Conowingo Watershed Implementation Plan

DRAFT

Prepared by the Center for Watershed Protection, Inc

As part of the U.S. EPA Cooperative Agreement 96366901

Chesapeake Bay Program
Science. Restoration. Partnership.

Center for Watershed Protection

Chesapeake Conservancy
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January 2020

Revised February 28, 2020

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List of Acronyms

BMP	Best Management Practice
CAP	County 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
GIS	Geographic Information System(s)
MDE	Maryland Department of the Environment
MPA	Mid-Point Assessment
MS4	Municipal Separate Storm Sewer System
NEIEN	National Environmental Information Exchange Network
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PA DEP	Pennsylvania Department of Environmental Protection
PFP	Pay for Performance
PSC	Principal Staff Committee
QAPP	Quality Assurance Project Plan
RFP	Request for Proposal(s)

TMDL	Total Maximum Daily Load
US EPA	United States Environmental Protection Agency
USACE	United States Army Corps of Engineers
WIP	Watershed Implementation Plan

Executive Summary

Established in 1983 with the signing of the first Chesapeake Bay agreement, the Chesapeake Bay Program Partnership, currently consisting of the 7 jurisdictions in the watershed (Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), the U.S. Environmental Protection Agency and the Chesapeake Bay Commission, has set a goal to restore Chesapeake Bay by 2025. 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 necessary to achieve water quality standards.

The 2010 TMDL (Appendix T) recognized that the Conowingo Reservoir was filling up 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 Conowingo Reservoir's trapping capacity would continue through 2025. The TMDL (EPA, 2010, Appendix T, page T-5) 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 2-year milestone loads based on the new delivered loads" (US EPA, 2010).

In 2017, as part of the Chesapeake Bay Program's Phase III WIP planning process, there was a Mid-Point Assessment (MPA) to evaluate jurisdictions' progress in achieving 60 percent 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 Conowingo Reservoir was effectively full, resulting in impacts to dissolved oxygen concentrations in the bay equivalent to an additional 6 million pounds of nitrogen and 260,000 pounds of phosphorus. At that time the Principal 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 targeting pollution reduction practices in the most effective areas. The PSC specified that the CWIP should prioritize placing pollution reduction practices in the most effective areas in order to reduce the level of effort and costs required to address Conowingo's pollution loads. The PSC also agreed the CWIP must incorporate innovations in financing that leverage both private capital and market forces to reduce restoration costs.

This draft CWIP provides the PSC, CWIP Steering Committee Members, EPA, and stakeholders with a first phase adaptive strategy that will, through the tracking of CWIP implementation successes and challenges, and through future modifications of the CWIP to address those challenges, iteratively build upon implementation successes and innovations in achieving pollution load reductions to address the impacts of Conowingo infill. The CWIP realizes the PSC's vision as a collaborative approach that complements jurisdiction 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.

CWIP development started by focusing on best management practices (BMPs) identified by jurisdictions as having the most capacity for additional implementation above their Phase 3 WIPs' commitments. Once these practices were identified, the next step was to identify the most effective basins for reducing pollution loads, which were then further refined to priority watersheds based on estimated BMP opportunity, total nitrogen delivery rate, and state agency efforts. **In implementing this approach, one key lesson identified is that focusing efforts on a small geographic region of highly effective basins limits the universe of available implementation opportunities and therefore brings the potential of increased implementation costs.** This has resulted in immediate challenges relating to identifying the full extent of required nutrient reduction practices in a fiscally realistic manner. This draft CWIP expands the geographic extent of the planning area to the full extent of the Conowingo WIP geography as part of the adaptive management process. This provides an opportunity to enlarge the pool of potential opportunities. This change would facilitate the implementation of practices by lowering costs.

A central focus of the CWIP is to promote flexible, cost-effective, and innovative approaches to address both CWIP financing needs and load reductions, as well as to accelerate green infrastructure practices that maximize co-benefits, particularly climate change resiliency and mitigation co-benefits. The CWIP also recognizes that in-water practices, such as reservoir dredging and reuse, submerged aquatic vegetation and a restored aquatic ecosystem also have pollution reduction benefits that must be further utilized or explored. Such BMPs may be explored in subsequent versions of the CWIP, but are not included in this initial CAST scenario as additional information is needed with these higher risk practices. The CWIP identifies an initial set of BMPs prioritized for this first phase and also 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, like pollution 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 like living shorelines or other innovative end products and developing nutrient reduction crediting science and frameworks for restored aquatic ecosystems like 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 sector) with additional pollution reduction capacity

The initial BMP implementation strategy in 6 million pounds of nitrogen reduction at a cost of $371,229,801 annualized.

This draft CWIP serves as a starting point for outreach and coordination with local stakeholders on a phased implementation framework that starts in priority watersheds and protection areas with current capacity and then expands to broader geographies to demonstrate the level of effort needed to fully address Conowingo pollution loads. The draft is intended to initiate discussion with the CWIP Steering

Committee and stakeholders, providing the opportunity for feedback on the direction of the strategy and guidance on adjustments and modifications as the partnership initiates the implementation process. As we move forward with implementation, the CWIP will utilize annual progress evaluations, 2-year milestones, and continued public engagement to adaptively manage this collaborative effort in a 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 nitrogen, loads entering the Chesapeake Bay as a result of the Conowingo Reservoir reaching dynamic equilibrium that that were not previously addressed 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 and MDE, 2015). As a result, more nitrogen and phosphorus are now entering the Chesapeake Bay than was estimated when the TMDL was established. As such, no jurisdictions were assigned the responsibility to achieve these additional reductions when the allocations were finalized in 2010. Even with full implementation of the seven Bay jurisdictions' Watershed Implementation Plans (WIPs), this additional pollutant loading due to the Conowingo Reservoir reaching dynamic equilibrium, will cause or contribute to water quality standards exceedances in the Chesapeake Bay. Consequently, these nutrient loads compromise the recovery of the Chesapeake Bay if no further action is taken. EPA documented[1] that adjustments to sediment and associated nutrient load reduction obligations would be needed if monitoring showed the trapping capacity of the dam was reduced (US EPA, 2010, Appendix T).

On October 28, 2018, the Chesapeake Bay Program (CBP) Principals' Staff Committee (PSC) approved a Framework for developing the CWIP (Appendix A) and identified nitrogen load reductions[2] as the primary goal of the CWIP since most of the Bay states are projected to exceed the phosphorus goals. Central to this partnership framework is 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.

Background

The Conowingo Reservoir is in the lower portion of the Susquehanna River basin. The Susquehanna River basin has a 27,500 square mile drainage area that is largely in Pennsylvania with 22% of its area in New York and 1% (281 sq. miles) in Maryland before emptying into the Chesapeake Bay. 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).

[1] Letter from the US EPA Region 3 Regional Administrator to the Principal's Staff Committee Members, October 26, 2018 (US EPA, 2018)
[2] Meeting minutes from PSC Meeting, January 24, 2020 (CBP, 2020)

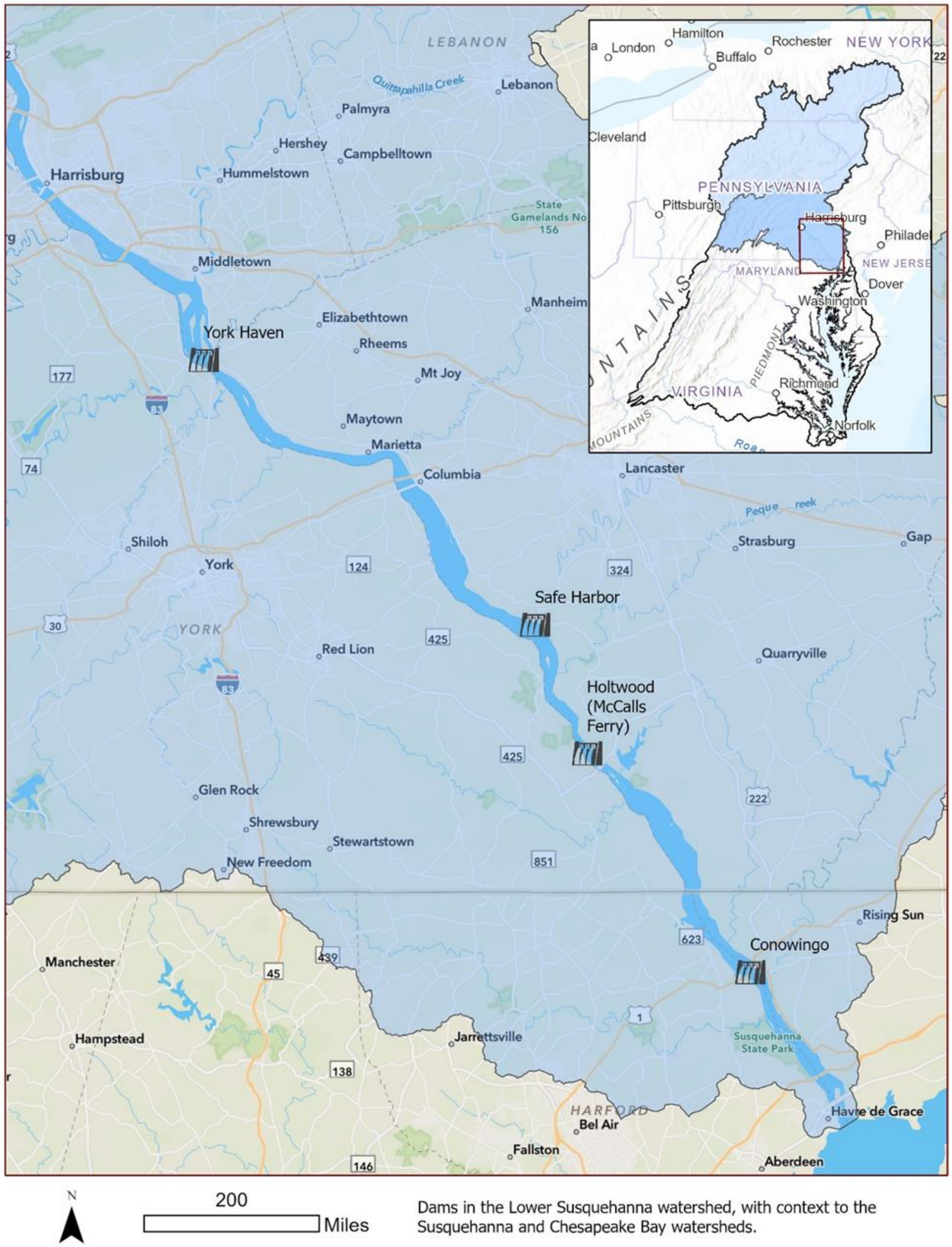

Figure 1. The Conowingo Reservoir in the Lower Susquehanna River Basin.

