreement and the 2010 TMDL, a goal will be to have all practices in place to achieve the necessary nutrient and sediment reductions by 2025.

Appendix D. BMP Opportunities Analysis

Map Name	Brief Description	Map Units	Datasets Referenced	Methods Used
Buffer Restoration opportunities	Total area of land suitable for buffer restoration within 100 ft of water network	Square Meters	Land Cover: 1-meter land cover data classified using 2013 NAIP imagery (Chesapeake Conservancy & University of Vermont, 2016) Water network (MD/PA): Lidar-derived water network combined with 2013 1-meter land cover data (Chesapeake Conservancy, 2018)	Pixels from the high-resolution land cover dataset within 100-ft distances of the water network were considered in the buffer analysis. Pixels classified as low vegetation, wetlands, or barren were considered buffer restoration opportunities. Area of buffer restoration opportunity is summed by county.
Living Shoreline opportunities	Total length of shoreline not already obstructed by the presence of a structure	Feet	Maryland Shoreline Inventory: Shoreline Situation Report, Comprehensive Coastal Inventory Program (Virginia Institute of Marine Science, College of William and Mary, 2006)	Line-of-sight assessment that describes the presence of shoreline structures for shore protection and recreational purposes. Unclassified shorelines identified as areas with potential opportunity for implementation. Length of opportunity is summed by county.
Wetland Restoration opportunities	Lands currently in agriculture that naturally accumulate water due to topography and have historically poorly draining soils	Square Meters	Potentially Restorable Wetlands (U.S. EPA, 2016)	Total land area identified as potential wetland restoration opportunities on agricultural land summed by county.
Urban BMP opportunities	Urban land outside of MS4 boundaries	Square Meters	Urban Areas/Urban Clusters (U.S. Census Bureau, 2010) Municipal Separate Storm Sewer System (MS4) Boundaries (Chesapeake Bay Program, 2019)	Area of urban land that falls outside of MS4 boundaries summed by county. These are potential locations for urban BMP implementation that is not already considered under current permitting processes.
Total nitrogen relative effectiveness	Change in DO that occurs in the Bay per pound of nutrient changed locally in the watershed	µg/L DO per million lbs of reduction	Relative Effectiveness (Chesapeake Bay Program, 2019)	See Emily Trentacoste, Gary Shenk, or Jeff Sweeney at the Chesapeake Bay Program.
CAST analysis on nitrogen loads	Theoretical opportunities for additional nitrogen reductions beyond projected Phase III WIP implementation	Pounds of nitrogen delivered to edge of stream/year	• CAST Phase III WIP Final Scenario Report (Chesapeake Bay Program, 2019) o Projected nitrogen delivery to edge-of-stream after full implementation of Phase III WIPs • CAST 2010 E3 Scenario Report (Chesapeake Bay Program, 2017)	WIP 3 load - E3 load = theoretical nitrogen load available for reduction through CWIP implementation. Outputs for this layer are summed by LRS.

Map Name	Brief Description	Map Units	Datasets Referenced	Methods Used
			○ E3 is defined as, “Everything by everyone everywhere” (e.g., BMPs implemented to theoretical maximum extent resulting in the lowest possible loads that could be delivered to local streams	

Appendix E. Summary of Analysis to Develop Nitrogen Load Reductions for the Primary CWIP Strategy

The primary CWIP strategy ("the strategy") was developed with the goal of achieving the most cost-effective (lowest $/lb of N reduction) possible. This appendix describes the methods used to select the geography, BMPs, and levels of implementation for the strategy. The strategy was evaluated using CAST.

Geography

The strategy focuses entirely on the Susquehanna River basin. This geographic focus ensures that the nitrogen reduction calculated by CAST is equivalent to the same reduction at the Conowingo Dam. For basins outside of the Susquehanna, an "exchange ratio" would need to be applied to equate the reductions achieved in that basin to an equivalent reduction in the Susquehanna River basin; for example, a ratio of 0.66 would be applied to any reductions achieved in the Lower Eastern Shore. The Land River Segments (LRSs) used in this analysis were selected using 1995 Watershed Modeling, before Conowingo infill.

Implementation was further targeted to the most N-effective (i.e., the greatest DO reduction per pound of N reduction) LRSs within the Susquehanna River basin. These basins were selected by arranging LRSs in order from the most to the least effective. Agricultural practices were applied only within the upper two quartiles, while practices for developed land focused more narrowly on the upper quartile.

List of BMPs

The BMPs implemented for this strategy were selected based on their N-effectiveness and potential application in the Susquehanna River basin. This effectiveness was based on state-level cost-effectiveness data provided on the CAST website (https://cast.chesapeakebay.net/Documentation/CostProfiles, accessed January, 2020). The BMPs selected included a suite of agricultural BMPs, and two highly effective BMPs for the developed sector. The BMPs, along with their resulting levels of implementation by state, are summarized in Table 7in the "Implementation Levels" section below.

Implementation Levels

This strategy uses both agricultural and urban BMPs to achieve pollutant load reductions. The methodology for selecting BMP implementation levels included a four-step process (described below):

1) Use existing state WIPs to select initial implementation levels for agricultural BMPs.
2) After running CAST, adjust these BMPs to meet N reduction goals using agricultural BMPs only.
3) Aggressively implement cost-effective urban BMPs in addition to the agricultural baseline practices.

4) Adjust agricultural BMP implementation downward in 5% increments.

Steps 1 & 2. Selecting Target Implementation Levels for Agricultural BMPs

The initial target implementation levels for agricultural practices were selected based on the implementation levels in the state WIP III plans. As a starting point, the maximum implementation level for each BMP by state was recorded. For example, if Conservation Tillage were applied to 90% of cropland acres in any LRS in Pennsylvania, this 90% would be the initial target level of implementation used for CAST modeling. These levels were used as a reference point, and then a single implementation level was used across all three states. CAST was run iteratively until the BMP implementation levels were able to achieve the six-million-pound nitrogen reduction goal. The resulting implementation levels, including both the original and modified targets by state, are summarized in Table 7.

Step 3. Aggressively Implement Cost-Effective BMPs on Developed Land

The strategy resulting from Steps 1 and 2 attained 6.6 million pounds of nitrogen reduction. In order to achieve a level of equity between the urban and agricultural sectors, this strategy aggressively implemented two cost-effective practices for developed lands (Forest Buffers and Forest Planting) on turf grass in non-regulated MS4 land. This land use was selected because it was assumed that BMP implementation levels in regulated MS4s would be very high in the WIP III plans. The acres of implementation for the practices were calculated using the WIP III level of implementation at the LRS scale:

- "The post-BMP acres" of the non-regulated turf grass source category was identified for each LRS in the targeted area.
- This area was multiplied by 2% for Urban Forest Buffers and 10% for Urban Forest Planting.
- These areas were added to the BMP input file for each of these practices.

Overall, these practices were at a low implementation level in the non-regulated MS4 areas in the WIP III plans.

Table 7. *Initial Target Agricultural BMP Implementation Levels (% of Land Area) Derived from WIP III Scenarios*

BMP	Source where applied	WIP III Implementation by State			Selected Implementation Level (CWIP Scenario)
		MD	NY	PA	
Nutrient Application Management Core Nitrogen	Agriculture No Open Space	69.49	19.27	100.00	90.00
Nutrient Application Management Rate Nitrogen	Agriculture No Open Space	34.62	19.27	48.56	48.56
Nutrient Application Management Placement Nitrogen	Agriculture No Open Space	19.86	19.27	23.23	23.23
Nutrient Application Management Timing Nitrogen	Agriculture No Open Space	9.89	19.27	51.36	51.36
Conservation Tillage	Cropland	47.39	0.00	40.39	47.39
High Residue Tillage	Cropland	76.92	0.00	67.02	67.00
Low Residue Tillage	Cropland	0.00	1.27	8.91	1.07
Prescribed Grazing	Pasture	41.18	62.32	100.00	90.00
Forest Buffers[1]	Cropland and Hay	N/A	N/A	N/A	3.04
Wetland Restoration – Headwaters	Agriculture	2.75	0.00	0.02	0.27
Wetland Restoration - Floodplain	Agriculture	0.00	0.02	0.42	0.51
Grass Buffers	Cropland and Hay	8.48	0.00	3.60	3.60
Soil and Water Conservation Plan	Agriculture	89.80	59.09	99.89	90.00
Manure Incorporation – Plow: Early	Cropland and Hay with Manure	0.00	0.00	9.74	5.00
Manure Incorporation: Plow: Late	Cropland and Hay with Manure	25.82	0.00	0.00	5.00
Manure Injection	Cropland and Hay with Manure	2.55	0.00	0.00	5.00
Barnyard Runoff Control	Feedlot	100.00	39.85	100.00	90.00
1: State-Level Implementation currently being recalculated.					

Step 4. Adjust BMP Implementation Downward

In the 2021 release of the CWIP, additional nitrogen reductions achieved by BMPs implemented on developed lands were offset by successively reducing the implementation levels of all the agricultural BMPs included in this strategy by 5%. By trial and error, the BMP implementation levels were all reduced 5% (only once), so that the resulting strategy has implementation levels for the agricultural BMPs that are 95% of the levels included in the initial strategy resulting from Steps 1 and 2.

In 2023, further adjustments were made in New York State when the CWIP Scenario was modified to match that state's nutrient reduction agreement. In achieving that goal, BMP implementation rates were adjusted so that the area of BMPs implemented as a part of the CWIP was set to 62.5% of the original CWIP levels.

Appendix F. Alternate CAST Strategies

The development of the CWIP included developing and reviewing a variety of CAST strategies to explore the cost and load reduction implications of various BMP strategies. Ultimately the CWIP Steering Committee along with the PSC agreed to put forward one priority strategy, which is presented in the CWIP. The additional CAST strategies developed as part of the planning process can serve as a starting point for evaluation during adaptive management or as part of contingency planning if the primary CWIP strategy is not effective at meeting load reduction targets and/or two-year milestones. The alternate CAST strategies retain their original nomenclature, which includes a number and name (see Table 8). The alternate strategies are divided into two levels: level 1 incudes strategies that had a majority of consensus on the CWIP Steering Committee and were presented to the PSC, and level 2 includes strategies that the majority of the CWIP Steering Committee did not support.

These alternate strategies present additional BMP options and expanded geographies. The majority of the scenarios rely primarily on the most cost-effective BMP options available, particularly in the agricultural sector.

Geographies

Three separate geographies were used among strategies, with targeting based on nitrogen-effectiveness at the LRS scale: 1) the entire Susquehanna, Western Shore, and Eastern Shore geobasins, 2) the top two quartile nitrogen-effective LRSs within the Susquehanna, Western Shore, and Eastern Shore geobasins, and 3) the entire Susquehanna plus upper quartile nitrogen-effective LRSs in the Chesapeake Bay watershed.

BMP Choice & Implementation Level

Overall, the strategies considered two broad BMP implementation approaches: Agricultural BMPs Only and Agricultural BMPs + Urban BMPs. To strive for consistency between the strategies, a maximum implementation level was selected for each strategy based on the maximum implementation level that a state had reported for any segment in their WIP III. As a result of this method, Delaware was not included in any strategy, since the state's WIP III plan uses a single level of implementation across the entire state. For each strategy, BMPs were implemented at the maximum level, but implementation levels for wetland restoration were later reduced in Strategies 6, 7, 8, and 9. In Strategies 6 and 7, the implementation level was reduced by 50% to reduce costs and nitrogen reduction targets. In Strategies 8 and 9, these practices were targeted toward a smaller and more effective list of LRSs.

The agricultural BMPs included: nutrient management, tillage operations, buffers, prescribed grazing, Soil and Water Conservation Plans, and wetland restoration. Most of these BMPs are an ongoing (annual or short-term), with the exception of prescribed grazing, buffers and wetland restoration. Two relatively cost-effective urban BMPs were chosen to represent the developed sector: bioswales and infiltration BMPs.

Differences between Strategy Methodologies

While the strategies are very similar in their assumptions and development, which relate primarily to the baseline condition, as well as the method for assigning BMP implementation levels. While these differences change the BMP composition slightly, they do not appear to have a major impact on any strategy's cost-effectiveness.

All the strategies presented in this CWIP use the WIP III implementation levels as a baseline. However, the baseline for Strategies 6, 7, 10 and 11 includes the "Land Policy" BMPs implemented in the WIP III plans, while the other strategies do not include these practices. This difference appears to have very little impact on the BMP implementation levels or load reductions.

Table 8. Overview of alternate CAST strategies.

Strategy	Geography	BMPs	Total N Reduction (lbs/year)	Total Annualized Cost ($/year)	Cost Effectiveness ($/pound)	CWIP Steering Committee Votes for Inclusion	Notes
1: Constrained	PA counties and non-MS4 MD counties within the Susquehanna, Western Shore, and Eastern Shore geobasins*	Agricultural + Urban	6.0 Million	$368 Million	$61	Yes: 0/8 No: 8/8	This is the only strategy that is aggregated by county; everything else is by land-river segment (LRS). Strategy 1 uses the WIP III for baseline conditions.
2: Enhanced WIP Implementation	Susquehanna watershed + Q1 N-effective[1] LRSs within the Bay watershed	Agricultural + Urban	6.1 Million	$236 Million	$39	Yes: 0/8 No: 8/8	Strategy 2 uses the WIP III baseline.
3: Nitrogen-Effective, Bay-wide	Q1 N-effective[2] LRSs within Bay watershed[3]	Agricultural	6.4 Million	$51 Million	$8	Yes: 2/8 No: 5/8 Stand-Aside: 1/8	Strategy 3 uses the modified WIP III baseline.
4: Nitrogen-Effective, Susquehanna	Q1 + Q2 N-effective LRSs within the Susquehanna watershed[3]	Agricultural	6.6 Million	$56 Million	$8	Yes: 3/8 No: 4/8 Stand-Aside: 1/8	
5: Nitrogen-Effective + Urban Equity, Susquehanna **(Primary CWIP Strategy)**	Q1+Q2 N-effective LRSs within the Susquehanna watershed[3]	Agricultural + Urban	6.6 Million	$51 Million	$8	Yes: 7/8 No: 0/8 Stand-Aside: 1/8	The BMPs in this strategy are the same as Strategy 4, but it also includes urban forest and urban buffer practices.

Strategy	Geography	BMPs	Total N Reduction (lbs/year)	Total Annualized Cost ($/year)	Cost Effectiveness ($/pound)	CWIP Steering Committee Votes for Inclusion	Notes
6: Cost-Effective Agricultural + Urban BMPs, Broadest Geography	Entire Susquehanna, Eastern Shore, and Western Shore geobasins	Agricultural + Urban	6.2 Million	$90 Million	$14	Yes: 0/8 No: 7/8 Stand-Aside: 1/8	Strategy 6 includes cost-effective agricultural BMPs and urban BMPs (specifically bioswales and infiltration). Strategy 6 incorporates BMP implementation levels consistent with Strategies 7 through 11.
7: Cost-Effective Agricultural BMPs, Broadest Geography	Entire Susquehanna, Eastern Shore, and Western Shore geobasins	Agricultural	6.0 Million	$68 Million	$11	Yes: 1/8 No: 7/8	Same BMPs as Strategy 6, but without urban BMPs
8: Cost-Effective Agricultural + Urban BMPs, Narrowest Geography	Q1+Q2 N-effective LRSs within the Susquehanna, Eastern Shore, and Western Shore geobasins	Agricultural + Urban	6.3 Million	$96 Million	$15	Yes: 5/8 No: 2/8 Stand-Aside: 1/8	Uses the same BMPs as Strategy 6 but focuses on the upper quartile LRSs. Uses modified WIP III baseline.
9: Cost-Effective Agricultural BMPs, Narrowest Geography	Q1+Q2 N-effective LRSs within the Susquehanna, Eastern Shore, and Western Shore geobasins	Agricultural	6.0 Million	$50 Million	$8	Yes: 3/8 No: 4/8 Stand-Aside: 1/8	Same BMPs as Strategy 8, but without urban BMPs
10: Cost-Effective Agricultural + Urban BMPs, Moderate Geography	Susquehanna watershed + Q1 N-effective[1] LRSs within the Bay watershed	Agricultural + Urban	6.2 Million	$82 Million	$14	Yes: 4/8 No: 4/8	This strategy is a modification of Strategy 3; it uses the same BMPs but a different focus geography. This strategy also uses the same BMPs as Strategies 6 and 8.

Strategy	Geography	BMPs	Total N Reduction (lbs/year)	Total Annualized Cost ($/year)	Cost Effectiveness ($/pound)	CWIP Steering Committee Votes for Inclusion	Notes
11: Cost-Effective Agricultural BMPs, Moderate Geography	Susquehanna watershed + Q1 N-effective[1] LRSs within the Bay watershed	Agricultural	6.1 Million	$66 Million	$11	Yes: 1/8 No: 7/8	Same BMPs as Strategy 10, but without urban BMPs[6]

[6] Practice verification protocols will be identified within the QAPP being written by the Reporting grantees. These protocols will be guided by conversations with key stakeholders, including the financing entity, jurisdictional representatives, and EPA, but will ultimately be approved by EPA. Automated verification methods are being piloted through FieldDoc's tracking system as part of the third activity within the Conowingo WIP grant but will likely be paired with in-field practice verification that will need to be built into the funding contracts for the practices.

Level 1 Alternate Strategies

Level 1 alternate strategies include those strategies that the majority of the CWIP Steering Committee supported and were provided to the PSC for review. The alternative strategies are placed in the order of support with Strategy 8 receiving the most support.

Strategy 8: Cost Effective Agricultural + Urban BMPs, Narrowest Geography

Strategy 8. Cost-Effective Agricultural + Urban BMPs, Narrowest Geography	
Geographic Extent	Top two quartiles of nitrogen-effective LRSs within the Susquehanna, Eastern Shore, and Western Shore geobasins
BMP Sector(s)	Cost-Effective Agricultural + Urban
States Included	Maryland, New York, Pennsylvania
N Reduction	6.32 million pounds/year
Total Annualized Cost	$96,218,006
Cost Per Pound	$15

Strategy 8 Geography

Strategies 8 and 9 are implemented within the top two quartiles (upper median) of nitrogen-effective LRSs within the Susquehanna, Eastern Shore, and Western Shore geobasins (Figure 7), with the exception of wetland restoration, which was concentrated in only the upper quartile segments.

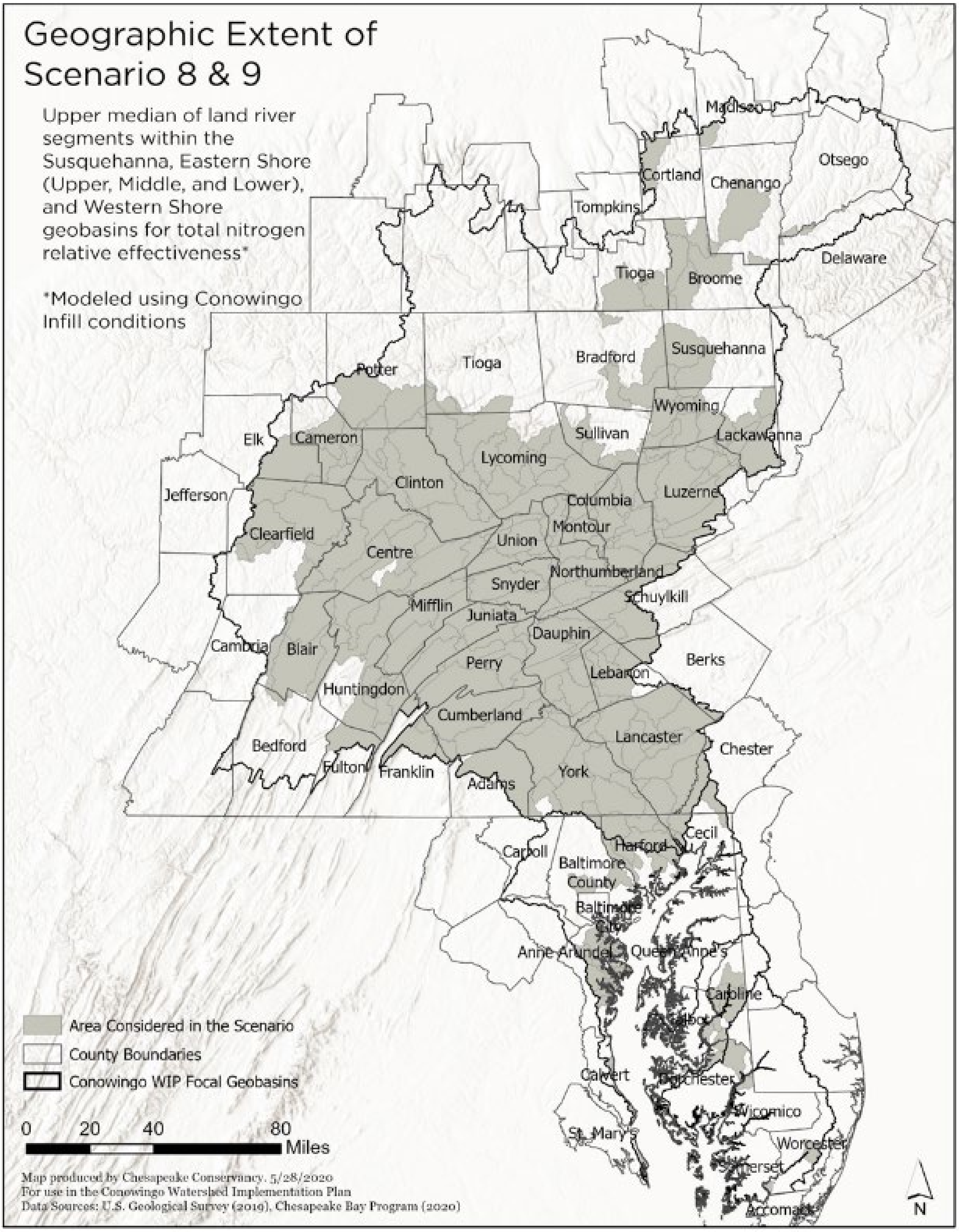


Figure 7. Geographic extent of Strategies 8 and 9.

Strategy 8 BMPs

Strategy 8 relies entirely on cost-effective urban and agricultural BMPs, similar to Strategies 6 and 10. This strategy is slightly different because it includes some forest buffers.

Table 9. Summary of acres of BMP implementation for Strategy 8.

BMPs Implemented in Strategy 8: Cost-Effective Agricultural + Urban BMPs, Narrowest Geography						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	-105*	2,479	414,788	417,162
Nutrient Application Management Rate Nitrogen	annual	Acres	4,634	2,479	687,206	694,319
Nutrient Application Management Placement Nitrogen	annual	Acres	-30*	2,479	275,790	278,239
Nutrient Application Management Timing Nitrogen	annual	Acres	1,324	2,479	682,045	685,848
Conservation Tillage	annual	Acres	17,775	12,791	146,485	177,052
High Residue Tillage	annual	Acres	-13,397*	12,508	56,479	55,590
Low Residue Tillage	annual	Acres	--	5,970	93,685	99,655
Prescribed Grazing	cumulative	Acres	8,358	4,942	100,484	113,784
Forest Buffers	cumulative	Acres in Buffers	1,571	1,042	20,362	22,975
Wetland Restoration	cumulative	Acres	3,063	--	3,560	6,623
Grass Buffers	cumulative	Acres in Buffers	7,376	385	24,081	31,842
Soil and Water Conservation Plan	cumulative	Acres	30,139	55,609	295,182	380,930
Manure Incorporation	annual	Acres	12,842	--	123,234	136,076
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	169	47	972	1,188
Urban Practices						
Infiltration Practices	cumulative	Acres	8,976	3,673	1,037	13,686
Bioswale	cumulative	Acres	9,911	--	20,006	29,917
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Strategy 8 Loads Results

Strategy 8 achieves 6.3 million pounds of nitrogen reduction, with 86% of the total reduction from Pennsylvania, and approximately 95% of the load reduction from the agricultural sector.

Table 10. Summary of Strategy 8 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 8: COST-EFFECTIVE AGRICULTURAL + URBAN BMPS, NARROWEST GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Strategy 8**	**N Reduction**
MD	Agriculture	14.31	13.74	0.57
	Developed	7.62	7.50	0.13
	Natural	6.23	6.20	0.03
	MD Total	**28.16**	**27.44**	**0.73**
NY	Agriculture	5.98	5.87	0.11
	Developed	1.41	1.39	0.02
	Natural	2.92	2.92	0.01
	NY Total	**10.31**	**10.18**	**0.14**
PA	Agriculture	42.34	37.22	5.12
	Developed	14.88	14.73	0.15
	Natural	17.58	17.39	0.18
	PA Total	**74.80**	**69.34**	**5.45**
	TOTAL	***113.27***	***106.96***	***6.32***

Strategy 8 Cost

The total cost (approximately $96 million) is distributed almost evenly between the agricultural and developed sectors.

Table 11. Summary of costs for BMPs implemented in Strategy 8.

Annualized Costs by State and Sector for Strategy 8. Cost-Effective Agricultural + Urban BMPs, Narrowest Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,787,421	$21,010,811	--	**$22,798,232**
NY	$529,289	$4,586,840	--	**$5,116,129**
PA	$47,219,212	$21,084,433	--	**$68,303,645**
Total	***$49,535,922***	***$46,682,084***	**--**	***$96,218,006***

Strategy 10: Cost-Effective Agricultural + Urban BMPs, Moderate Geography

Strategy 10. Cost-Effective Agricultural + Urban BMPs, Moderate Geography	
Geographic Extent	Entire Susquehanna watershed + upper quartile nitrogen-effective LRSs within the Chesapeake Bay watershed
BMP Sector(s)	Cost-Effective Agriculture + Urban
States Included	Maryland, New York, Pennsylvania, Virginia, West Virginia
N Reduction	6.19 million pounds/year
Total Annualized Cost	$82,065,999
Cost Per Pound	$13

Strategy 10 Geography

This strategy uses the same geography as Strategy 2, which includes the entire Susquehanna watershed, plus the upper quartile of nitrogen-effective LRSs in the Chesapeake Bay watershed (Figure 8).

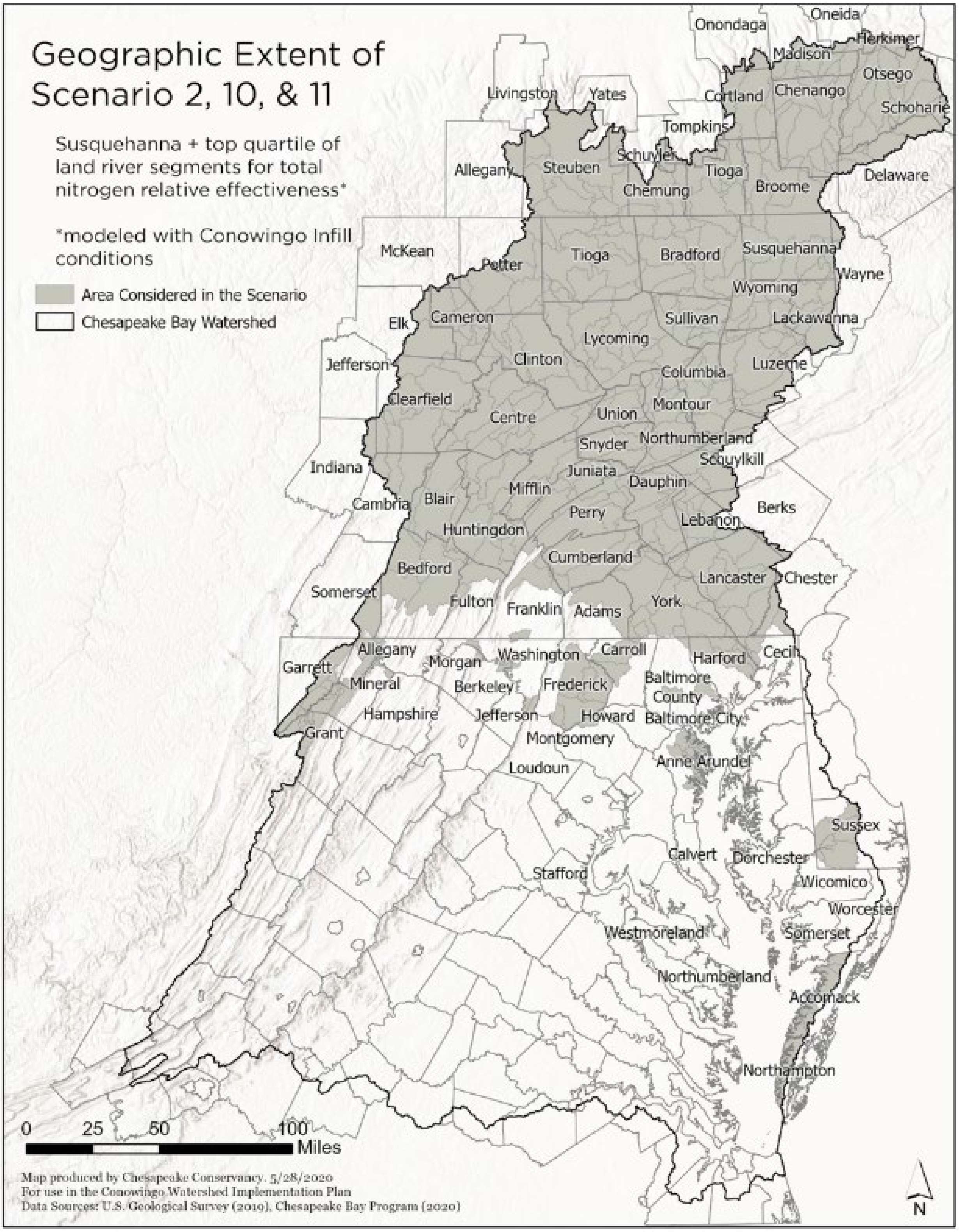


Figure 8. Geographic extent of Strategies 2, 10, and 11.

Strategy 10 BMPs

This strategy relies on both urban and agricultural BMPs, with a similar mix of practices as Strategies 6.1 and 8.

Table 12. Summary of acres of BMP implementation for Strategy 10.

BMPs Implemented in Strategy 10: Cost-Effective Agricultural + Urban BMPs, Moderate Geography								
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**VA**	**WV**	**Total**
Agricultural Practices								
Nutrient Application Management Core Nitrogen	annual	Acres	22,936	22,174	371,547	710	1,175	418,542
Nutrient Application Management Rate Nitrogen	annual	Acres	30,086	22,174	918,015	568	--	970,276
Nutrient Application Management Placement Nitrogen	annual	Acres	6,599	22,174	301,246	900	--	330,019
Nutrient Application Management Timing Nitrogen	annual	Acres	8,596	22,174	873,365	900	--	905,035
Conservation Tillage	annual	Acres	18,325	72,747	202,770	2,343	48	293,843
High Residue Tillage	annual	Acres	2,592	23,731	108,625	74	--	135,022
Low Residue Tillage	annual	Acres	--	20,401	-297*	--	--	20,104
Prescribed Grazing	cumulative	Acres	20,305	69,806	153,505	436	3,298	247,350
Wetland Restoration	cumulative	Acres	20,591	--	6,597	163	0	27,351
Grass Buffers	cumulative	Acres in Buffers	16,274	1,160	33,160	1,373	22	51,989
Soil and Water Conservation Plan	cumulative	Acres	63,696	566,544	315,725	2,599	3	948,567
Manure Incorporation	annual	Acres	39,148	--	14,673	--	--	53,821
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	12	416	1,269	19	5	1,721
Urban Practices								
Infiltration Practices	cumulative	Acres Treated	794	10,302	92	63	43	11,294
Bioswale	cumulative	Acres Treated	699	--	1,011	3	--	1,713
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).								