The dams in lower Susquehanna River have historically trapped and stored sediment and associated nutrients transported through the watershed, associated pollution loads 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 dams filling, 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. Bathymetry data from the Conowingo Reservoir (1996 to 2011) found a thirty-three percent decrease in reservoir sedimentation equating to a ten percent increase in sediment load to the Bay of 20.3 – 22.3 million tons. The inability for these reservoirs to trap sediment results in sediment being transported downstream where the nutrients associated with the sediments adversely impact dissolved oxygen levels in the Chesapeake Bay.

Analyses of the source of sediment transport from the reservoirs finds most of the sediment load from the lower Susquehanna River entering the Chesapeake Bay during storm events originates from the watershed, with less contributions from scour from the reservoirs (USACE and MDE, 2015). Analyses find the three reservoirs are no longer trapping sediment and associated nutrients over the long term and accumulated sediment is being released episodically during high-flow storm events. USACE and MDE (2015) concluded that the dams have reached a state of dynamic equilibrium where there is no appreciable change in the 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, that subsequently continues to accumulate sediment until the next high flow event.

The Chesapeake Bay Program Partnership (Partnership) estimates that, after fully implementing the 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). The Framework states that reductions to meet the Conowingo pollutant reduction 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).

Table 1. Additional nitrogen and phosphorus load reductions required for Conowingo Dam infill using the Phase 6 Suite of modeling tools.*

Jurisdiction	Nitrogen Load Reductions (M lbs./year)	Phosphorus Load Reductions (M lbs./year)
New York	0.32	0.011
Pennsylvania	3.31	0.113
Maryland	1.76	0.091
West Virginia	0.19	0.015
District of Columbia	0.00	0.001
Delaware	0.32	0.005
Virginia	1.38	0.155
Basin-wide	7.28	0.392

* Table reproduced from letter from the US EPA Region 3 Regional Administrator to the Principal's Staff Committee Members, October 26, 2018 (US EPA, 2018).

The decision to develop a CWIP by the PSC 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 Dam infill on the Chesapeake Bay (USACE and MDE, 2015; Easton et al., 2017). This decision by the PSC is based on the following (CBP, 2019):

- At the December 2017 PSC Meeting, the PSC agreed to assign the total pollutant reductions attributed to the Conowingo Dam infill to a separate Conowingo Planning Target and to collectively develop a separate CWIP.
- 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).
- At the March 2018 PSC Meeting, it was 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, include the CWIP.
- At the October 2018 PSC Meeting, the PSC approved a Framework for developing the CWIP. The Framework is included as Appendix C.

Conowingo WIP Framework

The CWIP is not a jurisdictional WIP, similar to the WIPs in support of the Chesapeake Bay TMDL. The CWIP presents an opportunity to build on existing, successful programs, as much as is feasible, to avoid creating duplicative bureaucracies. The CWIP encompasses an adaptive management approach consistent with other WIPs that represents the collective agreement amongst the Partnership and a transparent, fair and equitable process for all stakeholders. The CWIP is based on the best available information and supporting analyses to achieve the designated nitrogen 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 and transparently assess progress and redirect resources as necessary. As such, the CWIP will be updated as needed in recognition that programmatic and, or numeric commitments may need to be modified as part of the adaptive management process during the WIP timeframe through their two-year water quality milestone reporting process.

The Framework represents an agreement amongst all Bay jurisdictions that recognize:

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 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.

Geography of the Conowingo WIP

The basis for the Framework is targeting implementation in the most effective sub-basins of the watershed to achieve an additional reduction of six million pounds of nitrogen and 0.26 million pounds of phosphorus to mitigate the water quality impacts of Conowingo Reservoir infill on the Chesapeake Bay. The method used to identify the geography of the CWIP are consistent with those developed by the Partnership and applied as part of the original TMDL allocations in 2009. However, the Phase 6 Chesapeake Bay Watershed Model used the condition of dynamic equilibrium of the Conowingo. In general, the method to identify the most effective sub-basins considered transport of nutrients through the watershed into the tidal areas, then from the tidal areas to the Bay resulting in multiple watershed and estuary delivery factors affecting dissolved oxygen (DO) levels in the Bay. These models find the dissolved oxygen water quality standards in mainstem are the most difficult to achieve. The most-effective basins are not necessarily the areas within the upland drainage of the Conowingo Dam, nor closest to the Chesapeake Bay given the effect of local watershed characteristics on travel time, to include the impact of dams and impoundments. Further delivery to the Bay from the estuary considers the Bay's circulation and bathymetry (depth), for example.

The geographic boundary for the CWIP is shown in Figure 2. This boundary is based on the analysis that identified the areas within the Susquehanna River basin that were most effective to improve the DO in the Chesapeake Bay. These include the major river basins segmented by geologic factors or geo-basins: Susquehanna, Western Shore, Eastern Shore (Upper, Middle, and Lower).

The identification of the most-effective sub-basins for assigning pollutant load reduction responsibility follows an evaluation of four options of varying geography by the CBP Partnership and assumes the Conowingo Reservoir is in dynamic equilibrium (Appendix C). The evaluation included intensive discussion of the options with the CBP Partnership's Principals' Staff Committee (PSC) and resulted in the conceptual approach titled "Framework for the Conowingo Watershed Implementation Plan" which included the Susquehanna Basin + Most Effective Basins. The Framework and associated target geography were agreed to by the PSC at its December 2017 meeting and is used as the Conowingo Geography in the CWIP.

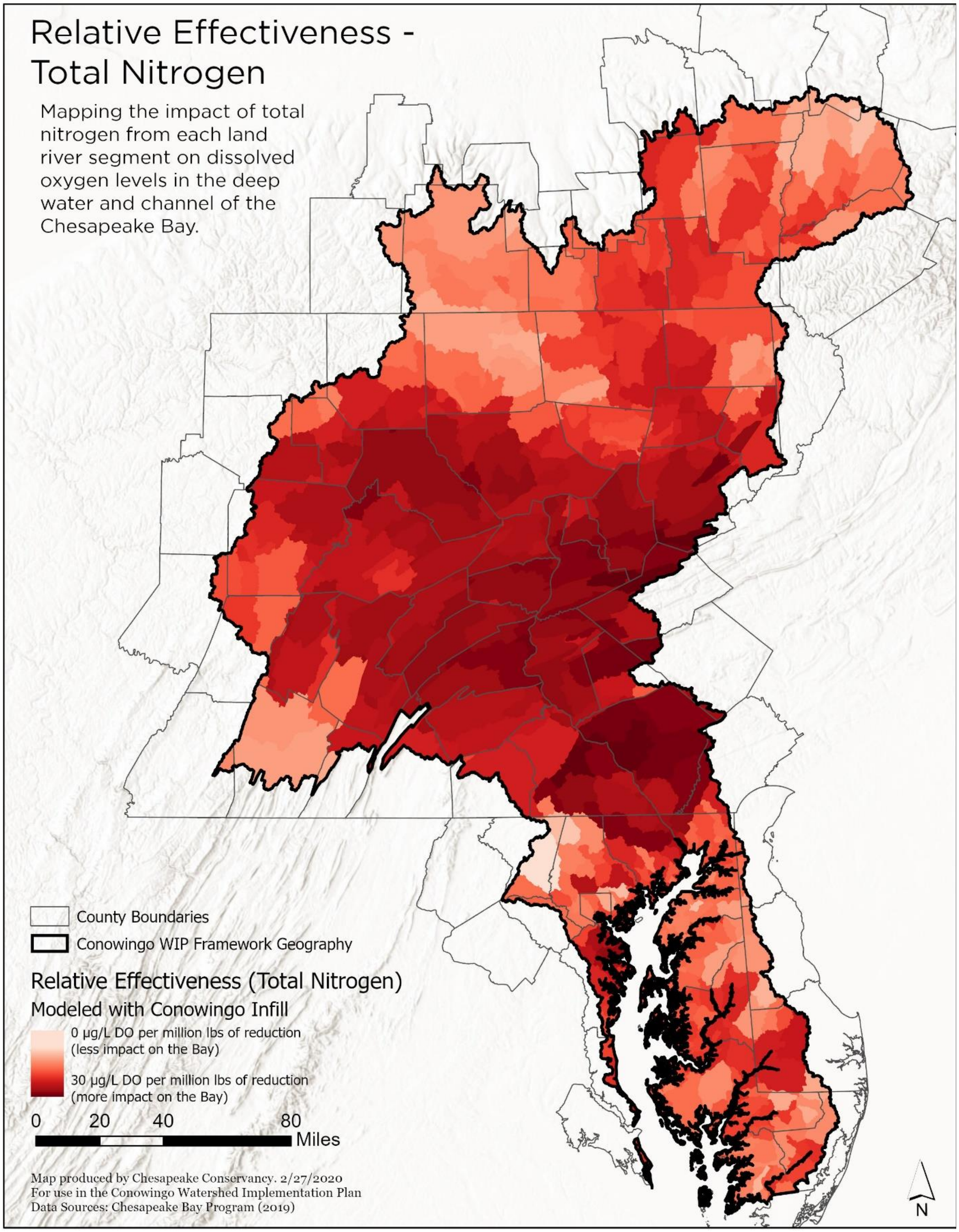

Figure 2. The geographical extent of the CWIP and the most effective basins in the Chesapeake Bay Watershed.