Strategy 10 Loads Results

Although this strategy includes segments outside of the Susquehanna, the majority of the load reduction comes from Pennsylvania (67%), with only very small amount from Virginia and West Virginia. Of all the strategies, this one has the greatest reduction from New York, since the entire Susquehanna watershed is included.

Table 13. Summary of Strategy 10 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 10: COST-EFFECTIVE AGRICULTURAL + URBAN BMPS, MODERATE GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Strategy 10**	**N Reduction**
MD	Agriculture	13.88	12.53	1.35
	Developed	7.57	7.56	0.01
	Natural	6.20	6.17	0.04
	MD Total	**27.65**	**26.26**	**1.40**
NY	Agriculture	5.94	5.47	0.47
	Developed	1.40	1.35	0.05
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.70**	**0.56**
PA	Agriculture	39.43	35.44	3.99
	Developed	14.87	14.87	0.01
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.60**	**4.17**
VA	Agriculture	7.32	7.25	0.06
	Developed	4.26	4.26	0.00
	Natural	4.97	4.97	0.00
	VA Total	**16.55**	**16.48**	**0.06**
WV	Agriculture	2.39	2.39	0.00
	Developed	1.01	1.01	0.00
	Natural	2.17	2.17	0.00
	WV Total	**5.57**	**5.57**	**0.00**
	TOTAL	***131.79***	***125.61***	***6.19***

Strategy 10 Cost

This strategy costs approximately $82 million, with most of the cost (80%) in the agricultural sector.

Table 14. Summary of costs for BMPs implemented in Strategy 10.

Annualized Costs by State and Sector for Strategy 10. Cost-Effective Agricultural + Urban BMPs, Moderate Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$8,538,540	$1,682,443	--	**$10,220,983**
NY	$4,320,831	$12,866,150	--	**$17,186,981**
PA	$53,290,516	$1,115,020	--	**$54,405,536**
VA	$32,923	$81,318	--	**$114,241**
WV	$85,035	$53,223	--	**$138,258**
Total	***$66,267,844***	***$15,798,154***	**--**	***$82,065,999***

These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP-specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Level 2 Alternate Strategies

Level 2 alternate strategies include those strategies that were **not** supported by the majority of the CWIP Steering Committee and were not provided to the PSC for review. The alternative strategies are placed in the order of cost effectiveness with the most cost-effective first.

Strategy 3: Nitrogen-Effective, Bay-wide

This strategy includes only the most cost-effective BMPs for nitrogen reduction, all of which are applied on agricultural lands within targeted geographic areas of the Chesapeake Bay watershed described below.

Strategy 3. Nitrogen-Effective, Bay-wide	
Geographic Extent	Upper quartile nitrogen-effective LRSs within Chesapeake Bay watershed
BMP Sector(s)	Agricultural
States Involved	Maryland, Pennsylvania, Delaware, Virginia, West Virginia
N Reduction	6,376,678 pounds/year
Total Annualized Cost	$50,989,853
Cost Per Pound	$8

Strategy 3 Geography[7]

This geographic option targets LRSs in the top quartile for relative effectiveness (based on nitrogen reduction) across the entire Bay watershed (Figure 9).

[7] The relative effectiveness of LRS in this scenario was based on CAST modeling assumptions used to develop the TMDL, which assume the Conowingo Dam is trapping sediment and associated nutrients. Use of these “1995 conditions” resulted in only minor differences in which LSRs are most effective. If selected by the PSC, the strategy will be refined to reflect the Conowingo infill condition.

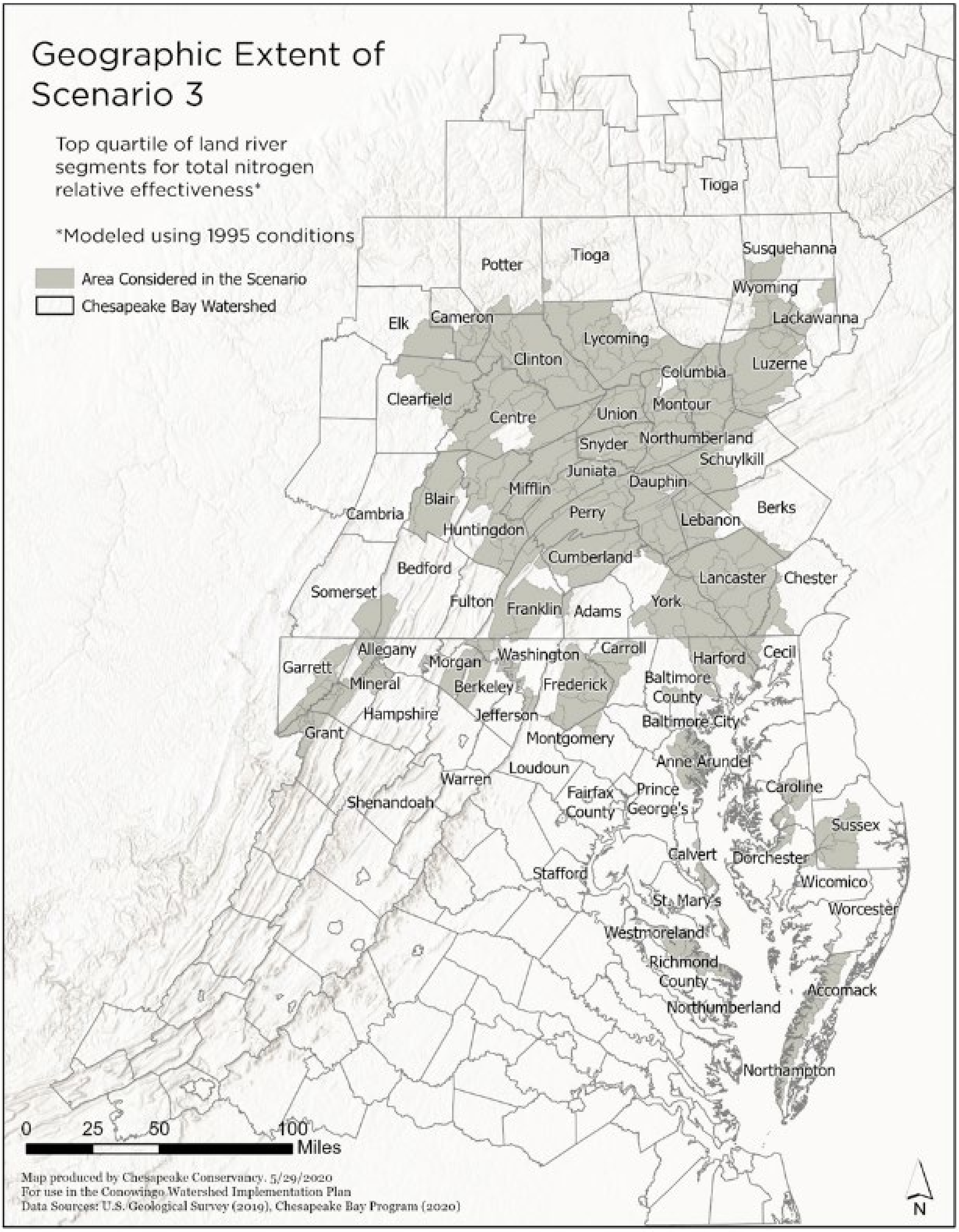


Figure 9. Geographic extent of Strategy 3.

Strategy 3 BMPs

This implementation strategy was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen. These BMPs only address agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation. This strategy is used to an illustrate an approach that optimizes cost-effectiveness of BMP implementation.

Table 15. Summary of acres of BMP implementation for Strategy 3.

BMPs Implemented in Strategy 3. Nitrogen-Effective, Bay-wide			
Practice	**Duration**	**Unit**	**Amount**
Nutrient Application Management Core Nitrogen	annual	Acres	497,108
Nutrient Application Management Rate Nitrogen	annual	Acres	680,286
Nutrient Application Management Placement Nitrogen	annual	Acres	230,891
Nutrient Application Management Timing Nitrogen	annual	Acres	644,867
Conservation Tillage	annual	Acres	160,978
High Residue Tillage	annual	Acres	63,263
Low Residue Tillage	annual	Acres	81,069
Prescribed Grazing	cumulative	Acres	127,102
Forest Buffers	cumulative	Acres in Buffers	11,882
Wetland Restoration	cumulative	Acres	14,480
Grass Buffers	cumulative	Acres in Buffers	46,762
Soil and Water Conservation Plan	cumulative	Acres	432,625
Manure Incorporation	annual	Acres	166,857
Barnyard Runoff Control	cumulative	Acres	1,309

Strategy 3 Loads Results

This BMP implementation strategy, as shown in Table *16*, exceeds the required reduction of 6 million pounds of nitrogen annually. Reductions are achieved almost entirely within the agricultural sector, as these practices are overall the most cost-effective and represent a large percent of the area being considered.

Table 16. Summary of Strategy 3 nitrogen load reductions.

NITROGEN LOAD REDUCTIONS (POUNDS) FOR STRATEGY 3: NITROGEN-EFFECTIVE, BAY-WIDE[1]				
STATE	**Sector**	**Baseline**	**Strategy 3**	**N Reduction**
DE	Agriculture	2,104,913	2,104,332	581
	Developed	427,933	427,933	-
	Natural	316,614	316,589	25
	Septic	114,768	114,768	-
	DE Total	**2,964,228**	**2,963,622**	**606**
MD	Agriculture	14,379,353	13,080,247	1,299,106
	Developed	7,620,554	7,620,554	-
	Natural	6,230,638	6,184,525	46,113
	Septic	2,551,945	2,551,945	-
	MD Total	**30,782,490**	**29,437,272**	**1,345,219**
PA	Agriculture	42,335,501	37,608,018	4,727,483
	Developed	14,878,339	14,878,339	-
	Natural	17,575,268	17,410,473	164,795
	Septic	1,985,768	1,985,768	-
	PA Total	**76,774,876**	**71,882,598**	**4,892,278**
VA	Agriculture	7,619,879	7,496,459	123,420
	Developed	4,351,743	4,351,743	-
	Natural	5,013,391	5,008,026	5,365
	Septic	1,063,019	1,063,019	-
	VA Total	**18,048,032**	**17,919,247**	**128,785**
WV	Agriculture	2,407,593	2,398,867	8,726
	Developed	1,008,137	1,008,137	-
	Natural	2,176,604	2,175,540	1,064
	Septic	284,212	284,212	-
	WV Total	**5,876,546**	**5,866,757**	**9,790**
	TOTAL	***134,446,172***	***128,069,495***	***6,376,678***
1: THE LOADS REPORTED IN THIS TABLE ARE ADJUSTED TO EQUATE TO NITROGEN REDUCTIONS FROM THE SUSQUEHANNA.				

Strategy 3 Cost

Table *17* provides an overview of the costs associated with implementation of the BMP strategy identified in Table *15*. The annualized costs are derived from CAST. Default costs for Pennsylvania, Maryland, Delaware, Virginia, and West Virginia within CAST were used to develop the cost estimates. A summary of the assumptions used to generate this estimate is provided in Appendix G.

Table 17. Summary of costs for BMPs implemented in Strategy 3.

Annualized Costs by State and Sector for Strategy 3: Nitrogen-Effective, Bay-Wide				
	Agriculture	**Developed**	**Natural**	**Total**
DE	--	--	--	--
MD	$6,241,295	--	--	$6,241,295
NY	--	--	--	--
PA	$44,385,635	--	--	$44,385,635
VA	$169,432	--	--	$169,432
WV	$193,491	--	--	$193,491
Total	***$50,989,853***	**--**	**--**	***$50,989,853***

BMP implementation in Delaware is minimal and the BMPs used in this strategy reduce overall costs so are listed as zero. These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP-specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Strategy 4: Nitrogen-Effective, Susquehanna

This strategy is similar to Strategy 3 in that it includes only the most cost-effective BMPs for nitrogen reduction, applied on agricultural lands. However, this strategy only applies BMPs within targeted geographic areas of the Susquehanna River basin, as described below.

Strategy 4. Nitrogen-Effective, Susquehanna	
Geographic Extent	Above-the-median, nitrogen-effective LRSs within the Susquehanna watershed
BMP Sector(s)	Agricultural
States Involved	Maryland, Pennsylvania, New York
N Reduction	6,615,657 pounds/year
Total Annualized Cost	$56,235,690
Cost Per Pound	$8

Strategy 4 Geography[8]

This geographic option targets those LRSs in the top two quartiles for relative effectiveness (based on nitrogen reduction) within the Susquehanna River basin only (Figure *10*).

[8] The strategy presented was based on 1995 Modeling and will be refined to reflect the Conowingo Infill N-effective basins reflected in Figure 10.

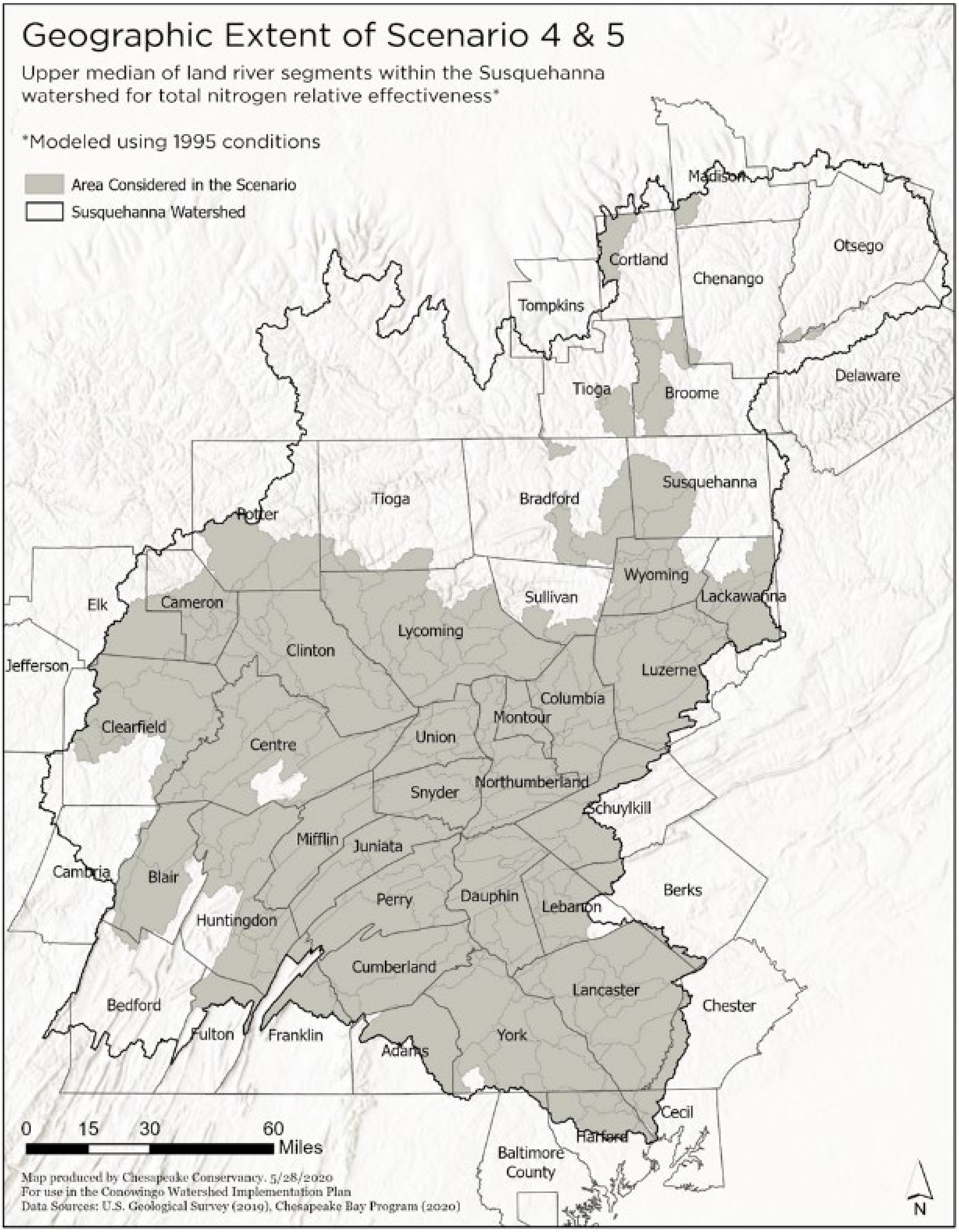


Figure 10. Geographic extent for Strategies 4 and 5.

Strategy 4 BMPs

This implementation strategy was developed to demonstrate the modeled nitrogen load reduction to the Bay based on the most effective BMPs for nitrogen (Table *18*). These BMPs only address agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation. This strategy is used to an illustrate an approach that looks primarily at reducing the cost per pound of nitrogen reduced but is limited to the Susquehanna River basin, which has the greatest relative influence on DO in the Bay.

Table 18. Summary of acres of BMP implementation for Strategy 4.

BMPs Implemented in Strategy 4: Nitrogen-Effective, Susquehanna			
Practice	**Duration**	**Unit**	**Amount**
Nutrient Application Management Core Nitrogen	annual	Acres	305,137
Nutrient Application Management Rate Nitrogen	annual	Acres	668,563
Nutrient Application Management Placement Nitrogen	annual	Acres	227,905
Nutrient Application Management Timing Nitrogen	annual	Acres	673,548
Conservation Tillage	annual	Acres	214,027
High Residue Tillage	annual	Acres	45,579
Low Residue Tillage	annual	Acres	9,616
Prescribed Grazing	cumulative	Acres	94,269
Forest Buffers	cumulative	Acres in Buffers	22,729
Wetland Restoration	cumulative	Acres	12,479
Grass Buffers	cumulative	Acres in Buffers	24,117
Soil and Water Conservation Plan	cumulative	Acres	204,016
Manure Incorporation	annual	Acres	200,029
Barnyard Runoff Control	cumulative	Acres	755

Strategy 4 Loads Results

This BMP implementation strategy, as shown in Table *19*, exceeds the required nitrogen reduction of 6 million pounds per year, reaching almost 6.6 million.

Table 19. Summary of Strategy 4 nitrogen load reductions.

NITROGEN LOAD REDUCTION (POUNDS) FOR STRATEGY 4: NITROGEN-EFFECTIVE, SUSQUEHANNA				
STATE	**SECTOR**	**BASELINE**	**STRATEGY 4**	**N REDUCTION**
MD	Agriculture	783,258	628,688	154,569
	Developed	338,577	338,577	-
	Natural	261,156	254,545	6,610
	Septic	198,843	198,843	-
	MD Total	**1,581,834**	**1,420,653**	**161,179**
NY	Agriculture	5,980,815	5,832,273	148,541
	Developed	1,398,622	1,398,622	-
	Natural	2,922,999	2,915,574	7,425
	Septic	176,675	176,675	-
	NY Total	**10,479,111**	**10,323,144**	**155,966**
PA	Agriculture	38,269,615	32,142,759	6,126,856
	Developed	13,936,730	13,936,730	-
	Natural	16,439,618	16,268,052	171,566
	Septic	1,724,857	1,724,857	-
	PA Total	**70,370,820**	**64,072,398**	**6,298,422**
	TOTAL	***82,431,765***	***75,816,195***	***6,615,657***

Strategy 4 Cost

Table *20* provides an overview of the costs associated with implementation the BMP strategy identified in Table *18*. The annualized costs are derived from CAST using a Chesapeake Bay cost basis, which is the average of unit cost estimates for all states. This option is also very cost-effective.

Table 20. Summary of costs for BMPs implemented in Strategy 4.

Annualized Costs by State and Sector for Strategy 4: Nitrogen-Effective, Susquehanna				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,073,475	$3,813	-	$1,077,289
NY	$1,742,223	$65,371	-	$1,807,594
PA	$48,216,777	$5,133,682	$348	$53,350,807
Total	***$51,032,475***	***$5,202,866***	***$348***	***$ 56,235,690***

These costs should be considered as initial estimates only and may change significantly on a per unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP-specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Strategy 9: Cost-Effective Agricultural BMPs, Narrowest Geography

Strategy 9. Cost-Effective Agricultural BMPs, Narrowest Geography	
Geographic Extent	Top two quartiles of nitrogen-effective LRSs within the Susquehanna, Eastern Shore, and Western Shore geobasins
BMP Sector(s)	Cost-Effective Agriculture
States Included	Maryland, New York, Pennsylvania
N Reduction	6.01 million pounds/year
Total Annualized Cost	$49,535,922
Cost Per Pound	$8

Strategy 9 Geography

Strategy 9 uses the same geography as Strategy 8 (Figure *11*).

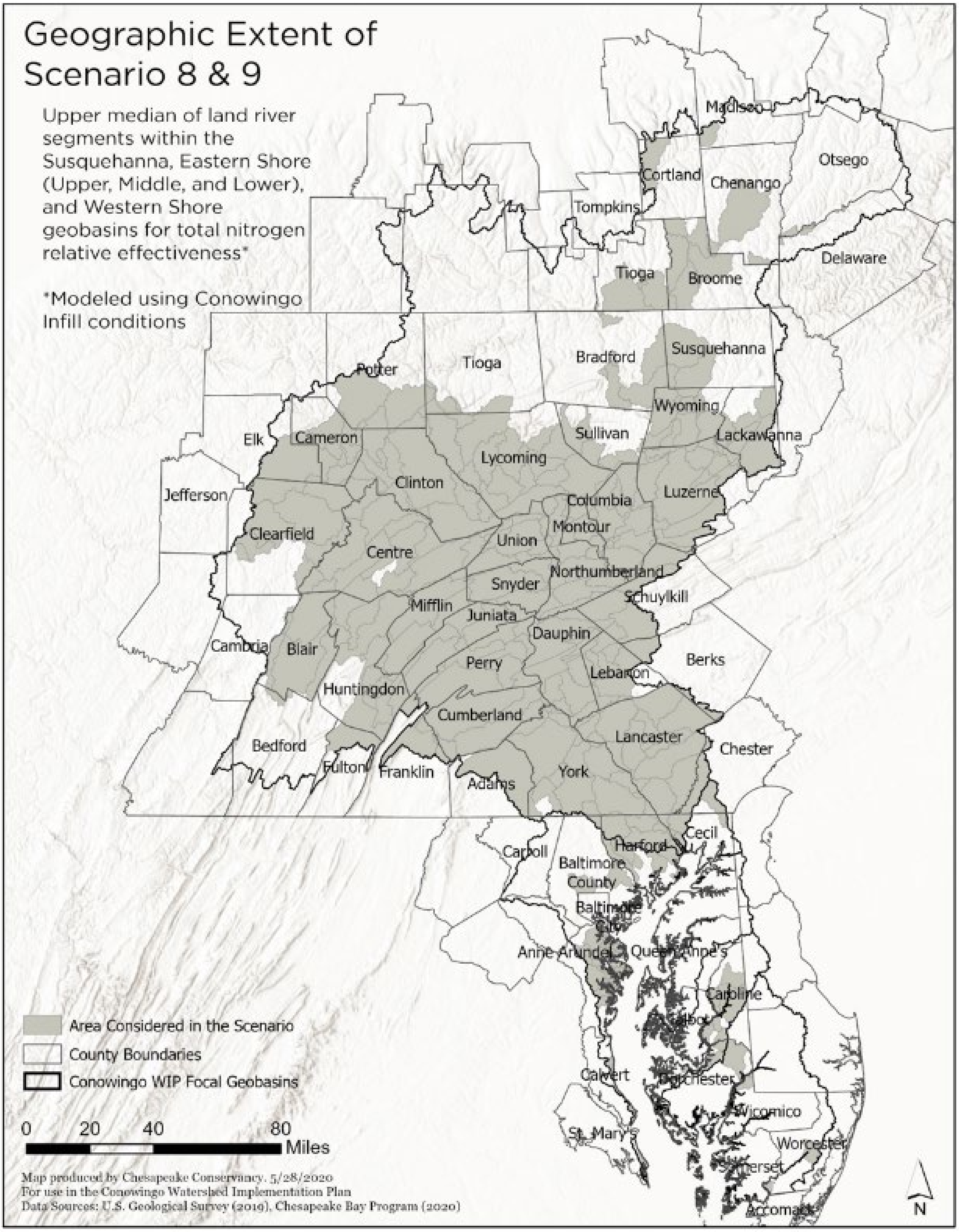


Figure 11. Geographic extent of Strategies 8 and 9.

Strategy 9 BMPs

Strategy 9 relies entirely on agricultural BMPs (Table *21*).

Table 21. Summary of acres of BMP implementation for Strategy 9.

BMPs Implemented in Strategy 9: Cost-Effective Agricultural BMPs, Narrowest Geography						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	-105*	2,479	414,788	417,162
Nutrient Application Management Rate Nitrogen	annual	Acres	4,634	2,479	687,206	694,319
Nutrient Application Management Placement Nitrogen	annual	Acres	-30*	2,479	275,790	278,239
Nutrient Application Management Timing Nitrogen	annual	Acres	1,324	2,479	682,045	685,848
Conservation Tillage	annual	Acres	17,775	12,791	146,485	177,051
High Residue Tillage	annual	Acres	-13,397*	12,508	56,479	55,590
Low Residue Tillage	annual	Acres	--	5,970	93,685	99,655
Prescribed Grazing	cumulative	Acres	8,358	4,942	100,484	113,784
Forest Buffers	cumulative	Acres in Buffers	1,571	1,042	20,362	22,975
Wetland Restoration	cumulative	Acres	3,063	--	3,560	6,623
Grass Buffers	cumulative	Acres in Buffers	7,376	385	24,081	31,842
Soil and Water Conservation Plan	cumulative	Acres	30,139	55,609	295,182	380,930
Manure Incorporation	annual	Acres	12,842	--	123,234	136,076
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	169	47	972	1,188
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Strategy 9 Loads Results

Strategy 9 results in a 6.0-million-pound reduction in nitrogen loads, with 88% of the reduction coming from Pennsylvania.

Table 22. Summary of Strategy 9 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 9: COST-EFFECTIVE AGRICULTURAL BMPS, NARROWEST GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Scenario 9**	**N Reduction**
MD	Agriculture	14.31	13.74	0.57
	Developed	7.62	7.62	--
	Natural	6.23	6.21	0.02
	MD Total	**28.16**	**27.57**	**0.59**
NY	Agriculture	5.98	5.87	0.11
	Developed	1.41	1.41	--
	Natural	2.92	2.92	0.01
	NY Total	**10.31**	**10.20**	**0.12**
PA	Agriculture	42.34	37.22	5.12
	Developed	14.88	14.88	--
	Natural	17.58	17.40	0.18
	PA Total	**74.80**	**69.50**	**5.29**
	TOTAL	***113.27***	***107.26***	***6.01***

Strategy 9 Cost

The total cost (approximately $50 million) is among the least expensive of the strategies, and it is spent entirely in the agricultural sector.

Table 23. Summary of costs for BMPs implemented in Strategy 9.

Annualized Costs by State and Sector for Strategy 9. Cost-Effective Agricultural BMPs, Narrowest Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$1,787,421	--	--	**$1,787,421**
NY	$529,289	--	--	**$529,289**
PA	$47,219,212	--	--	**$47,219,212**
Total	***$49,535,922***	**--**	**--**	***$49,535,922***

Strategy 7: Cost-Effective Agricultural BMPs, Broadest Geography

Strategy 7. Cost-Effective Agricultural BMPs, Broadest Geography	
Geographic Extent	Entire Susquehanna, Eastern Shore and Western Shore geobasins
BMP Sector(s)	Cost-Effective Agriculture
States Included	Maryland, New York, Pennsylvania
N Reduction	6.09 million pounds/year
Total Annualized Cost	$67,733,046
Cost Per Pound	$11

Strategy 7 Geography

Strategy 7 uses the same geography as Strategy 6 (Figure *12*).

Strategy 7 BMPs

This strategy relies entirely on cost-effective agricultural BMPs (Table *24*).

Table 24. Summary of acres of BMP implementation for Strategy 7.

BMPs Implemented in Strategy 7: Cost-Effective Agricultural BMPs, Broadest Geography						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	30,242	22,174	373,437	425,853
Nutrient Application Management Rate Nitrogen	annual	Acres	31,025	22,174	913,312	966,511
Nutrient Application Management Placement Nitrogen	annual	Acres	8,645	22,174	298,619	329,438
Nutrient Application Management Timing Nitrogen	annual	Acres	8,864	22,174	868,420	899,458
Conservation Tillage	annual	Acres	101,738	72,747	203,809	378,294
High Residue Tillage	annual	Acres	-21,516*	23,731	110,095	112,310
Low Residue Tillage	annual	Acres	--	20,401	-236*	20,165
Prescribed Grazing	cumulative	Acres	27,894	65,535	138,762	232,191
Wetland Restoration	cumulative	Acres	24,264	--	1,400	25,664
Grass Buffers	cumulative	Acres in Buffers	32,577	1,160	32,823	66,560
Soil and Water Conservation Plan	cumulative	Acres	129,605	524,166	279,875	933,646
Manure Incorporation	annual	Acres	72,647	--	14,720	87,367
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	670	391	1,051	2,112
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Strategy 7 Loads Results

This strategy reduces nitrogen loads by 6.1 million pounds per year, with the reductions coming almost entirely from the agricultural sector. Additionally, 65% of the load reduction comes from Pennsylvania, 27% from Maryland, and the remainder from New York.

Table 25. Summary of Strategy 7 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 7: COST-EFFECTIVE AGRICULTURAL BMPS, BROADEST GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Scenario 7**	**N Reduction**
MD	Agriculture	13.88	12.25	1.62
	Developed	7.57	7.57	--
	Natural	6.20	6.16	0.05
	MD Total	**27.65**	**25.98**	**1.67**
NY	Agriculture	5.94	5.49	0.45
	Developed	1.40	1.40	--
	Natural	2.92	2.89	0.03
	NY Total	**10.26**	**9.78**	**0.48**
PA	Agriculture	39.43	35.66	3.77
	Developed	14.87	14.87	--
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.82**	**3.94**
TOTAL		***109.67***	***103.58***	***6.09***

Strategy 7 Cost

The total cost for this strategy is approximately $68 million/year, with all of the costs in the agricultural sector, and approximately 77% of the costs in Pennsylvania.

Table 26. Summary of costs for BMPs implemented in Strategy 7.

Annualized Costs by State and Sector for Strategy 7. Cost-Effective Agricultural BMPs, Broadest Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$11,471,478	--	--	**$11,471,478**
NY	$4,144,222	--	--	**$4,144,223**
PA	$52,117,345	--	--	**$52,117,345**
Total	***$67,733,046***	**--**	**--**	***$67,733,046***

Strategy 11: Cost-Effective Agricultural BMPs, Moderate Geography

Strategy 11. Cost-Effective Agricultural BMPs, Moderate Geography	
Geographic Extent	Entire Susquehanna watershed + upper quartile nitrogen-effective LRSs within the Chesapeake Bay watershed
BMP Sector(s)	Cost-Effective Agriculture
States Included	Maryland, New York, Pennsylvania, Virginia, West Virginia
N Reduction	6.12 million pounds/year
Total Annualized Cost	$66,267,845
Cost Per Pound	$11

Strategy 11 Geography

Strategy 11 uses the same geography as Strategy 10 (Figure *13*).

Strategy 11 BMPs

Strategy 11 uses agricultural BMPs only.

Table 27. Summary of acres of BMP implementation for Strategy 11.