Roles and Responsibilities

The CWIP was developed through the guidance and recommendations of a Steering Committee, a subcommittee of the PSC. This 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. EPA is not a formal member of this committee due to its oversight role as part of the Bay TMDL accountability framework. The decisions of the committee follow a list of guiding principles (US EPA, 2018, Appendix A).

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

EPA will:

a. Evaluate the CWIP and provide biennial evaluations of the progress toward attaining the goals in 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 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 CWIP Steering Committee.

The Steering Committee will:

a. Consist of a representative from each jurisdiction and the Chesapeake Bay Commission. Each Bay jurisdiction and the CBC may also solicit comments on the CWIP framework from key stakeholders.
b. Develop the CWIP with EPA staff and contractor support.
c. Guide the development of a financing strategy and implementation of the CWIP, working with the third party.

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 3 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.

The PSC will:

a. Approve the final draft CWIP for submittal to EPA and the Partnership for review and comment.
b. Approve the final CWIP before posting on the CBP Partnership website in June 2020.
c. Review the progress of the CWIP Steering Committee in the development and implementation of the CWIP on a regular basis.

Third Party Contractor, herein referred to as the CWIP Implementation Management Team will, pursuant to EPA Cooperative Agreements:

a. Work with the Steering Committee to establish a timeline to implement the CWIP.

b. Develop draft and final CWIP documents, to include two-year milestones, that will articulate the programmatic, implementation and numeric commitments to achieve the necessary load reductions due to the Conowingo Dam infill.

c. Document approaches and strategies to select and implement best management practices to cost-effectively and efficiently achieve the necessary load reductions and create a BMP Opportunity Analysis that identifies catchment-scale locations of high-priority opportunities for the load reductions.

d. Facilitate the implementation of projects funded specifically in pursuit of CWIP goals or as identified through the financing framework.

e. Develop and implement tracking and reporting protocols and tools to readily track and verify creditable practices for the CWIP.

f. Work with the States to develop and implement engagement strategies with local communities in the priority geographies to advise the Steering Committee on locally relevant and actionable load reduction strategies.

g. Develop a draft and final financial strategy to provide the administrative and financial resources to implement load reduction strategies.

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.

The CWIP Implementation Management Team is currently divided into three EPA contracted activities:

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

Accounting for the Impacts of Climate Change

According to the Partnership, the CWIP will be assigned additional load reductions due to the impacts of climate change. Recognizing these additional loads will impede the progress to improve the health of the Bay, the PSC agreed to a three-part approach for addressing climate change impacts in the Phase III WIPs and future two-year milestones. These are also applicable to the CWIP. The approach included the following commitments:

1. Incorporate climate change in the WIPs by including a narrative strategy that describes the state and local jurisdictions' current action plans and strategies to address climate change.
2. Understand the science by refining the climate modeling and assessment framework; continue to sharpen the understanding of the science, the impacts of climate change, and any research gaps and needs.
3. Incorporating Climate Change into Two-year Milestones by no later than 2022-2023, starting to account for additional nutrient and sediment pollutant loads due to 2025 climate change, determining how climate change will impact the BMPs included in the WIPs and address these vulnerabilities. The PSC also acknowledged that jurisdictions could address additional nutrient and sediment pollutant loads due to 2025 climate change in the WIPs.

At such time the additional loads are assigned, the two-year milestone periods will be used to adjust the scale and scope of the load reduction strategies for those jurisdictions that have not previously addressed the additional loads. At the time of the release of this draft CWIP, the methods to address climate change and the WIPs following the Water Quality Goal Implementation Meeting February 10-11,2020 is pending PSC approval. If additional reductions are assigned, they will be incorporated into the Conowingo WIP. An expanded list of creditable and reportable BMPs may be considered that provide an effective means to mitigate the effects of climate change.

The CWIP was developed, in part, to focus resources to an initial set of priority practices including riparian buffers/reforestation, wetlands, living shoreline and other green infrastructure stormwater practices that also provide climate co-benefits. These green infrastructure practices 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. A central tenet of the CWIP will be to significantly scale up implementation of these green infrastructure practices in the most effective areas to both fully reduce Conowingo loads to the Bay and build programmatic and funding capacity to accelerate these practices watershed-wide.

Key features and processes of these land-based priority BMPs provide enhanced storage capacity for flood mitigation of more intense and larger precipitation events, reduce emissions of greenhouse gases through carbon sequestration and lower temperatures through shading, evapotranspiration, and replacing heat-holding surfaces like asphalt. Focusing CWIP resources and funding to these practices in priority watersheds may stimulate the development of versatile designs that provide multiple benefits to local communities.

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 Chesapeake Bay 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 not an organized entity responsible for growth management. The priority geographies represent an aggregation of land-river segments within portions of counties in Pennsylvania and Maryland. Consequently, it is expected that the change in load reductions due to growth will be accounted for through the State-specific Phase III WIPs accounting processes.

Priority Geographies (Areas for Outreach and Implementation)

An initial focus of the Conowingo WIP was the identification of six priority geographies in Pennsylvania and three in Maryland based on their ranking as a most effective basin following the analysis described in the Framework, the perceived capacity to implement load reduction strategies, and the amount of regulated land (**Error! Reference source not found.**, Figure 3). The priority geographies were agreed upon by the Steering Committee and PSC based on State-specific input. In implementing this approach, one key lesson that has been identified is that focusing efforts on small geographic region of highly effective basins limits the universe of available implementation opportunities and therefore brings the potential of increased implementation costs. Therefore, while these smaller areas may be the focus initial outreach for the CWIP, the remaining areas within the Conowingo geography are equally eligible for project implementation. The initial nine priority areas have an identified capacity where there are opportunities available for implementation, existing knowledge of the capacity of local communities and state agencies to implement strategies and their support to reduce targeted pollutant loads.

While it is recognized that York and Lancaster counties in Pennsylvania provide the greatest contributions to nutrient and sediment loads within the Susquehanna River Basin, these counties are designated by Pennsylvania as priority areas to achieve load reductions towards Pennsylvania's Phase III WIP load reductions, providing less opportunity for additional implementation strategies targeting the Conowingo nutrient and sediment load reductions. In Maryland some watersheds on the Western Shore also provide significant nitrogen loads however due to the amount of regulated land, primarily due the NPDES MS4 program, there are less opportunities for additional cost-effective implementation strategies. This approach will continue to be evaluated as part of future CWIP milestones with reports on progress to determine if priority geographies could be expanded, or new priority areas identified.

The following aggregation of the land-river segments into the following nine priority geographies are shown in **Error! Reference source not found.**.

<table>
<tr><td colspan="4">Table 2. Recommended location of CWIP priority geographies and justification for aggregation.</td></tr>
<tr><td colspan="2">PENNSYLVANIA</td><td colspan="2">MARYLAND</td></tr>
<tr><td>1. Luzerne County</td><td>Not adjacent to other priority land-river segments. Established county-based programs to potentially tap into.</td><td>1. Top of the Bay Eastern Shore: Harford and Cecil counties</td><td>Adjacent to priority land-river segments. Maryland Portion of Susquehanna River Watershed</td></tr>
<tr><td>2. Confluence (portions of Lycoming, Northumberland, Montour, Union, Snyder Counties)</td><td>Adjacent land-river segments. Potential to tap into existing coordinated efforts including the Northcentral Stream Restoration Partnership and the Conservation Union.</td><td>2. Mid-Eastern Shore: Kent and Queen Anne’s counties</td><td rowspan="2">Two distinct geographies with non-adjacent priority land-river segments. Nitrogen loading rates similar to Conowingo; limited regulated land.</td></tr>
<tr><td>3. Central (portions of Clinton, Centre, Mifflin Counties)</td><td>Adjacent land-river segments. Potential to tap into existing coordinated efforts including the Precision Conservation Partnership.</td><td>3. Lower Eastern Shore. Caroline, Talbot, Dorchester, Wicomico and Somerset counties</td></tr>
<tr><td>4. Western (Blair, Bedford Counties)</td><td>Adjacent land-river segments.</td><td colspan="2" rowspan="3"></td></tr>
<tr><td>5. Cumberland County</td><td>Not adjacent to other priority land-river segments.</td></tr>
<tr><td>6. Lebanon County</td><td>Not adjacent to other priority land-river segments</td></tr>
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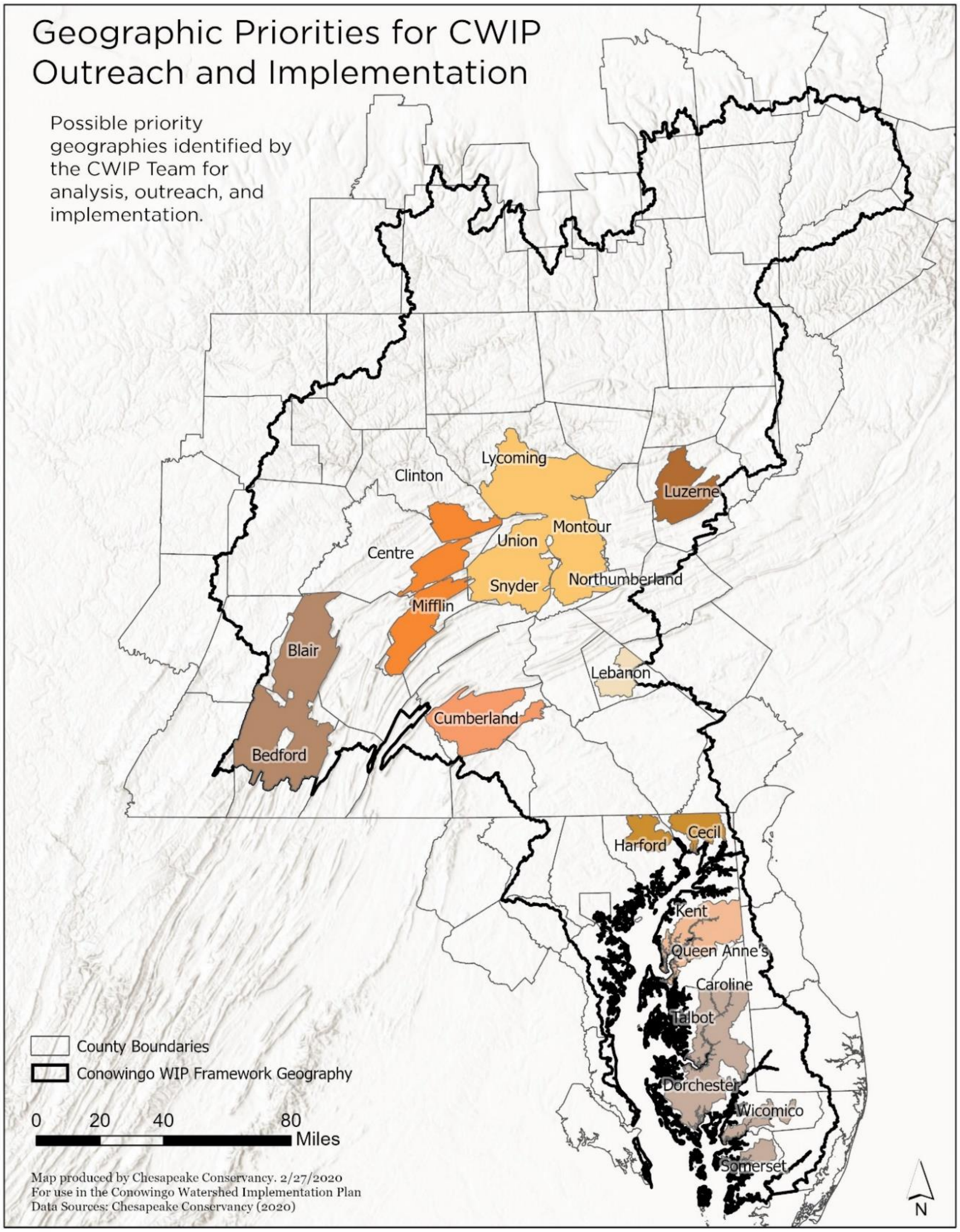

Figure 3. Nine (9) priority geographies for the CWIP Outreach and Implementation differentiated by color.

Comprehensive Local, Regional, and Federal Engagement Strategies and Commitments

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 to achieve a healthy Chesapeake Bay is achieved. The CWIP does not require the development of plans specific to local or priority geographies, rather an aggregation of targeted, priority implementation of practices, that together will achieve the necessary load reductions. The success of the WIP requires participation from all six States and the District of Columbia to ensure accountability that all actions needed are taken within the agreed upon timeline, and consistent with the guiding principles. The engagement strategy will be carried out in concert with the Partnership and state 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 states to develop the state-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 draft of Frequently Asked Questions (FAQ) document has been completed and provided in Appendix B. A webinar is also planned in the July – August timeframe following the adoption of the CWIP in June 2020.

There are four phases for local and regional stakeholder outreach developed by the CWIP Implementation Management Team. 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 (2019 – 2020): Planning phase for stakeholder outreach and development of general materials and focus on soliciting input on draft CWIP.
- Phase 2 (2020 – 2021): Outreach will focus on delivering the WIP, collecting data on specific projects that will be implemented to achieve the two-year milestones and provide training to local stakeholders on the data tools produced as part of the CWIP to support project planning for implementation.
- Phases 3 – 4 (2021 – 2025): These phases include Years 3 through 6 where outreach will focus on reconvening stakeholders twice per year to review and evaluate progress and make recommendations on the next two-year milestones. The development of additional training and guidance documents may be pursued based on feedback from stakeholders to include input from the Steering Committee.

Federal and Partnership engagement will be achieved through the continuation of the CWIP Steering Committee. The success of CWIP implementation will require continuous input from 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. Steering Committee meetings may occur quarterly or monthly based on the needs of the CWIP.

Engagement and 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, technical and financial resources to achieve the desired outcomes. This requires broad-based local community support that is guided and coordinated by State agencies. The CWIP Implementation Management Team, led by the Conservancy, will advocate for local communities as an advisor to the Steering Committee to ensure that CWIP recommendations and products are locally relevant and actionable. As such, a central goal of the CWIP is to 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.

A second goal is to effectively communicate and provide timely information about financing options to implement nutrient reducing strategies.

A third goal is to 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.

Currently, outreach strategies are developed in priority geographies of Pennsylvania and Maryland.

Strategies

Pennsylvania

PA DEP developed a phased approach to implement the Phase III WIP through their Countywide Action Plans or CAPs. The CAPs assign each of the 43 counties within the Chesapeake Bay watershed into one of four tiers (Tiers 1 – 4), where each tier represents 25% of the pollutant load reduction for the Phase III WIP. Four counties (Lancaster, York, Franklin and Adams) participated in a pilot CAP process with completed plans in 2019. The engagement strategy for the Pennsylvania portion of the CWIP works to align development of the CAPs for the Phase III with the CWIP (Figure 4; Table 3). The ongoing CAP process allows the CWIP Implementation Management Team to interact directly with local stakeholders and state agency staff in the development of integrated strategies. The six priority geographies in Pennsylvania will provide flexibility to accommodate implementation of practices through the CAP process.

Implementation efforts in the Tier 1 counties of Lancaster, York, and the Tier 3 county of Adams are designated by PA DEP to largely meet the Chesapeake Bay TMDL and therefore additional capacity for the CWIP in these three counties is expected to be limited at this time. Therefore, the CWIP is focusing engagement and implementation efforts in Pennsylvania to Tier 2, 3 and 4 counties. This will allow the CWIP Implementation Management Team to integrate the engagement strategy into the Phase III WIP strategy creating efficiencies for all participants ensuring consistent communication and fostering collaboration. Together the CWIP and PA DEP will use the Phase III WIP two-year milestone process to align the CAP for Tiers 3 4 with the CWIP timeline in the identified priority geographies. Table 4 identifies the two-year milestone period and the schedule for counties identified by PA DEP to initiate their CAP process within that time period, along with the Tier 3 or 4 counties associated with one of the priority geographies as part of the CWIP.

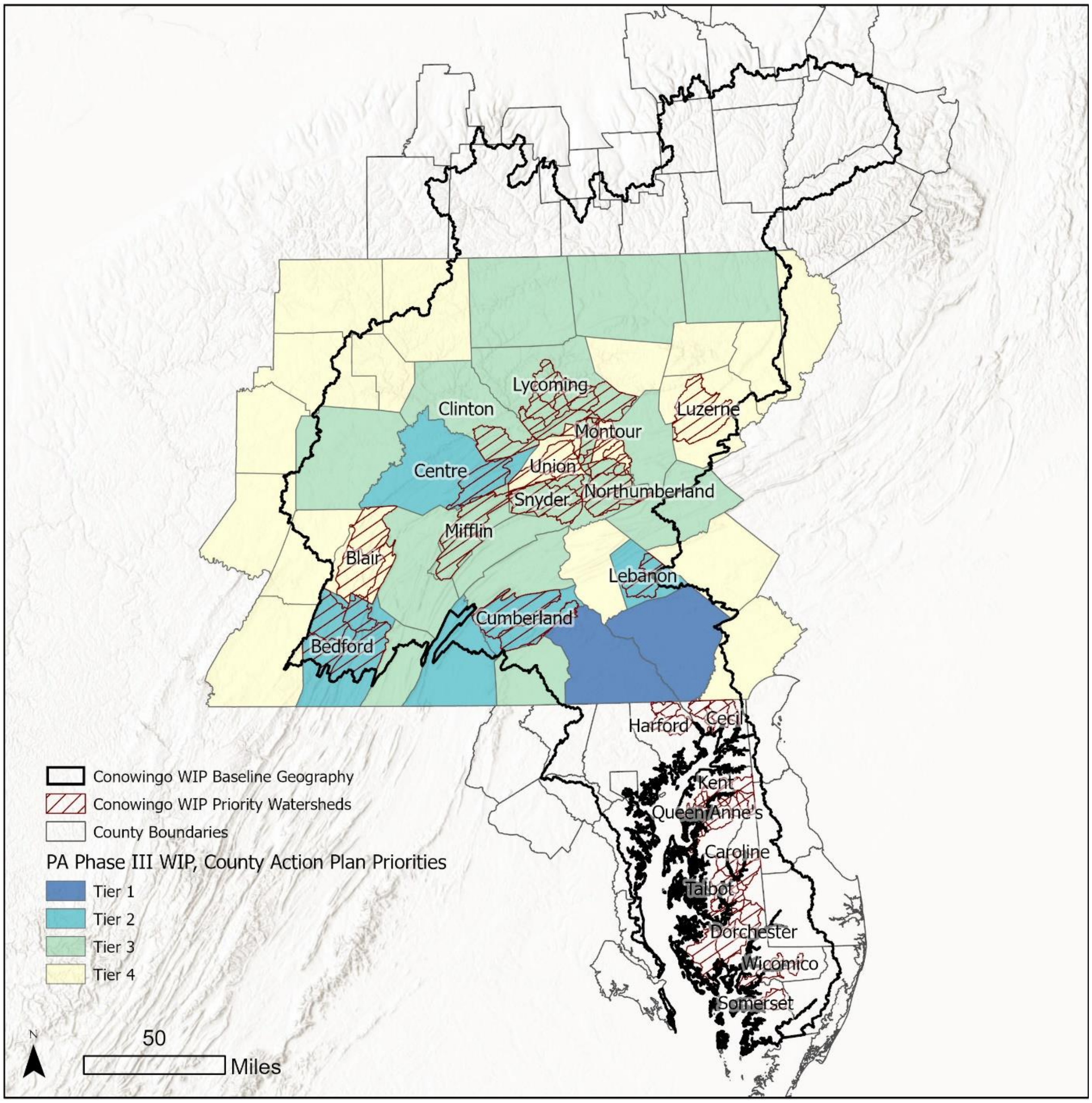

Figure 4. An overlay of the CWIP priority geographies in Pennsylvania with the tiers associated with the CAPs.