BMPs Implemented in Strategy 11: Cost-Effective Agricultural BMPs, Moderate Geography								
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**VA**	**WV**	**Total**
Agricultural Practices								
Nutrient Application Management Core Nitrogen	annual	Acres	22,936	22,174	371,547	710	1,175	418,542
Nutrient Application Management Rate Nitrogen	annual	Acres	30,086	22,174	918,015	568	--	970,843
Nutrient Application Management Placement Nitrogen	annual	Acres	6,599	22,174	301,246	900	--	330,919
Nutrient Application Management Timing Nitrogen	annual	Acres	8,596	22,174	873,365	900	--	905,035
Conservation Tillage	annual	Acres	18,325	72,747	202,770	2,343	48	296,233
High Residue Tillage	annual	Acres	2,592	23,731	108,625	74	--	135,022
Low Residue Tillage	annual	Acres	--	20,401	-297*	--	--	20,104
Prescribed Grazing	cumulative	Acres	20,305	69,806	153,505	436	3,298	247,350
Wetland Restoration	cumulative	Acres	20,591	--	6,597	163	--	27,351
Grass Buffers	cumulative	Acres in Buffers	16,274	1,160	33,160	1,373	22	51,989
Soil and Water Conservation Plan	cumulative	Acres	63,696	566,544	315,725	2,599	3	948,567
Manure Incorporation	annual	Acres	39,148	--	14,673	--	--	53,821
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	12	416	1,269	19	5	1,721
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).								

Strategy 11 Loads Results

Strategy 11 results in a 6.1-million-pound reduction in nitrogen loads, with the majority of the load reduction (68%) coming from Pennsylvania.

Table 28. Summary of Strategy 11 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 11: COST-EFFECTIVE AGRICULTURAL BMPS, MODERATE GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Scenario 11**	**N Reduction**
MD	Agriculture	13.88	12.53	1.35
	Developed	7.57	7.57	0.00
	Natural	6.20	6.17	0.04
	MD Total	**27.65**	**26.27**	**1.39**
NY	Agriculture	5.94	5.47	0.47
	Developed	1.40	1.40	0.00
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.75**	**0.51**
PA	Agriculture	39.43	35.44	3.99
	Developed	14.87	14.87	0.00
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.60**	**4.16**
VA	Agriculture	7.32	7.25	0.06
	Developed	4.26	4.26	0.00
	Natural	4.97	4.97	0.00
	VA Total	**16.55**	**16.48**	**0.06**
WV	Agriculture	2.39	2.39	0.00
	Developed	1.01	1.01	0.00
	Natural	2.17	2.17	0.00
	WV Total	**5.57**	**5.57**	**0.00**
	TOTAL	***131.80***	***125.68***	***6.12***

Strategy 11 Cost

This strategy costs approximately $66 million, with approximately $53 million of the cost in Pennsylvania.

Table 29. Summary of costs for BMPs implemented in Strategy 11.

Annualized Costs by State and Sector for Strategy 11. Cost-Effective Agricultural BMPs, Moderate Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$8,538,540	--	--	**$8,538,540**
NY	$4,320,831	--	--	**$4,320,831**
PA	$53,290,516	--	--	**$53,290,516**
VA	$32,923	--	--	**$32,923**
WV	$85,035	--	--	**$85,035**
Total	***$66,267,845***	**--**	**--**	***$66,267,854***

Strategy 6: Cost-Effective Agricultural + Urban BMPs, Broadest Geography

Strategy 6. Cost-Effective Agricultural + Urban BMPs, Broadest Geography	
Geographic Extent	Entire Susquehanna, Eastern Shore and Western Shore geobasins
BMP Sector(s)	Cost-Effective Agricultural + Urban
States Included	Maryland, New York, Pennsylvania
N Reduction	6.19 million pounds/year
Total Annualized Cost	$89,683,430
Cost Per Pound	$14

Strategy 6 Geography

Strategies 6 and 7 use the entire Susquehanna, Eastern Shore, and Western Shore geobasins (Figure *12*), referred to as the "Susquehanna + Most Effective Basins" option in the CWIP Framework document. All of the cost-effective agricultural BMPs are implemented at their maximum level, defined by WIPs, with the exception of wetland restoration, which was reduced by 50% to lower the overall nutrient reduction and cost.

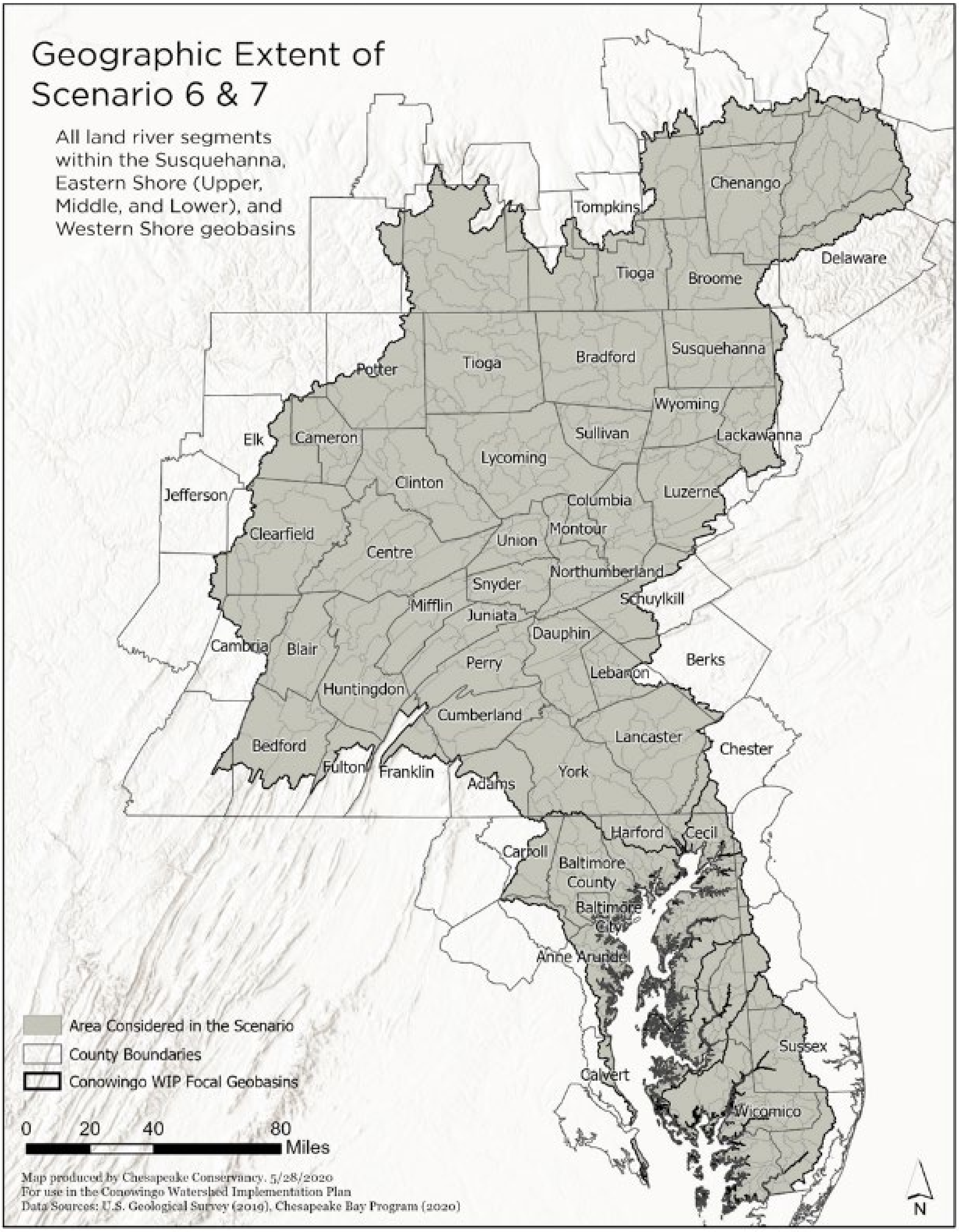


Figure 12. Geographic extent of Strategies 6 and 7.

Strategy 6 BMPs

Strategy 6 relies on a suite of cost-effective agricultural BMPs (Table *30*), along with two urban BMPs: infiltration and bioswales.

Table 30. Summary of acres of BMP implementation for Strategy 6.

BMPs Implemented in Strategy 6: Cost-Effective Agricultural + Urban BMPs, Broadest Geography						
Practice	**Duration**	**Unit**	**MD**	**NY**	**PA**	**Total**
Agricultural Practices						
Nutrient Application Management Core Nitrogen	annual	Acres	30,242	22,174	373,437	425,853
Nutrient Application Management Rate Nitrogen	annual	Acres	31,025	22,174	913,312	966,511
Nutrient Application Management Placement Nitrogen	annual	Acres	8,645	22,174	298,619	329,438
Nutrient Application Management Timing Nitrogen	annual	Acres	8,864	22,174	868,420	899,458
Conservation Tillage	annual	Acres	101,738	72,747	203,809	378,294
High Residue Tillage	annual	Acres	-21,516*	23,731	110,095	112,310
Low Residue Tillage	annual	Acres	--	20,401	-236*	20,165
Prescribed Grazing	cumulative	Acres	27,894	65,535	138,762	232,191
Wetland Restoration	cumulative	Acres	24,264	--	1,400	25,664
Grass Buffers	cumulative	Acres in Buffers	32,577	1,160	32,823	66,560
Soil and Water Conservation Plan	cumulative	Acres	129,605	524,166	279,875	933,646
Manure Incorporation	annual	Acres	72,647	--	14,720	87,367
Barnyard Runoff Control + Loafing Lot Management	cumulative	Acres	670	391	1,051	2,112
Urban Practices						
Infiltration Practices	cumulative	Acres	1,300	10,302	92	11,694
Bioswale	cumulative	Acres	6,415	--	1,011	7,426
* Negative values indicate a loss in acreage in a BMP. This is typically due to shifting to another category (e.g., high residue tillage shifting to conservation tillage).						

Strategy 6 Loads Results

Strategy 6 reduces nitrogen loads by 6.2 million pounds per year, with 64% of the load reduction from Pennsylvania, 28% from Maryland and the remainder from New York (Table *31*). The bulk of the load reduction is from the agricultural sector.

Table 31. Summary of Strategy 6 nitrogen load reductions (values in millions of pounds).

NITROGEN LOAD REDUCTIONS (MILLIONS OF POUNDS) FOR STRATEGY 6: COST-EFFECTIVE AGRICULTURAL + URBAN BMPS, BROADEST GEOGRAPHY				
STATE	**Sector**	**Baseline**	**Scenario 6**	**N Reduction**
MD	Agriculture	13.88	12.25	1.62
	Developed	7.57	7.54	0.03
	Natural	6.20	6.15	0.05
	MD Total	**27.65**	**25.94**	**1.70**
NY	Agriculture	5.94	5.49	0.45
	Developed	1.40	1.35	0.05
	Natural	2.92	2.88	0.04
	NY Total	**10.26**	**9.72**	**0.54**
PA	Agriculture	39.43	35.66	3.77
	Developed	14.87	14.87	0.01
	Natural	17.46	17.29	0.17
	PA Total	**71.76**	**67.82**	**3.95**
	TOTAL	***109.67***	***103.48***	***6.19***

Strategy 6 Cost

The total cost for this strategy is approximately $90 million/year. Although urban BMPs represent only a small fraction (< 2%) of the total load, approximately 25% of the costs are in the developed sector.

Table 32. Summary of costs for BMPs implemented in Strategy 6.

Annualized Costs by State and Sector for Strategy 6. Cost-Effective Agricultural + Urban BMPs, Broadest Geography				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$11,471,478	$7,969,215	--	**$19,440,693**
NY	$4,144,222	$12,866,150	--	**$17,010,372**
PA	$52,117,345	$1,115,020	--	**$53,232,365**
Total	***$67,733,045***	***$21,950,385***	**--**	***$89,683,430***

Strategy 2: Enhanced WIP Implementation

This strategy considers that there may be additional opportunity to implement WIP III BMPs, which can be credited towards the CWIP. The strategy assumes a 25% increase in implementation of BMPs at the WIP III level of implementation within the geographic areas defined below.

Strategy 2. Enhanced WIP Implementation	
Geographic Extent	Entire Susquehanna watershed + upper quartile nitrogen-effective LRSs within the Bay watershed
BMP Sector(s)	Agricultural + Urban
States Included	Maryland, Pennsylvania, Delaware, New York, Virginia, West Virginia
N Reduction	6,098,727 pounds/year
Total Annualized Cost	$235,908,443
Cost Per Pound	$39

Strategy 2 Geography

This geography includes the entire Susquehanna River basin, along with additional LRSs in the top quartile for relative effectiveness (based on nitrogen reduction) in the Chesapeake Bay Watershed. The dark areas in Figure *13* highlight the upper quartile segments.

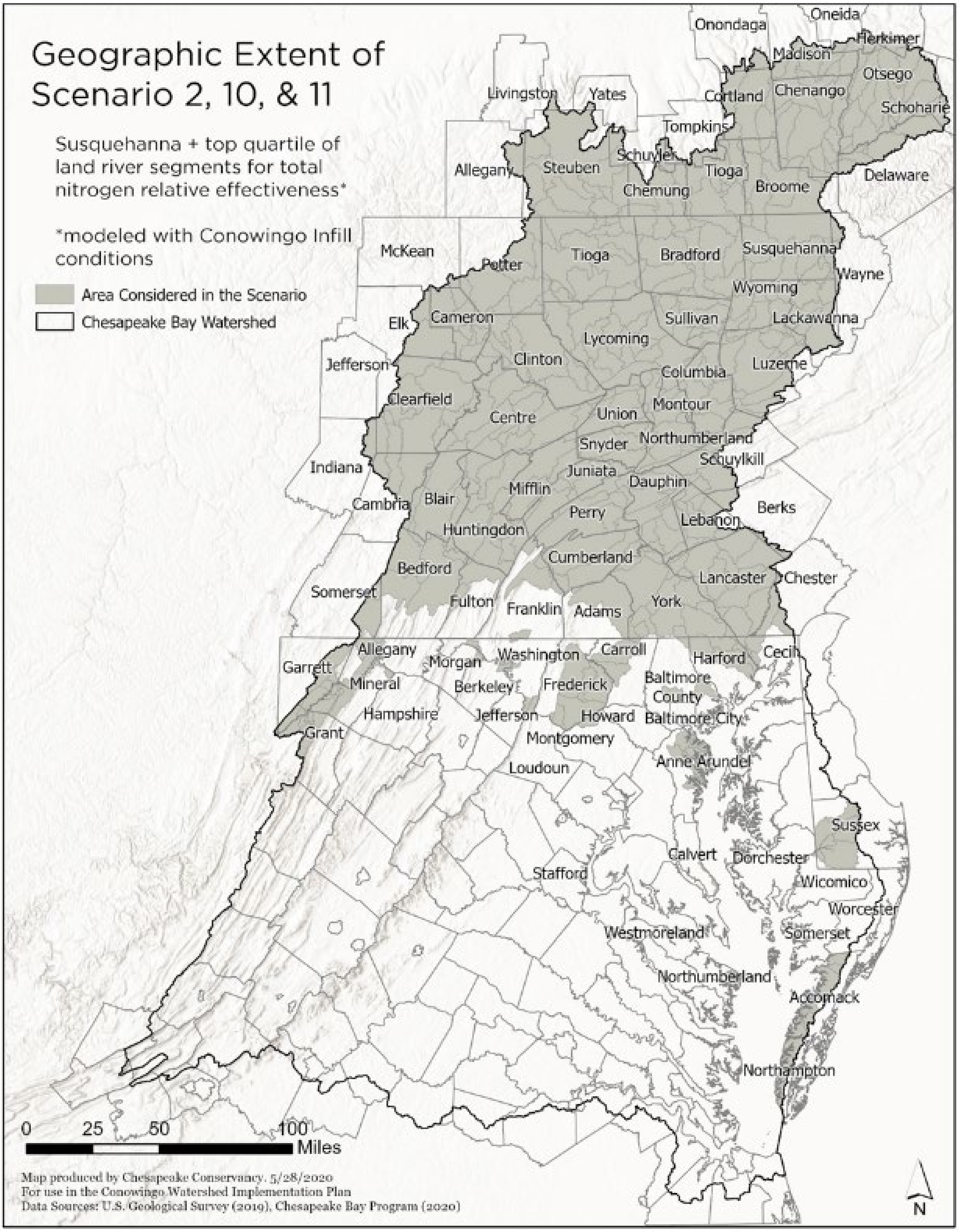


Figure 13. Geographic extent of Strategies 2, 10, and 11.