Table 3. Pennsylvania counties and their Tiers for CAPs (the bold typeface indicates the counties within or a part of CWIP priority geography. 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*	Franklin*	Adams*	Schuylkill	**Union**	Potter

York*	**Lebanon** **Cumberland** **Center** **Bedford**	**Northumberland** Perry **Snyder** Huntingdon Columbia **Mifflin** **Lycoming**	Bradford Juniata **Clinton** Tioga Susquehanna Clearfield Fulton	Chester Dauphin Berks **Blair** Lackawanna **Luzerne** **Montour** Cambria Sullivan	Somerset Wyoming Elk Indiana Cameron Wayne Mckean Jefferson Carbon

Table 4. PA DEP Proposed Draft Alignment of CAP development and CWIP in Priority Geographies and the Chesapeake Bay Program Two-year Milestones (the milestone periods are based on July 1 – June 30).

Two-Year Milestone Period	Proposed Time Period to Develop CAPs and Integrate CWIP
2018 – 2020	Jan/Feb 2020: Center, Bedford, Cumberland, Lebanon
2020 – 2022	Late Fall 2020: Blair, Northumberland/ Montour, Lycoming, Union/Snyder, Luzerne

Audience (for stakeholder engagement workshops)

Currently three counties identified as CWIP priorities are scheduled to begin County Action Planning efforts in January 2020: Centre, Lebanon, and Cumberland.

Table 5 provides a preliminary list of potential collaborative efforts in the identified counties. This information will assist the CWIP Implementation Management Team identify how outreach can be integrated into the CAPs planning process as well as existing regional collaboratives. These organizations were identified in the PA DEP local area goals document. Meetings with these organizations are planned in January through February 2020 to further discuss the CWIP and their potential capacity and role in its development and implementation.

Table 5. Local and regional outreach efforts to facilitate CWIP engagement.

Geography #	Counties	PA DEP priority for WIP outreach	Existing Collaborative Efforts
1	Luzerne	Tier 4	
2	Lycoming	Tier 3	Northcentral Stream Restoration Partnership, Conservation Union
	Northumberland	Tier 3	
	Montour	Tier 4	
	Union	Tier 4	
	Snyder	Tier 3	
3	Clinton	Tier 4	Precision Conservation Partnership
	Centre	**Tier 2**	
	Mifflin	Tier 3	
4	Blair	Tier 4	Blair County Stormwater Consortium
	Bedford	Tier 4	
5	**Cumberland**	**Tier 2**	County Action Planning
6	**Lebanon**	**Tier 2**	County Action Planning

Communications

The CWIP Implementation Management Team members, 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 for the CAPs. CWIP Implementation Management Team members will join DEP staff at select County Action Plan meetings beginning in January 2020 to discuss the complementarity of CWIP with Phase 3 Chesapeake Bay WIP. County Action Planning will continue in the remaining geographies beyond the delivery of the final CWIP; therefore, the CWIP Implementation Management Team will work with DEP to conduct outreach to the remaining CWIP priority geographies during the March-May CWIP public comment period.

Timeframe

CWIP Implementation Management Team members will join DEP staff at CAP meetings beginning in January 2020 to discuss the complementarity of CWIP with Phase 3 Chesapeake Bay WIP. County Action Planning in the remaining geographies will begin after the delivery of final CWIP; therefore, CWIP Implementation Management Team will work with DEP to conduct outreach to the remaining CWIP priority geographies during the March-May CWIP public comment period.

Tier 2 Counties

January 2020 – April 2020: The CWIP Implementation Management Team will integrate outreach to Tier 2 Counties through the County Action Planning process by coordinating with PA DEP and participating in

County Action Plan meetings and phone calls with Action Plan coordinators/Leaders. These Tier 2 counties include Lebanon, Cumberland, Center and Bedford.

Tier 3 and 4 Counties

February 2020 – May 2020: CWIP Implementation Management Team outreach to Tier 3 and 4 counties who are not currently going through the County Action Planning process with PA DEP but are scheduled to go through that process in the near future. The outreach 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 County Action Plan process. Outreach in these locations will include participating in regional partnership meetings as well as phone calls and in-person meetings with key stakeholders. These counties include Luzerne, Blair, Clinton, Mifflin, Lycoming, Northumberland, Montour, Union, Snyder

CWIP Milestone Planning in Pennsylvania

The CWIP Implementation Management Team at the direction of PA DEP will coordinate CWIP milestone planning efforts with the CAP process. Schedules for CWIP milestone draft and final delivery are to align with jurisdictional 2-year milestone targets.

Maryland

A Maryland specific outreach strategy has been developed in recognition that Maryland has completed county-based strategies 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 CWIP Implementation Management Team will communicate with Maryland Department of Environment and Maryland Department of Agriculture to ensure that communication efforts regarding CWIP and the Phase III WIP complement each other. The primary stakeholders identified for Maryland WIP and CWIP engagement strategies are the same and includes organizations that have a central role in project implementation. The organizations include county, municipal, federal and soil conservation district staff associated with source-sector specific organizations to include stormwater, agriculture, county agencies, c and federal agencies and facilities.

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 Priority Geographies. These groups were selected because they have been or are currently engaged in WIP projects and reporting and because they have area strong understanding of the Priority Geographies. These groups will also be engaged during future outreach activities to share feedback on milestones and best management practices (BMP). Invitees are to include:

- County Conservation District and USDA Natural Resources Conservation Service, local Maryland Department of Agriculture, Department of Public Works, and Planning staff currently doing WIP work.

- Key Maryland Department of Natural Resources 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.

Although the meetings will be open to the public, the goal is to get feedback from those familiar with WIPs related to the draft CWIP strategy. It is anticipated that the meeting format will be the same for all three initial stakeholder workshops in Maryland. The anticipated format is:

- The Activity 2 Team, led by the Harry R. Hughes Center and MD Sea Grant Extension in partnership with the Center for Watershed Protection, Inc. (CWP) with support from the Chesapeake Conservancy will start with introductory remarks, the history of and need for a Conowingo WIP, the identification of Most-Effective Basins and Priority Geographies, and workshop objectives.
- CWP and the Chesapeake Conservancy will provide a technical overview regarding the best management practice (BMP) identification and selection process and the implementation opportunity maps that resulted from this process.
- The Harry R Hughes Center and MD Sea Grant Extension will facilitate breakout sessions for attendees' geography (e.g. county, watershed, other jurisdiction) and get feedback on initial concerns, potential for proposed BMPs, areas that are missing, constraints, and ongoing activities, which will be used to inform revisions to the next iteration of the draft Conowingo WIP.
- The Harry R Hughes Center and MD Sea Grant will compile feedback from all three workshops and provide to Steering Committee thru CWP.

The project team members will also coordinate closely with Activity Teams 2 and 3. These teams will be invited to present at the workshops and share status updates on their respective activities.

Communications

The CWIP Implementation Management Team members will utilize its *Constant Contact* database it developed during the Phase III WIP process to send out initial workshop notices and can include the ability for respondents to ask questions that can be passed along to the CWIP Implementation Management Team.

Three meeting locations in Maryland will be identified based on the priority geographies to convene the Stakeholder Engagement Workshops. The timeline for Year 1 is summarized below.

December 2019 – June 2020

During this timeframe outreach will focus on identifying project opportunities to reduce loads associated with the CWIP

December 2019 – **January 2020:** Front-load ***Constant Contact*** email addresses.
January 2020: Select three locations for Maryland Stakeholder Engagement Workshops based on Most Effective Basins.
February 2020: Send out workshop notices and open registration.
March – May 2020: Hold three workshops in Maryland.

March – June 2020: Provide workshop feedback to the CWIP Management Implementation Team in other related Activities.

July 2020 – June 2021

Upon finalizing the CWIP and draft two-year milestones, outreach will focus on delivering the CWIP and collecting data on specific projects that will be implemented to achieve the two-year milestones. The CWIP Management Implementation Team, led by the Harry R. Hughes Center, also organizes regular statewide WIP meetings and will allow for alignment of WIP III and CWIP meetings.

July – August 2020: Conduct a webinar to share the Final WIP.
October – December 2020: In-person regional engagement meetings to solicit input on two-year milestones due January 2021.
February 2021: Roll out of the BMP opportunity blueprint with support to local stakeholders on the data tools produced to support planning of projects to implement the WIP.

Years 3 - 6

Provide technical assistance to local stakeholders to support implementation and reporting of projects toward meeting the two-year milestones by providing access to partner-led and external training opportunities

Reconvene local stakeholders in eight communities at the conclusion of each two-year milestone deadline to evaluate progress and make recommendations on the next set of two-year milestones.

BMP Implementation Strategy

As this CWIP serves as a starting point for outreach and coordination with local stakeholders, the purpose of the BMP Opportunity Analysis is to demonstrate a scenario of BMP implementation that may achieve the reduction of 6 million pounds of nitrogen at the county-scale. The specific location and type of BMPs will be identified in subsequent phases of the CWIP implementation as described in the Programmatic and Numeric Implementation Commitments section.