Strategy 2 BMPs

This implementation strategy was developed to demonstrate the modeled nitrogen load reduction to the Chesapeake Bay based on BMPs that were selected by the jurisdictions as part of their WIP III strategies. These BMPs address both developed and agricultural load sources, are accepted BMPs by the CBP partnership, and data is available to map the extent of available area for future implementation. This strategy is used to illustrate the ability to achieve the needed load reductions by increasing the scale, scope, or number of WIP III projects. Additionally, this strategy could integrate with another strategy that involves participation in a trading program where load reduction credits are available from WIP III projects that exceed their individual project goals and produce additional tradable credit. The BMPs in this strategy include those in the jurisdictions' WIPs, as well as others implemented prior to the WIP[9], and are provided in Appendix H.

Strategy 2 Loads Results

This BMP implementation strategy, as shown in Table 33, achieves the required reduction of slightly over 6 million pounds annually.

[9] The full suite of BMPs included in this scenario can be refined to reflect a narrower range of practices.

Table 33. Summary of Strategy 2 nitrogen load reductions.

NITROGEN LOAD REDUCTIONS (POUNDS) FOR STRATEGY 2: ENHANCED WIP IMPLEMENTATION				
STATE	**Sector**	**Baseline**	**Strategy 2**	**N Reduction**
DE	Agriculture	1,206,209	1,075,719	130,489
	Developed	264,208	250,857	13,352
	Natural	176,331	173,131	3,199
	Septic	56,121	53,468	2,653
	DE Total	**1,702,869**	**1,553,175**	**149,693**
MD	Agriculture	3,571,216	3,233,321	337,895
	Developed	2,147,369	2,099,466	47,903
	Natural	1,557,861	1,533,448	24,412
	Septic	837,096	825,800	11,296
	MD Total	**8,113,542**	**7,692,035**	**421,506**
NY	Agriculture	4,918,504	4,654,984	263,520
	Developed	1,398,622	1,248,440	150,182
	Natural	2,844,262	2,814,968	29,295
	Septic	176,675	176,675	-
	NY Total	**9,338,063**	**8,895,067**	**442,997**
PA	Agriculture	35,795,450	31,291,008	4,504,443
	Developed	14,064,630	13,847,623	217,007
	Natural	16,487,560	16,284,325	203,235
	Septic	1,767,113	1,722,399	44,714
	PA Total	**68,114,753**	**63,145,355**	***4,969,399***
VA	Agriculture	590,902	512,982	77,920
	Developed	132,627	125,614	7,012
	Natural	198,344	192,908	5,436
	Septic	28,758	27,046	1,712
	VA Total	**950,631**	**858,550**	**92,080**
WV	Agriculture	219,951	208,491	11,460
	Developed	148,966	148,234	732
	Natural	282,158	280,795	1,363
	Septic	27,776	27,279	497
	WV Total	**678,851**	**664,799**	**14,052**
	TOTAL	***88,898,709***	***82,808,981***	***6,089,727***
1: THE LOADS REPORTED IN THIS TABLE ARE ADJUSTED TO EQUATE TO NITROGEN REDUCTIONS FROM THE SUSQUEHANNA.				

Strategy 2 Cost

Table *34* provides an overview of the costs associated with implementation of the BMP strategy identified in Table *33*. The annualized costs are derived from CAST. This strategy is more cost-effective than Strategy 1, but it has not been optimized to select the most cost-effective BMPs.

Table 34. Summary of costs for BMPs implemented in Strategy 2.

Annualized Costs by State and Sector for Strategy 2: Enhanced WIP Implementation					
	Agriculture	**Developed**	**Natural**	**Septic**	**Total**
DE	$2,635,272	$2,063,607	$1,644,871	$1,405,222	**$7,748,972**
MD	$4,160,624	$11,394,309	$11,247,559	$4,177,592	**$30,980,084**
NY	$14,736,078	$57,419,493	$288,990	-	**$72,444,561**
PA	$41,749,277	$45,334,120	$22,519,019	$6,211,214	**$115,813,630**
VA	$1,824,054	$3,931,166	$1,585,852	$1,046,643	**$8,387,715**
WV	$180,534	$286,337	$15,115	$51,495	**$533,481**
Total	***$65,285,839***	***$120,429,032***	***$37,301,406***	***$12,892,166***	***$235,908,443***

These costs should be considered as initial estimates only and may change significantly on a per-unit basis depending on how projects are financed and the scale at which the projects are implemented. These costs do not include associated financial services costs or technical assistance costs provided at the local level to facilitate implementation of CWIP-specific BMPs. Those additional costs will be identified during the outreach phase and with input from the Financing Strategy.

Strategy 1: Constrained

Strategy 1 refines the first BMP strategy from the previous January 2020 CWIP. This strategy reflects BMPs that are exclusively land based and urban BMPs. The BMPs selected here are also constrained to only Pennsylvania and portions of Maryland.

Strategy 1. Constrained	
Geographic Extent	PA counties and non-MS4 MD counties within the Susquehanna, Eastern Shore, and Western Shore geobasins
BMP Sector(s)	Agricultural + Urban
States Included	Maryland, Pennsylvania
N Reduction	6,000,026 pounds/year
Total Annualized Cost	$367,838,818
Cost Per Pound	$62

Strategy 1 Geography

This geographic option, presented in the CWIP Framework as the "Susquehanna + Most Effective Basins," represents the entire Susquehanna Basin along with the major state basins that are most effective for improving DO in the Chesapeake Bay based on reducing phosphorus in the watershed. The top six most effective basins for phosphorus represent a statistical break in the data and when combined with the three Susquehanna basins provide a simple, consolidated boundary within which to target the CWIP. Figure *14* illustrates this geography, which includes the Susquehanna, Western Shore, and Eastern Shore (Upper, Middle, and Lower) geobasins. This boundary was selected by the PSC as the geographic focus for the CWIP and was used to develop the January 2020 CWIP BMP scenario. This strategy focuses BMP implementation on counties whose entire land area is fully contained within the boundary. This strategy excludes jurisdictions in New York and Delaware due to low effectiveness, and MS4 jurisdictions in Maryland outside the Susquehanna basin due to the amount of regulated land.

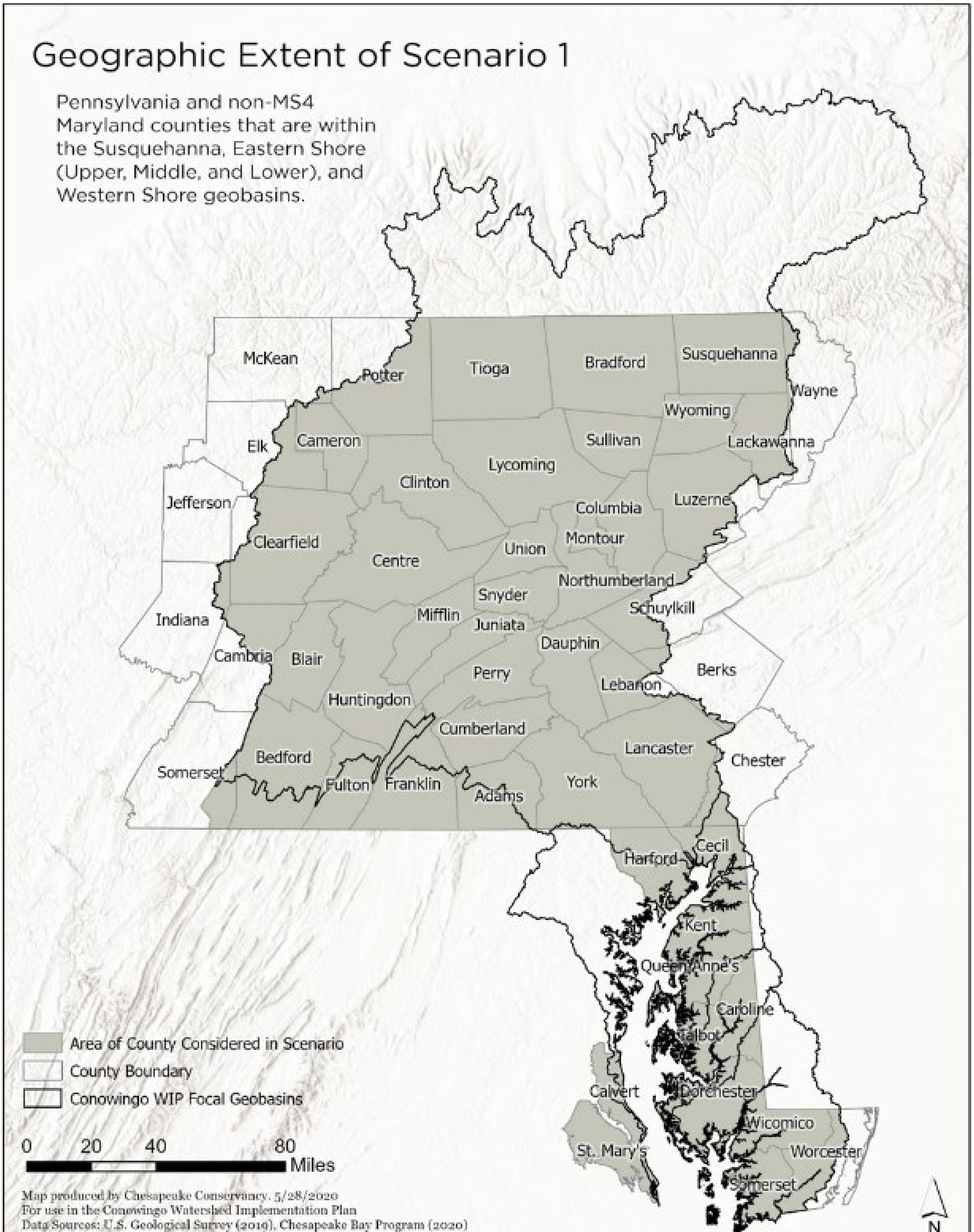


Figure 14. Geographic extent of Strategy 1.

Strategy 1 BMPs

This implementation strategy was developed to demonstrate the modeled nitrogen load reduction to the Bay based on BMPs that were selected collectively by the CWIP Steering Committee. Further, the BMPs address both developed and agricultural load sources, are accepted BMPs by the CBP partnership and data is available to map the extent of available area for future implementation (Table *35*).

Table 35. Summary of acres of BMP implementation for Strategy 1.

Proposed BMPs in Strategy 1: Constrained				
Practice	**Unit**	**Maryland**	**Pennsylvania**	**Total**
Agricultural Practices				
Forest Buffers on Fenced Pasture Corridor	Acres in Buffers	8,580	95,804	104,384
Forest Buffers	Acres in Buffers	16,111	44,960	61,071
Wetland Restoration	Acres	6,586	34,326	40,912
Non-Urban Stream Restoration	Feet	419,995	2,959,918	3,379,913
Non-Urban Shoreline Management	Feet	773,022	-	773,022
Urban Practices				
Bioswale	Acres Treated	2,415	12,137	14,552
Urban Stream Restoration	Acres	324,384	1,358,957	1,683,341

Strategy 1 Loads Results

The data sources and methods used to quantify the load reductions are included in Appendix E. This initial BMP implementation strategy achieves the required reduction of 6 million pounds annually (Table 36).

Table 36. Summary of Scenario 1 nitrogen load reductions.

NITROGEN LOADS (POUNDS) FOR STRATEGY 1: CONSTRAINED				
STATE	**Sector**	**Baseline**	**Strategy 1**	**N Reduction**
MD	Agriculture	13,840,672	12,989,629	851,043
	Developed	7,684,437	7,674,370	10,067
	Natural	6,271,233	6,089,006	182,227
	Septic	2,545,801	2,545,801	-
	MD Total	**30,342,143**	**29,298,806**	**1,043,337**
PA	Agriculture	39,428,949	35,123,923	4,305,026
	Developed	14,874,103	14,798,709	75,394
	Natural	17,459,042	16,882,773	576,269
	Septic	1,985,752	1,985,752	-
	PA Total	**73,747,846**	**68,791,157**	**4,956,689**
	TOTAL	***104,089,989***	***98,089,963***	***6,000,026***

Strategy 1 Cost

Table 37 provides an overview of the costs associated with implementation of the BMP strategy identified in Table 35. The annualized costs are derived from the CBP partnership's Chesapeake Assessment Scenario Tool (CAST). This strategy is the least cost-effective option, largely because many agricultural practices were not incorporated, and due to efforts to restrict the loss of cropland.

Table 37. Summary of costs for BMPs implemented in Strategy 1.

Annualized Costs by State and Sector for Strategy 1. Constrained				
	Agriculture	**Developed**	**Natural**	**Total**
MD	$7,127,298	$ 2,388,661	$ 55,299,681	***$ 64,815,641***
PA	$ 73,290,317	$ 12,003,399	$ 217,729,462	***$ 303,023,178***
Total	***$ 80,417,615***	***$ 14,392,060***	***$ 273,029,143***	***$ 367,838,819***

Appendix G. Assumptions for Cost Estimates within the CWIP Implementation Strategy

The cost estimates included in the CWIP strategy are based on annualized costs, estimated based on the practice lifespan, and component costs including Capital Cost, Operations and Maintenance Costs, and Opportunity Cost. The cost data presented in the plan document included data from three sources: CAST 2010, CAST 2018 (aggregated at both the state and watershed scale) and University of Maryland Center for Environmental Science (UMCES) Technical Report # TS-730-19. The Annualized Cost is calculated From the Lifespan, Capital Cost, Operation and Maintenance Cost, and Opportunity Cost data (Equations 1 and 2):

Equation 1.

$$C_{annual} = \quad C_{capital} \times f + C_{O\&M} + C_{Opportunity} \times i$$

C_{annual}	= Annual cost ($/year)
$C_{capital}$	= Capital cost ($)
$C_{O\&M}$	= Operations and maintenance costs ($/year)
$C_{opportunity}$	= Opportunity cost ($)
i	= Annualization rate, equals 0.05
f	= Annualization factor, Equation 2

The annualization factor, f, in equation 2 is calculated from the annualization rate, assuming annual compound interest (always 5%) over the annualization period, or lifespan, of the practice:

Equation 2.

$$f = \frac{i}{(1+i)^n - 1} + i$$

N	= Lifespan (years)

Table *38* through Table ***42*** summarize the Total Annualized Cost, Lifespan, Capital Cost, Operation and Maintenance Costs, and Opportunity Cost of each BMP based on CAST 2010, CAST 2018 (aggregated at both the state and watershed scale) and University of Maryland Center for Environmental Science (UMCES) Technical Report # TS-730-19 cost data.

Table 38 Summary of Total Annualized Cost of BMPs from Various Sources										
Sector	BMP	Unit	Total Annualized Cost ($/year)							
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES Low	UMCES Median	UMCES High
BMPs in Primary CWIP Strategy										
Ag.	Barnyard Runoff Control	acre	559.4	579.90	579.93	656.04	661.01	57.42	942.43	3993.59
Ag.	Forest Buffer	acre	99.53	299.33	406.51	380.91	336.69	151.06	361.71	487.6
Ag.	Grass Buffer	acre	43.6	181.27	240.93	207.93	203.18	107.44	141.48	167.25
Ag.	Manure Incorporation	acre	17.34	20.23	20.23	20.23	20.23	n/a	56.67	n/a
Ag.	Manure Injection	acre	989.19	2629.67	2322.72	2790.3	2734.69	3702.68	3702.68	3702.68
Ag.	Nutrient Management Core N	acre	16.63	6.06	6.15	5.65	6.11	n/a	n/a	n/a
Ag.	Nutrient Management N Placement and Timing	acre	17.13	9.24	9.24	8.81	9.34	n/a	n/a	n/a
Ag.	Nutrient Management N Rate	acre	22.36	9.24	9.24	8.81	9.34	n/a	n/a	n/a
Ag.	Precision Intensive Rotational/Prescribed Grazing	acre	18.83	47.13	85.33	68.12	64.3	n/a	245.30	n/a
Ag.	Soil Conservation and Water Quality Plans	acre	1.94	26.55	26.16	29.95	25.44	n/a	49.29	n/a
Ag.	Tillage Management	acre	0	0	0	0	0	n/a	22.94	n/a
Ag.	Wetland Restoration - Floodplain	acre	95.27	442.59	193.09	163.08	201.33	n/a	n/a	n/a
Ag.	Wetland Restoration - Headwater	acre	294.57	477.67	453.41	433.89	493.29	143.16	602.30	1825.71
Dev.	Forest Buffer	acre	86.17	178.46	236.75	242.76	230.08	n/a	n/a	n/a
Dev.	Forest Planting	acre	82.57	42.54	38.67	46.66	44.04	2958.95	3715.08	57247.07

Table 38 Summary of Total Annualized Cost of BMPs from Various Sources										
Sector	**BMP**	**Unit**	**Total Annualized Cost ($/year)**							
			Watershed Average CAST 2010	**Watershed Average CAST 2018**	**Pennsylvania CAST 2018**	**New York CAST 2018**	**Maryland CAST 2018**	**UMCES Low**	**UMCES Median**	**UMCES High**
BMPs in Alternate Strategies										
Ag.	Forest Buffer-Narrow with Exclusion Fencing	acre	1757.51	1260.59	1563.11	1575.67	1427.9	n/a	n/a	n/a
Ag.	Forest Buffer-Streamside with Exclusion Fencing	acre	651.9	581.57	756.96	749.7	645.76	n/a	n/a	n/a
Dev.	Bioswale	acre treated	989.19	2629.67	2322.72	2790.3	2734.69	3702.68	3702.68	3702.68
Dev.	Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	acre treated	1248.94	3048.95	2602.06	3109.4	3187.47	2751.05	4287.69	8482.13
Dev.	Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	acre treated	1248.94	2894.49	2461.63	2939.98	3027.56	n/a	n/a	n/a
Natl.	Non Urban Shoreline Management	foot	6.84	13.12	13.12	13.12	13.12	n/a	n/a	n/a
Natl.	Non Urban Stream Restoration	foot	6.84	105.34	105.34	105.34	105.34	18.27	18.27	18.27
Natl.	Urban Stream Restoration	foot	145.32	105.34	105.34	105.34	105.34	n/a	92.58	n/a

Table 39 Summary of Lifespan of BMPs from Various Sources								
Sector	BMP	Unit	Lifespan (years)					
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES
BMPs in Primary CWIP Strategy								
Ag.	Barnyard Runoff Control	acre	15	15	15	15	15	10
Ag.	Forest Buffer	acre	75	40	40	40	40	10
Ag.	Grass Buffer	acre	10	10	10	10	10	10
Ag.	Manure Incorporation	acre	1	1	1	1	1	1
Ag.	Nutrient Management Core N	acre	1	5	5	5	5	n/a
Ag.	Nutrient Management N Placement and Timing	acre	1	1	1	1	1	n/a
Ag.	Nutrient Management N Rate	acre	1	1	1	1	1	n/a
Ag.	Precision Intensive Rotational/Prescribed Grazing	acre	3	1	1	1	1	1
Ag.	Manure Injection	acre	1	1	1	1	1	n/a
Ag.	Soil Conservation and Water Quality Plans	acre	10	1	1	1	1	1
Ag.	Tillage Management	acre	1	1	1	1	1	1
Ag.	Wetland Restoration - Floodplain	acre	15	15	15	15	15	n/a
Ag.	Wetland Restoration - Headwater	acre	15	15	15	15	15	15
Dev.	Forest Buffer	acre	75	40	40	40	40	n/a
Dev.	Forest Planting	acre	28	28	28	28	28	20

Table 39 Summary of Lifespan of BMPs from Various Sources								
Sector	BMP	Unit	Lifespan (years)					
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES
BMPs in Alternate Strategies								
Ag.	Forest Buffer-Narrow with Exclusion Fencing	acre	75	25	25	25	25	n/a
Ag.	Forest Buffer-Streamside with Exclusion Fencing	acre	75	30	30	30	30	n/a
Dev.	Bioswale	acre treated	50	35	35	35	35	20
Dev.	Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	acre treated	50	35	35	35	35	20
Dev.	Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	acre treated	50	35	35	35	35	n/a
Natl.	Non Urban Shoreline Management	foot	20	20	20	20	20	n/a
Natl.	Non Urban Stream Restoration	foot	20	20	20	20	20	10
Natl.	Urban Stream Restoration	foot	5	20	20	20	20	20

Table 40 Summary of Capital Cost of BMPs from Various Sources										
Sector	BMP	Unit	Capital Cost ($)							
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES Low	UMCES Median	UMCES High
BMPs in Primary CWIP Strategy										
Ag.	Barnyard Runoff Control	acre	5806.4	6012.98	6013.28	6802.42	6853.89	250.34	7084.15	30644.39
Ag.	Forest Buffer	acre	1810.16	2900.06	4062.42	4165.54	2974.75	375	2001.55	2973.63
Ag.	Grass Buffer	acre	290.68	642.78	899.15	903.17	586.12	38.13	301.02	500
Ag.	Manure Incorporation	acre	0	0	0	0	0	n/a	53.97	n/a
Ag.	Manure Injection	acre	0	0	0	0	0	n/a	n/a	n/a
Ag.	Nutrient Management Core N	acre	0	8.86	8.86	8.86	8.86	n/a	n/a	n/a
Ag.	Nutrient Management N Placement and Timing	acre	0	8.8	8.8	8.39	8.9	n/a	n/a	n/a
Ag.	Nutrient Management N Rate	acre	0	8.8	8.8	8.39	8.9	n/a	n/a	n/a
Ag.	Precision Intensive Rotational/Prescribed Grazing	acre	10.32	44.89	81.27	64.88	61.24	n/a	219.33	n/a
Ag.	Soil Conservation and Water Quality Plans	acre	15	25.29	24.91	28.52	24.23	n/a	46.94	n/a
Ag.	Tillage Management	acre	0	0	0	0	0	n/a	21.85	n/a
Ag.	Wetland Restoration - Floodplain	acre	453.79	3240.84	544.56	582.65	471.11	n/a	n/a	n/a
Ag.	Wetland Restoration - Headwater	acre	2522.44	3604.93	3246.67	3393.53	3501.53	266.41	5032.11	17730.7
Dev.	Forest Buffer	acre	1662.22	3062.26	4062.42	4165.55	3947.96	n/a	n/a	n/a
Dev.	Forest Planting	acre	1230.17	518.04	470.95	568.17	536.27	2604	12027	679154

Table 40 Summary of Capital Cost of BMPs from Various Sources										
Sector	BMP	Unit	Capital Cost ($)							
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES Low	UMCES Median	UMCES High
BMPs in Alternate Strategies										
Ag.	Forest Buffer-Narrow with Exclusion Fencing	acre	31074.68	10911.33	13529.46	13864.9	12228.83	n/a	n/a	n/a
Ag.	Forest Buffer-Streamside with Exclusion Fencing	acre	11559.96	5569.1	7216.47	7396.99	6057.85	n/a	n/a	n/a
Dev.	Bioswale	acre treated	10982.38	19162.87	17420.79	21017.34	19837.22	18776	18776	18776
Dev.	Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	acre treated	15369.29	25829.12	23481.02	28328.71	26738.06	2336	21486	73758
Dev.	Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	acre treated	15369.29	23991.31	21810.28	26313.05	24835.58	n/a	n/a	n/a
Natl.	Non Urban Shoreline Management	foot	85.24	100.72	100.72	100.72	100.72	n/a	n/a	n/a
Natl.	Non Urban Stream Restoration	foot	85.24	513.24	513.24	513.24	513.24	133.36	133.36	133.36
Natl.	Urban Stream Restoration	foot	408.24	513.24	513.24	513.24	513.24	n/a	568	n/a

Table 41 Summary of Operation and Maintenance Cost of BMPs from Various Sources								
Sector	**BMP**	**Unit**	**Operation and Maintenance Cost ($/year)**					
			Watershed Average CAST 2010	**Watershed Average CAST 2018**	**Pennsylvania CAST 2018**	**New York CAST 2018**	**Maryland CAST 2018**	**UMCES**
BMPs in Primary CWIP Strategy								
Ag.	Barnyard Runoff Control	acre	0	0.6	0.6	0.68	0.69	25
Ag.	Forest Buffer	acre	0	58	81.25	83.31	59.5	10
Ag.	Grass Buffer	acre	0	25.71	35.97	36.13	23.44	10
Ag.	Manure Incorporation	acre	17.34	20.23	20.23	20.23	20.23	0
Ag.	Manure Injection	acre	85.28	85.28	85.28	92.45	81.7	n/a
Ag.	Nutrient Management Core N	acre	16.63	4.01	4.1	3.6	4.06	n/a
Ag.	Nutrient Management N Placement and Timing	acre	17.13	0	0	0	0	n/a
Ag.	Nutrient Management N Rate	acre	22.36	0	0	0	0	n/a
Ag.	Precision Intensive Rotational/Prescribed Grazing	acre	15.04	0	0	0	0	15
Ag.	Soil Conservation and Water Quality Plans	acre	0	0	0	0	0	0
Ag.	Tillage Management	acre	0	0	0	0	0	0
Ag.	Wetland Restoration - Floodplain	acre	44.65	52.11	52.11	52.11	52.11	n/a
Ag.	Wetland Restoration - Headwater	acre	44.65	52.11	52.11	52.11	52.11	25
Dev.	Forest Buffer	acre	0.86	0	0	0	0	n/a
Dev.	Forest Planting	acre	0	7.77	7.06	8.52	8.04	0

Table 41 Summary of Operation and Maintenance Cost of BMPs from Various Sources								
Sector	BMP	Unit	Operation and Maintenance Cost ($/year)					
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES
BMPs in Alternate Strategies								
Ag.	Forest Buffer-Narrow with Exclusion Fencing	acre	156.08	458.56	554.6	568.28	522.2	n/a
Ag.	Forest Buffer-Streamside with Exclusion Fencing	acre	52	191.45	238.95	244.88	213.65	n/a
Dev.	Bioswale	acre treated	358.61	1341.74	1219.76	1471.58	1388.95	2159
Dev.	Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	acre treated	334.57	1177.48	1070.44	1291.43	1218.92	2471
Dev.	Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	acre treated	334.57	1135.25	1032.04	1245.11	1175.2	n/a
Natl.	Non Urban Shoreline Management	foot	0	5.04	5.04	5.04	5.04	n/a
Natl.	Non Urban Stream Restoration	foot	0	64.16	64.16	64.16	64.16	1
Natl.	Urban Stream Restoration	foot	51.03	64.16	64.16	64.16	64.16	47

Table 42 Summary of Opportunity Cost of BMPs from Various Sources								
Sector	BMP	Unit	Opportunity Cost ($)					
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES
BMPs in Primary CWIP Strategy								
Ag.	Barnyard Runoff Control	acre	0	0	0	0	0	0
Ag.	Forest Buffer	acre	132.51	1446.36	1770.23	1096.76	2076.61	1849.95
Ag.	Grass Buffer	acre	119.13	1446.36	1770.23	1096.76	2076.61	1849.95
Ag.	Manure Incorporation Low Disturbance Late	acre	0	0	0	0	0	0
Ag.	Manure Injection	acre	0	0	0	0	0	n/a
Ag.	Nutrient Management Core N	acre	0	0	0	0	0	n/a
Ag.	Nutrient Management N Placement	acre	0	0	0	0	0	n/a
Ag.	Nutrient Management N Rate	acre	0	0	0	0	0	n/a
Ag.	Nutrient Management N Timing	acre	0	0	0	0	0	n/a
Ag.	Precision Intensive Rotational/Prescribed Grazing	acre	0	0	0	0	0	0
Ag.	Soil Conservation and Water Quality Plans	acre	0	0	0	0	0	0
Ag.	Tillage Management	acre	0	0	0	0	0	0
Ag.	Wetland Restoration - Floodplain	acre	138.04	1565.01	1770.23	1096.76	2076.61	n/a
Ag.	Wetland Restoration - Headwater	acre	138.04	1565.01	1770.23	1096.76	2076.61	1849.95
Dev.	Forest Buffer	acre	0	0	0	0	0	n/a
Dev.	Forest Planting	acre	0	0	0	0	0	55000

Table 42 Summary of Opportunity Cost of BMPs from Various Sources								
Sector	BMP	Unit	Opportunity Cost ($)					
			Watershed Average CAST 2010	Watershed Average CAST 2018	Pennsylvania CAST 2018	New York CAST 2018	Maryland CAST 2018	UMCES
BMPs in Alternate Strategies								
Ag.	Forest Buffer-Narrow with Exclusion Fencing	acre	132.51	556.91	971.31	472.73	760.75	n/a
Ag.	Forest Buffer-Streamside with Exclusion Fencing	acre	132.51	556.91	971.31	472.73	760.75	n/a
Dev.	Bioswale	acre treated	579.96	2352.37	780.79	703.12	2684.85	741
Dev.	Infiltration Practices w/ Sand, Veg. - A/B soils, no underdrain	acre treated	1449.9	5880.92	1951.97	1757.8	6712.13	1852
Dev.	Infiltration Practices w/o Sand, Veg. - A/B soils, no underdrain	acre treated	1449.9	5880.92	1951.97	1757.8	6712.13	n/a
Natl.	Non Urban Shoreline Management	foot	0	0	0	0	0	n/a
Natl.	Non Urban Stream Restoration	foot	0	0	0	0	0	0
Natl.	Urban Stream Restoration	foot	0	0	0	0	0	0

Appendix H. BMPs & Counties within Each CAST Strategy

BMPs with respective durations and units within each CAST strategy.	
Strategy	**BMPs (Duration; Unit)**
1: Constrained	Agricultural BMPs • Forest Buffers on Fenced Pasture Corridor (Cumulative; Acres in Buffers) • Forest Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Non-Urban Stream Restoration (Cumulative Feet) • Non-Urban Shoreline Management (Cumulative; Feet) Urban BMPs • Urban Stream Restoration (Cumulative; Feet) • Bioswale (Cumulative; Feet)
2: Enhanced WIP Implementation	Full Suite of BMPs implemented in the WIP 3 programs. Google drive shared with the Group includes the input files.
3: Nitrogen-Effective, Bay-wide 4: Nitrogen-Effective, Susquehanna 7: Conowingo Geography, Agriculture Only 9: Conowingo, Cost-Effective LRSs, Agriculture Only 11: Susquehanna, Cost-Effective LRSs, Agriculture Only	• Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres) • Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres) • Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Forest Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres)
5: Susquehanna, Nitrogen-Effective + Urban Equity	Agricultural BMPs • Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres) • Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres)

BMPs with respective durations and units within each CAST strategy.	
Strategy	**BMPs (Duration; Unit)**
	• Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres) Urban BMPs • Urban Forest Buffers (Annual; Acres) • Urban Forest Planting (Annual; Acres)
6: Conowingo Geography, Agriculture + Urban	Agricultural BMPs • Nutrient Application Management Core Nitrogen (Annual; Acres) • Nutrient Application Management Rate Nitrogen (Annual; Acres) • Nutrient Application Management Placement Nitrogen (Annual; Acres) • Nutrient Application Management Timing Nitrogen (Annual; Acres) • Conservation Tillage (Annual; Acres) • High Residue Tillage (Annual; Acres) • Low Residue Tillage (Annual; Acres) • Prescribed Grazing (Cumulative; Acres) • Grass Buffers (Cumulative; Acres in Buffers) • Wetland Restoration (Cumulative; Acres) • Soil and Water Conservation Plan (Cumulative; Acres) • Manure Incorporation (Annual; Acres) • Barnyard Runoff Control (Cumulative; Acres) Urban BMPs • Urban Forest Buffers (Annual; Acres) • Urban Forest Planting (Annual; Acres) • Urban Tree Planting • Bioswales