The BMPs considered in this initial analysis were selected as collectively, they address both developed and agricultural load sources, are accepted BMPs by the Partnership and can be mapped. The BMPs included: wetland restoration, forested buffers, stream restoration, living shorelines, bioreactors and bioswales. Other nitrogen cost-effective BMPs such as cover crops were not considered as part of this implementation strategy due to their limited opportunity in both Maryland and Pennsylvania given the efforts in their Phase III WIPs. The BMP opportunities analysis included the identification of areas within the Conowingo WIP geography where there is: 1) suitable watershed and land cover characteristics to implement wetlands, forested buffers, stream restoration and living shorelines BMPs 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 IIII WIP goals as estimated from the difference between the "E3" and

Phase III WIP scenarios. The data sources and methods used to derive the BMP opportunities are included in Appendix C.

Considering the data analysis demonstrated below, the nine priority geographies were selected based on the potential to implementation the selected BMPs to exceed jurisdictional Phase III WIP goals. To support stakeholders in these geographies, the CWIP Implementation Management Team will develop project-scale BMP Opportunity Analysis to identify specific locations where priority BMPs could be implemented. The BMP Opportunity analysis provides flexibility and adaptability to put projects in the ground as they become available, and implemented projects will be designated as either a Conowingo or Phase III WIP credit through reporting and tracking

Figure 5 through Figure 8 illustrate the extent to which four of these BMPs may be implemented. Maps for bioreactors and bioswales are not provided as insufficient data sources were available to spatially represent the opportunity for implementation. The corresponding load reductions for all six BMPs are shown in Table 6 based on preliminary CAST analyses. The CAST analyses was based on a comparison the “E3” and “Phase III WIP” scenarios for counties within the CWIP geography that resulted in a maximum potential of BMP opportunity A description of the methods used in the CAST analysis are provided in Appendix E. CAST was not used to estimate the load reductions from bioreactors as this BMP is not yet available in CAST.

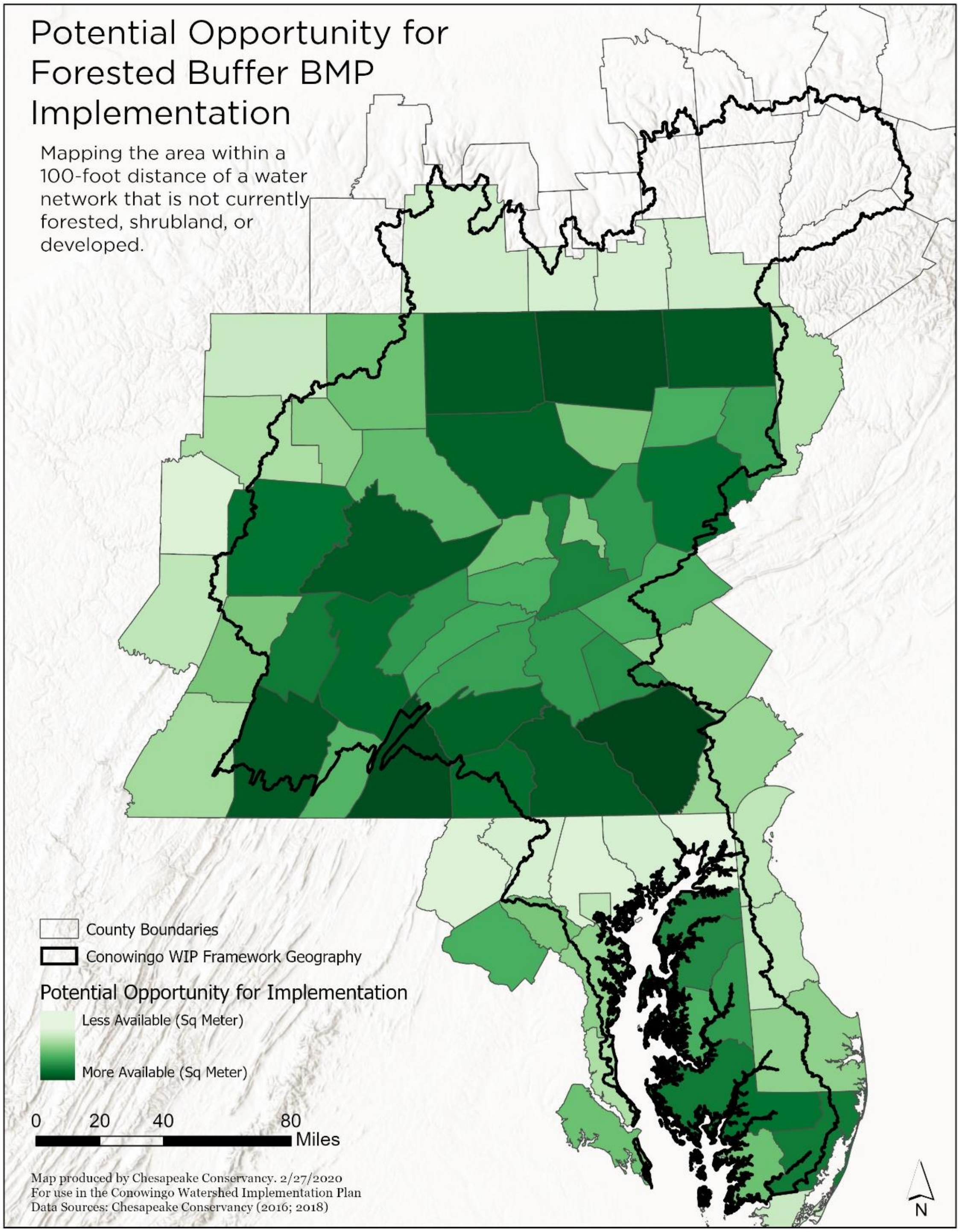

Figure 5. Opportunity to implement forest buffers within the Conowingo geography.

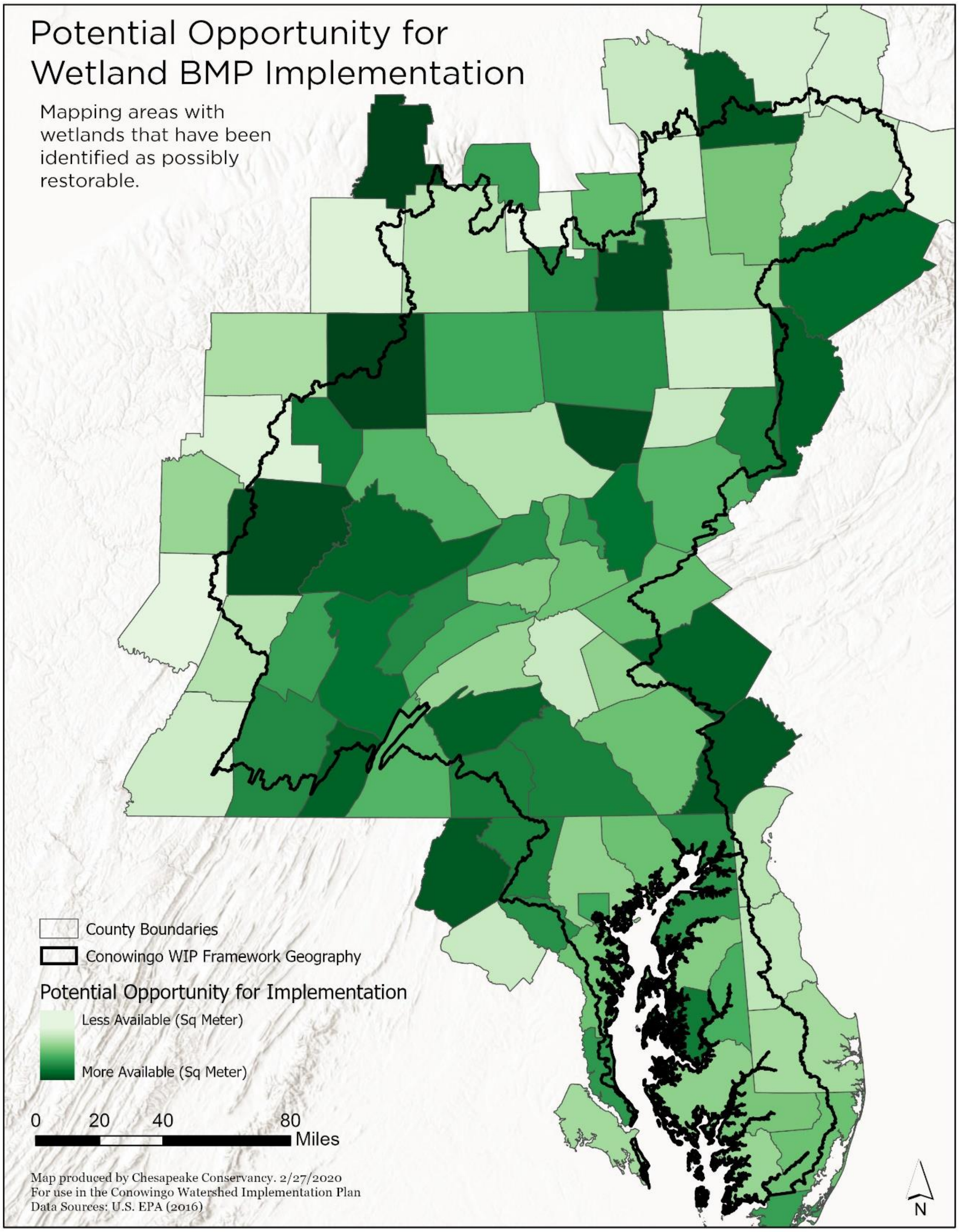

Figure 6. Opportunity to implement wetland restoration in the Conowingo WIP geography.

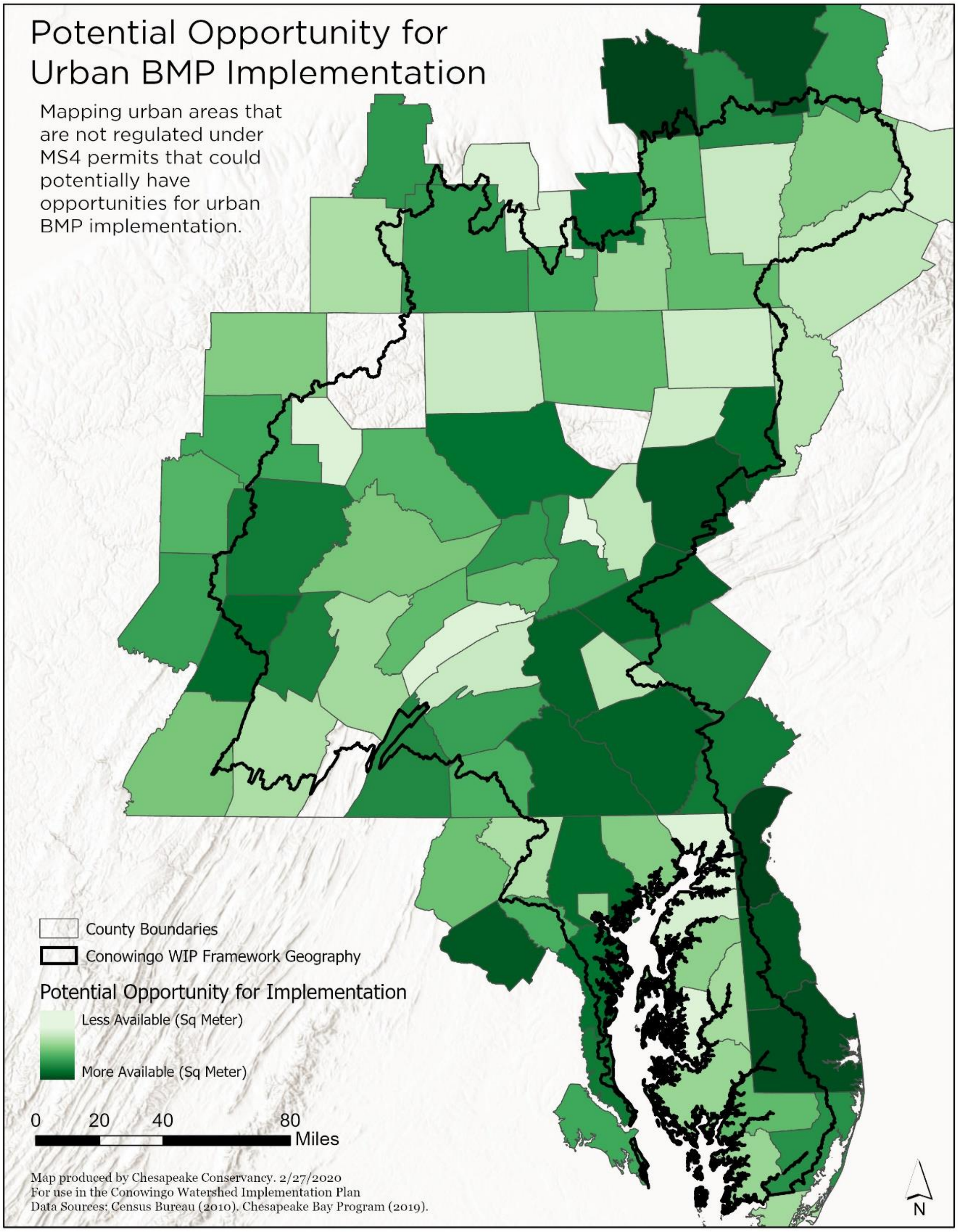

Figure 7. Opportunity to implement stormwater BMPs on developed land outside the MS4-area in the Conowingo WIP geography.

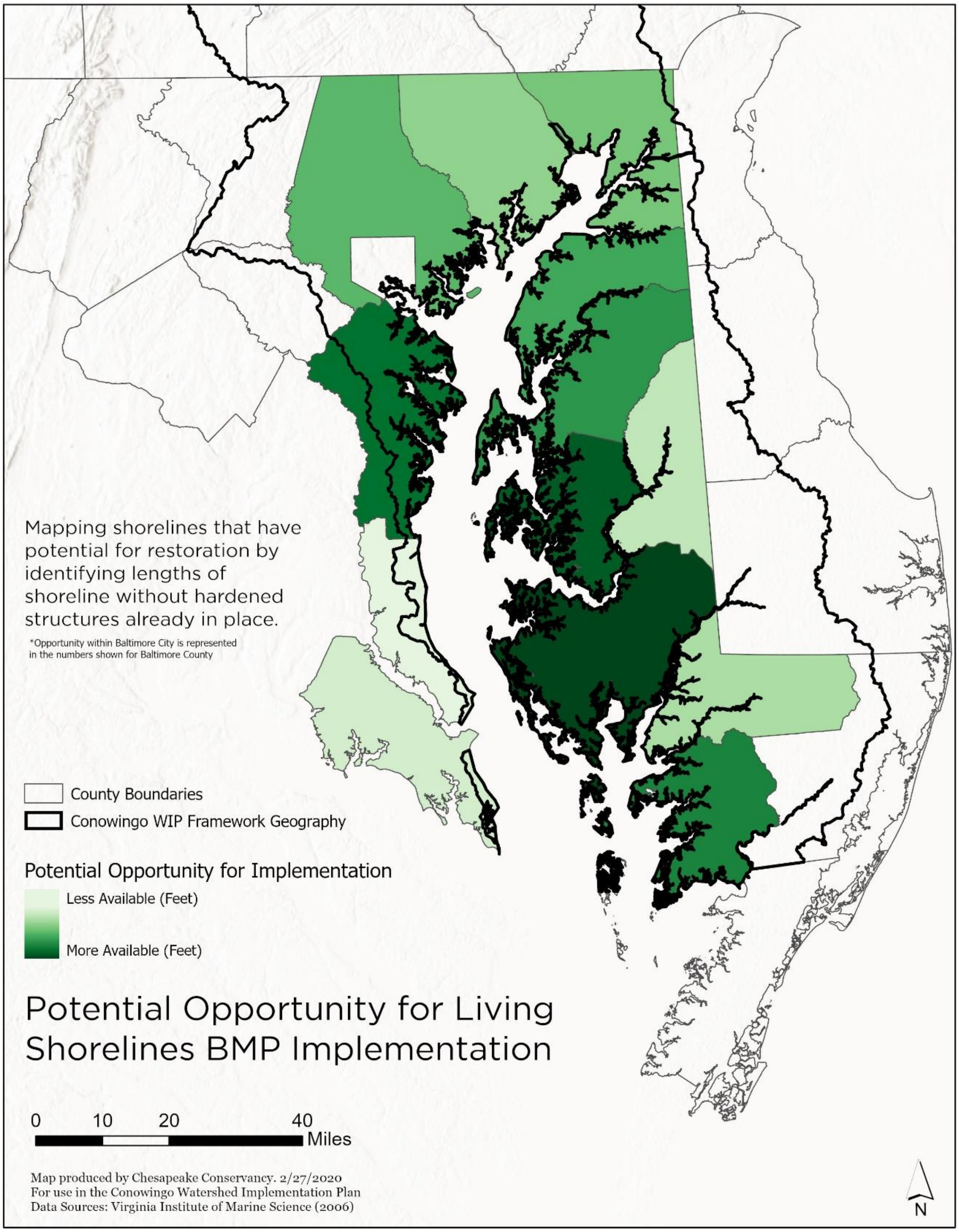

Figure 8. Opportunity to implement living shorelines in the Conowingo WIP geography.

Programmatic and Numeric Implementation Commitments

Approach

The CWIP Implementation Program is developed around the PSC's Efficiency in Innovation Principle by using Pay for Performance (PFP) solicitations and contracts to deploy implementation funding to the highest performing projects. PFP contracting focuses financing to "certain" total nitrogen reductions as efficiently and effectively as possible (as opposed to financing specific projects without the direct link to the nitrogen goal) and creates a system that incentivizes additional reductions. These types of contract mechanisms align the incentives of permittees and implementers to cost-effectively produce and sustain pollutant load reductions that achieve water quality goals. Linking payments to pollutant load reductions, rather than, or in addition to reimbursing expenses typical of grant-based funding programs, minimizes risk of funding ineffective projects that do not deliver intended results (Praul, n.d.). The success of this approach for project implementation has been demonstrated by several jurisdictions and agencies in the Chesapeake Bay Watershed including programs administered by Anne Arundel County, Maryland Depart of the Transportation State Highway Administration, and Pennsylvania Department of Transportation. This project delivery approach allows engages stakeholders such as landowners, communities, NGOs, public sector agencies, and private sector companies to access funding for project implementation and incentivizes optimization in project selection and delivery. It also avoids creating potentially duplicative program areas that require administrative inputs. Instead, the PFP approach leverages existing programs and private sector capacity by providing access to CWIP funds through a future contracting process that will have well-defined metrics and goals. Further, PFP contracts can be structured to lessen the financial burden of public funds as project offers seek practices to achieve measurable CWIP outcomes that are most nitrogen cost effective and dovetail with the Chesapeake Bay load reduction outcomes. Contracts solicitations can also be developed to account for secondary and co-benefits (habitat, flood control, etc.) if desired by the Partnership.

The PFP approach is designed to 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 flexibly and innovation the Conowingo Implementation Program identifies "Project Tiers" to evaluate a level of risk associated with a variety of specific BMPs. This tier-based system allows stakeholders and project offers the flexibility to innovate, optimize, and efficiency to incorporate a variety of practices that are proven (currently or in the future) to offer nitrogen load reduction performance while taking risk factors into consideration. Figure 9 shows how specific BMPs are categorized into these project tiers.