BMPs with respective durations and units within each CAST strategy.	
Strategy	**BMPs (Duration; Unit)**
6.1: Conowingo Geography, Agriculture + Urban 8: Conowingo, Cost-Effective LRSs, Agriculture + Urban 10: Susquehanna, Cost-Effective LRSs, Agriculture + Urban	Same agricultural BMPs as Scenario 6 Urban BMPs • Urban Infiltration • Bioswales

Maximum implementation level (%) for each state/BMP combination for Strategies 6.11 through 11.						
BMP_Short_Name	**Source**	**MD**	**NY**	**PA**	**VA**	**WV**
barnrunoffcont	feed	95	95	95	93	84
conplan	ag	95	95	95	74	21
conservetill	crop	47.4	33.2	40.4	82	64
forestbuffers	agopenspace	95	9.8	95	95	3
grassbuffers	crophay	8.7	0.6	3.6	3	1
hrtill	crop	76.	30.9	67.0	22	0
incorplowearly	crophaywithmanure	0	0	9.7	0	0
incorplowlate	crophaywithmanure	26.3	0	0	0	0
injection	crophaywithmanure	2.2	0	0	0	0
lowrestill	crop	0	15.1	8.9	0	0
nmcoren	agnoopen	69.6	21.8	95	85	23
nmplacen	agnoopen	19.9	21.8	25	63	0
nmraten	agnoopen	34.7	21.8	48.6	63	0
nmtimen	agnoopen	9.9	21.8	51.4	63	0
precrotgrazing	pasture	67.8	95	100	71	76
wetlandrestorefloodplain	ag	0	0	0.4	1	0.01701323
wetlandrestoreheadwater	ag	8.2	0	0.02	1	0

Maximum implementation level (%) for each state/BMP combination for Strategies 6.11 through 11.						
BMP_Short_Name	**Source**	**MD**	**NY**	**PA**	**VA**	**WV**
infiltration	nonregulated	6.5	18.9	0.09	5	5
bioswale	nonregulated	5.7	0	1.99	2	2

Counties within each CAST strategy.						
Strategy	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**	**Delaware**
1: Constrained	• Calvert • Caroline • Cecil • Dorchester • Harford • Kent • Queen Anne's • Somerset • St. Mary's • Talbot • Wicomico • Worcester	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • McKean • Mifflin • Montour	--	--	--	--

Counties within each CAST strategy.

Strategy	Maryland	Pennsylvania	New York	Virginia	West Virginia	Delaware
		• Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York				
2: Enhanced WIP Implementation 10: Susquehanna, Cost-Effective LRSs, Agriculture + Urban 11: Susquehanna, Cost-Effective LRSs, Agriculture Only	• Allegany • Anne Arundel • Baltimore City • Baltimore County • Calvert • Carrol • Cecil • Dorchester • Frederick • Garrett • Harford • Howard • Montgomery • Somerset • Washington • Wicomico • Worcester	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne	• Allegany • Broome • Chemung • Chenango • Cortland • Delaware • Herkimer • Livingston • Madison • Oneida • Onondaga • Otsego • Schoharie • Schuyler • Steuben • Tioga • Tompkins • Yates	• Accomack • Loudoun • Northampton • Northumberland • Stafford • Westmoreland	• Berkeley • Grant • Hampshire • Jefferson • Mineral • Morgan	• Sussex

Counties within each CAST strategy.						
Strategy	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**	**Delaware**
		• Lycoming • McKean • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York				
3: Nitrogen-Effective, Bay-wide	• Allegany • Anne Arundel • Baltimore City • Baltimore County • Calvert • Caroline • Carroll • Cecil • Dorchester • Frederick • Garrett • Harford • Montgomery • Prince George's • St. Mary's • Washington • Wicomico	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Juniata • Lackawanna • Lancaster	• Tioga	• Accomack • Fairfax County • Loudoun • Northampton • Northumberland • Richmond County • Shenandoah • Stafford • Warren • Westmoreland	• Berkeley • Grant • Hampshire • Jefferson • Mineral • Morgan	• Sussex

Counties within each CAST strategy.

Strategy	Maryland	Pennsylvania	New York	Virginia	West Virginia	Delaware
	• Worcester	• Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Susquehanna • Tioga • Union • Wyoming • York				
4: Nitrogen-Effective, Susquehanna 5: Susquehanna, Nitrogen-Effective + Urban Equity	• Baltimore County • Cecil • Harford	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Jefferson • Juniata • Lackawanna • Lancaster	• Broome • Chenango • Cortland • Delaware • Madison • Otsego • Tioga • Tompkins	--	--	--

Counties within each CAST strategy.						
Strategy	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**	**Delaware**
		• Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Sullivan • Susquehanna • Tioga • Union • Wyoming • York				
6.1: Conowingo Geography, Agriculture + Urban 7: Conowingo Geography, Agriculture Only	• Anne Arundel • Baltimore City • Baltimore County • Calvert • Caroline • Carroll • Cecil • Dorchester • Harford • Howard • Kent • Queen Anne's • Somerset • St. Mary's • Talbot • Wicomico • Worcester	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon • Indiana • Jefferson • Juniata • Lackawanna	• Allegany • Broome • Chemung • Chenango • Cortland • Delaware • Herkimer • Livingston • Madison • Oneida • Onondaga • Otsego • Schoharie • Schuyler • Steuben • Tioga • Tompkins • Yates	• Accomack	--	• Kent • New Castle • Sussex

Counties within each CAST strategy.						
Strategy	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**	**Delaware**
		• Lancaster • Lebanon • Luzerne • Lycoming • McKean • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Somerset • Sullivan • Susquehanna • Tioga • Union • Wayne • Wyoming • York				
8: Conowingo, Cost-Effective LRSs, Agriculture + Urban 9: Conowingo, Cost-Effective LRSs, Agriculture Only	• Anne Arundel • Baltimore City • Baltimore County • Calvert • Caroline • Carroll • Cecil • Dorchester • Harford • Queen Anne's Somerset • St. Mary's • Talbot • Wicomico	• Adams • Bedford • Berks • Blair • Bradford • Cambria • Cameron • Centre • Chester • Clearfield • Clinton • Columbia • Cumberland • Dauphin • Elk • Franklin • Fulton • Huntingdon	• Broome • Chenango • Cortland • Delaware • Madison • Otsego • Tioga • Tompkins	• Accomack	--	--

Counties within each CAST strategy.						
Strategy	**Maryland**	**Pennsylvania**	**New York**	**Virginia**	**West Virginia**	**Delaware**
	• Worcester	• Jefferson • Juniata • Lackawanna • Lancaster • Lebanon • Luzerne • Lycoming • Mifflin • Montour • Northumberland • Perry • Potter • Schuylkill • Snyder • Sullivan • Susquehanna • Tioga • Union • Wyoming • York				

Appendix I. Scenario Results - 2035 Land Cover

The following tables present an alternative scenario that was run to evaluate land cover changes proposed through 2035. The land cover data, provided to CWP by EPA, resulted in a very slight increase in load reduction with minor changes in BMP implementation: NY returned a minor decrease, MD returned a minor increase, and PA resulted in a minor shift in the type of BMPs to be implemented.

BMPs Implemented in the Primary CWIP Scenario using 2035 Land Cover (2020 land cover in parentheses)						
Practice	**Duration**	**Unit**	**Amount (Thousands)**			
Agricultural Practices			*MD*	*NY*	*PA*	*Total*
Nutrient Application Management Core Nitrogen	annual	Acres	10.6(10)	26(33)	159(179)	196(223)
Nutrient Application Management Rate Nitrogen	annual	Acres	9.1(8.9)	8.9(13)	590(602)	608(624)
Nutrient Application Management Placement Nitrogen	annual	Acres	2.0(1.9)	-1.4(0.5)	198(204)	199(207)
Nutrient Application Management Timing Nitrogen	annual	Acres	18	10(14)	580(594)	609(626)
Conservation Tillage	annual	Acres	**5.8(4.2)**	6.5(7.8)	**208(204)**	**220(216)**
High Residue Tillage	annual	Acres	**1.0(-1.2)**	10(12)	**43(38)**	**54(48)**
Low Residue Tillage	annual	Acres	0.3	-0.1(0.0)	**9.5(9.4)**	9.8
Prescribed Grazing	cumulative	Acres	4.4(5.7)	1.2(0.9)	61(77)	67(84)
Forest Buffers	cumulative	Acres in Buffers	**0.7(0.6)**	0.9(1.2)	**22(18)**	**23(20)**
Wetland Restoration	cumulative	Acres	0.3	0.2(0.3)	11	11(12)
Grass Buffers	cumulative	Acres in Buffers	**1.1(1.0)**	1.2(1.5)	18	21
Soil and Water Conservation Plan	cumulative	Acres	3.0	5.1(16)	69(94)	77(113)
Manure Incorporation	annual	Acres	**2.2(2.0)**	5.0(6.1)	180(181)	188(189)
Barnyard Runoff Control	cumulative	Acres	0.0	0.0	0.5	0.6
Urban Practices						
Urban Forest Planting	cumulative	Acres	0.1	0.6	**49(48)**	**50 (49)**
Urban Forest Buffers	cumulative	Acres	0.0	0.2	17	17
Green text shows an increase. Red text shows a decrease. Black text shows no change (within rounding error)						

NITROGEN LOAD REDUCTION (MILLIONS OF POUNDS) FOR THE PRIMARY CWIP STRATEGY USING 2035 LAND COVER (2020 LAND COVER IN PARENTHESES)				
STATE	Sector	Baseline – from WIP III Implementation	Primary CWIP Strategy	N Reduction
MD	Agriculture	0.85	0.68	0.17
	Developed	0.35	0.35	0.00
	Natural	0.26	0.25 (0.26)	0.01
	Septic	0.20(0.19)	0.20 (0.19)	0.00
	MD Total	1.67	1.50	0.18
NY	Agriculture	5.63 (5.62)	5.51 (5.50)	0.12
	Developed	1.52	1.51(1.52)	0.01
	Natural	2.96 (2.97)	2.96	0.01
	Septic	0.19	0.19	0.00
	NY Total	12.39	12.26	0.13
PA	Agriculture	39.27 (39.20)	33.55 (33.51)	5.72 (5.69)
	Developed	13.94 (13.98)	13.30 (13.34)	0.64
	Natural	16.51	16.42	0.09
	Septic	1.66	1.66	0.00
	PA Total	79.40 (79.29)	72.95 (72.87)	6.44 (6.41)
	TOTAL	79.46(79.35)	86.70(86.62)	6.75(6.72)

GREEN TEXT SHOWS AN INCREASE.
RED TEXT SHOWS A DECREASE.
BLACK TEXT SHOWS NO CHANGE (WITHIN ROUNDING ERROR)

Appendix J. Watershed Implementation Plan (WIP) Sediment Planning Targets (Fact Sheet)

Watershed Implementation Plan (WIP) Sediment Planning Targets

The 2010 Chesapeake Bay Total Maximum Daily Load (Bay TMDL) is in place to ensure the Bay and its tidal rivers maintain a healthy water quality by setting limits on the amount of nutrients (nitrogen and phosphorus pollution) and sediment that flow into it. Each of the six watershed states – Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia – and the District of Columbia recently developed roadmaps called Phase III Watershed Implementation Plans (WIPs) to guide them in meeting their pollutant reduction goals by 2025. Sediment allocations under the Bay TMDL were established differently than those for nutrient pollutants due to scientific evidence supporting the greater importance of reducing nitrogen and phosphorus loads entering the Bay.

How does sediment harm the Bay and its rivers and streams?

In addition to nitrogen and phosphorus, excess sediment is a leading factor in the poor health of the Bay and its tributaries. Major sources of sediment in the watershed include eroding land and stream banks from upstream and eroding shore and coastlines in tidal areas.

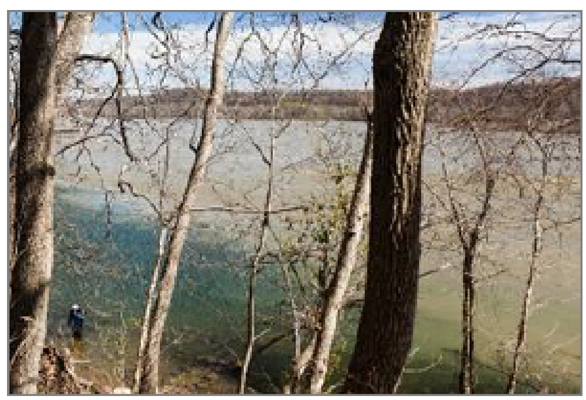
Sediment is made up of loose particles of sand, silt and clay that can be carried long distances in flowing water. Sediment often floats instead of settling to the bottom, giving the water a cloudy appearance.

Cloudy water prevents sunlight from reaching underwater grasses and other plants that grow in shallow waters. These underwater plants die without sunlight, which harms young fish and shellfish that use them for shelter. Because elevated levels of nitrogen and phosphorus fuel algae growth that clouds the water further, it is important to control these pollutant levels to keep the Bay and our local waters healthy.

An eroding stream bank along Codorus Creek, PA, carries sediment downstream. (Photo Credit: Chesapeake Bay Program)

How is sediment managed under the Bay TMDL?

While the Bay TMDL sets allocations for sediment loads, scientific and technical findings note that reducing nutrient pollutants yield greater progress towards meeting water quality standards. The Chesapeake Bay Program measures Bay water quality standards through water clarity, chlorophyll *a* (a measure of algae growth) and dissolved oxygen. Sediment loads under the Bay TMDL specifically address issues related to water clarity in the Bay and its impact on underwater grasses.



Cloudy, sediment-filled water travels down the Susquehanna River, MD. (Photo Credit: Chesapeake Bay Program)

Sediment targets set for each state-basin.

State-Basins	Sediment Targets (millions of lbs./year)
DC Potomac	35.8
DE Eastern Shore	23.5
MD Eastern Shore	2585.1
MD Patuxent	370.4
MD Potomac	1692.5
MD Susquehanna	101.8
MD Western Shore	2526.8
NY Susquehanna	518.0
PA Eastern Shore	28.9
PA Potomac	316.9
PA Susquehanna	1866.3
PA Western Shore	0.3
VA Eastern Shore	368.1
VA James	1752.4
VA Potomac	1630.2
VA Rappahannock	1247.2
VA York	803.6
WV James	10.9
WV Potomac	492.1

How are the target pollution loads determined?

The Phase III WIP planning targets were developed using a methodology similar to that used to develop the 2010 Bay TMDL allocations. Targets were set using the updated Phase 6 Watershed Model, which has been refined and contains more data than the previous version. The improved modeling tools offer additional insight on how nutrient and sediment loads have changed as pollution control measures have been implemented across the watershed.

How is sediment addressed in the WIPs?

Many of the best management practices put into place to address nitrogen and phosphorus pollution, including cover crops, conservation tillage and stream restoration, also help reduce sediment pollution. Updated nitrogen and phosphorus targets for the Phase III WIPs were set in 2018, and sediment targets in late 2019, following the evaluation of each jurisdiction's Phase III WIP.

The management actions identified by each watershed jurisdiction in their respective Phase III WIPs to meet nitrogen and phosphorus targets were run through the Phase 6 suite of modeling tools to evaluate the potential sediment reductions. These results formed the basis for the sediment targets.

These sediment loads were adjusted proportionally to account for modeling results that exceeded or fell below the Phase III WIP nitrogen and phosphorus targets. An additional 10% margin of error was added to the calculated Phase III WIP sediment target in each major state-basin (i.e., common watershed areas within each state).

What if pollution loads are not reduced by 2025?

The Chesapeake Bay Program will provide as many resources as possible to help the jurisdictions meet their Phase III WIP planning targets by 2025. Potential federal actions may occur if jurisdictions do not meet their targeted pollution reductions; however, any federal actions will be guided by common sense, the best available information and a shared goal to restore the Chesapeake Bay.

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