Tier I- Lowest Relative Risk

Tier I projects are considered priority BMPs in the Conowingo WIP and are land based therefore easier to track and verify over time. They have established and approved Chesapeake Bay Program 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 Chesapeake Bay Program 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 Conowingo WIP is not feasible at this time. These projects offer a moderate level of risk due 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 projects may or may not be land based but do not have an approved Chesapeake Bay Program protocol or credit. These practices may have significant potential for load reduction, but additional research and development will be required to document water quality improvement metrics. 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.

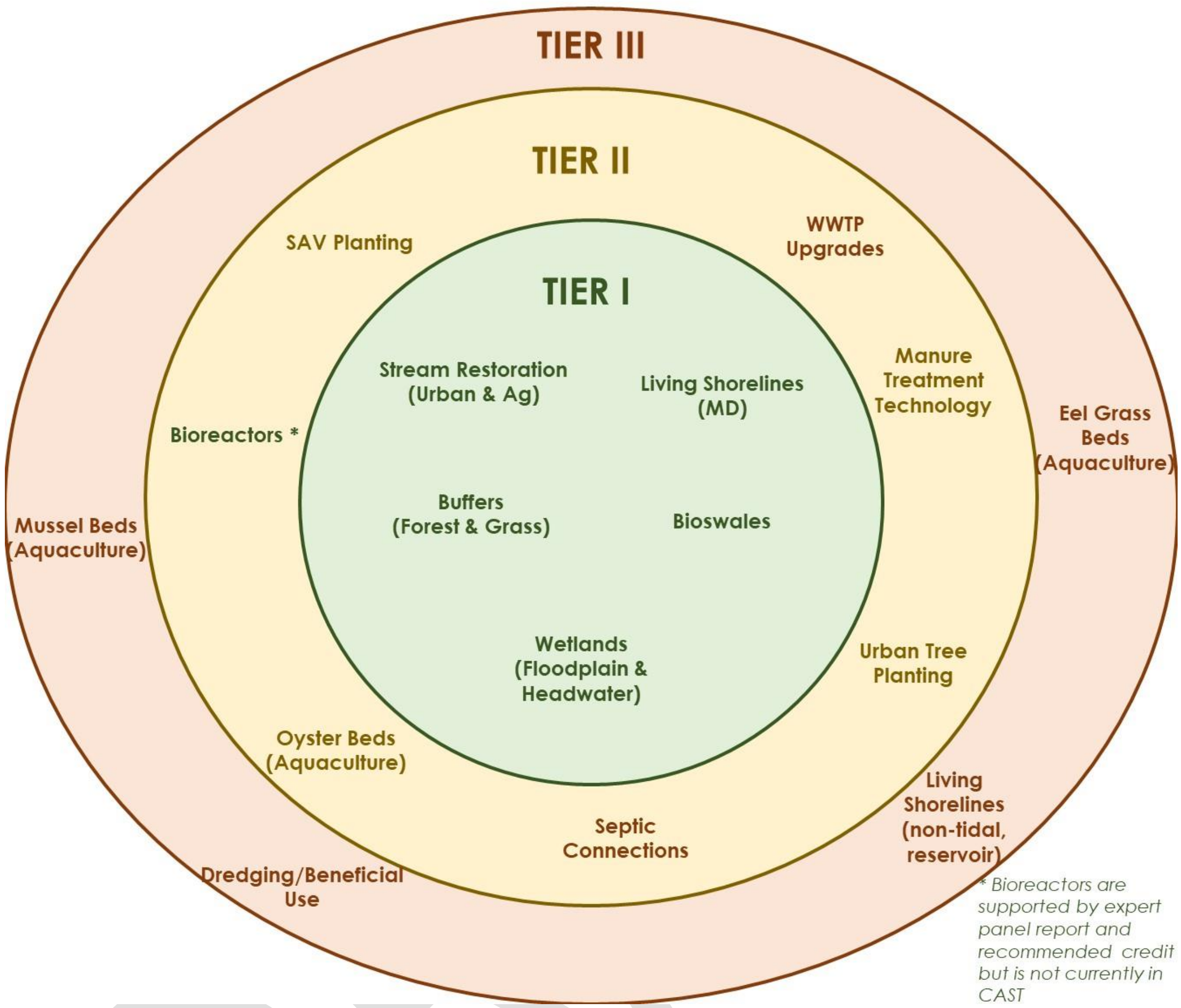

Figure 9. BMP project tiers matrix.

Conowingo Implementation Program Structure

The Conowingo Implementation Program is structured to dovetail and work in tandem with a Financing institution to deploy implementation funds in the most efficient way possible while providing thorough review and oversight of project offers and contracts.

The Conowingo Implementation Program will use a management team (Conowingo Implementation Team, CIT) to:

- Evaluate project offers on a technical basis
- Evaluate project offers on a cost basis
- Develop and execute performance-based contracts
- Review, monitor, and track individual contracted project progress
- Confirm, verify, and track completed contracted projects
- Make payments based on the terms of the contrast

- Ensure the practices funded by the contract are tracked as CWIP projects and are not double counted.

The CIT will work with stakeholders, landowners, local jurisdictions, and the private sector to:

- Provide information and education to increase the awareness of the CWIP Implementation Program and the technical requirements of the PFP contract solicitation including the review process for priority practices that are eligible, metrics for evaluating project offers, and the process for including Tier II or Tier III practices in project offers.
- Provide GIS resources and information to help interested parties identify the most nitrogen cost effective locations, through the BMP Opportunity Analysis (Appendix D)
- Provide case-study examples of successful projects (when available)
- Ensure coordination of CWIP implementation with WIP III implementation at the local and state level

The CIT will be created and tasked with review and tracking for project investments at all stages of implementation with staff resources focusing on managing the program as opposed to managing the implementation of individual projects. The technical leads for the CIT are the Center for Watershed Protection and the Chesapeake Conservancy. As technical leads, these organizations provide direct support to stakeholders working to identify and implement Conowingo WIP projects. This may include the following:

- Assistance understanding contract solicitation requirements
- Educate interested parties on uncertainty, Edge of Tide, and Exchange ratios when developing responses
- Site visits to review and document current conditions of specific sites
- Provide GIS products to facilitate project identification, review, verification and calculation of Conowingo WIP Credit

The CIT would consist of members to that can fulfill the following roles and responsibilities:

Conowingo Implementation Program Manager: Oversee and manager the Implementation team, participate in the technical review, act as point of contact with CWIP Steering committee and CBP, identify and contract additional experts (as needed) to evaluate innovate project ideas, act as point of contact with project offeror's, oversees project verification and documentation *(the Center for Watershed Protection will function in this role).*

Restoration Experts: Participate in the technical review by providing reviewing and commenting on the project approach, design, location, feasibility, and potential co-benefits. Restoration experts are individuals with a demonstrated track record of successful implementation of similar projects.

Civil Engineer: Participate in the technical review by reviewing and commenting on the project approach, design, location, feasibility, and potential co-benefits. Engineers are licensed or otherwise qualified experts with a demonstrated track record (*the Center for Watershed Protection with contractor support* will function in this role).*

GIS Specialists: Participate in the technical review by using available data and tools to review specific solicitation responses for potential primary and secondary benefit and develop tools to help stakeholder and interested parties identify and assess nitrogen cost effective opportunities *(the Chesapeake Conservancy will function in this role)*

Modeler: Participate in the technical review by reviewing and double-checking modeled load reduction estimates provided in specific solicitation responses *(the Center for Watershed Program with support from EPA, and/or contractors will function in this role).*

Pay-for-Performance Contract expert/Procurement Professional: Participate in the contract development and execution process develops contract solicitation language and pay for performance contract language. (*a qualified contractor will function in this role).*

CWIP Finance Institution Representative: Participate in the contract development and execution process, develops contract solicitation language, and pay for performance contract language, processes requests for payments, distributes funds. (this role will be further defined in the financing strategy).

Outreach Specialists: Participate in outreach and education events developed for local stakeholders, landowners, and the private sector and provide information on contract solicitations and responses, CWIP tools and resources, and updates on progress or changes in the program *(the Chesapeake Conservancy, Center for Watershed Protection, University of Maryland Sea Grant Extension, and Harry R. Hughes Center will function in this role).*

The technical review process will require support from qualified contractors who have specific knowledge and skills in key areas. The CIT Program manager will identify potential contractors for each role using a request for qualification process to identify candidates that possess the required skills. The selection criteria will ensure there is are no conflicts of interest by disqualifying any reviewers from consideration if they are part of a project offer in that cycle. Once qualified, potential contractors will provide hourly rate costs which will be used as the basis for competitive selection. The CIT Program Manager will provide a roster to EPA and the Steering Committee of all selected contractors with a brief resume for approval. Approved contractors will be compensated based on their approved hourly rate and a predetermined number of hours to participate in the review process.

Conowingo Implementation Program Process

The CIT Program Manager will solicit contracts one-time per year with payment terms tied directly to the CWIP nitrogen load reduction goals. The contract solicitation will require that project offers utilize Chesapeake Bay Program protocols and specifications in the responses and FieldDoc as part of the submittal process which will be evaluated for technical merit. Through the use of FieldDoc, 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.

Exchange ratio is the adjustment factor applied to all for projects located outside of the Susquehanna watershed to compensate for the adjusted level of effort required to achieve comparable results in the Susquehanna watershed.

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 Chesapeake Bay Program modeling tools and accepted by the Partnership (Davis-Martin, 2017).

All project offers will be thoroughly evaluated by the Conowingo Implementation Team for technical merit and will take into account project location when evaluating the credit. The technical review approach will be similar to 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 Conowingo WIP 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 and the PSC's Transparency Principle by providing a contracting mechanism for project implementation that can transparently document practices that are funded by and implemented for credit towards achieving Conowingo WIP goals.

Pay-For-Performance Project Selection Process

The CIT will develop an implementation process that is transparent and identifies cost-effective projects for implementation to make progress towards the CWIP load reduction of 6 million pounds of nitrogen. A six-step process is proposed from contract solicitation and technical review to project acceptance and verification (Figure 10). Each of these steps is described below.

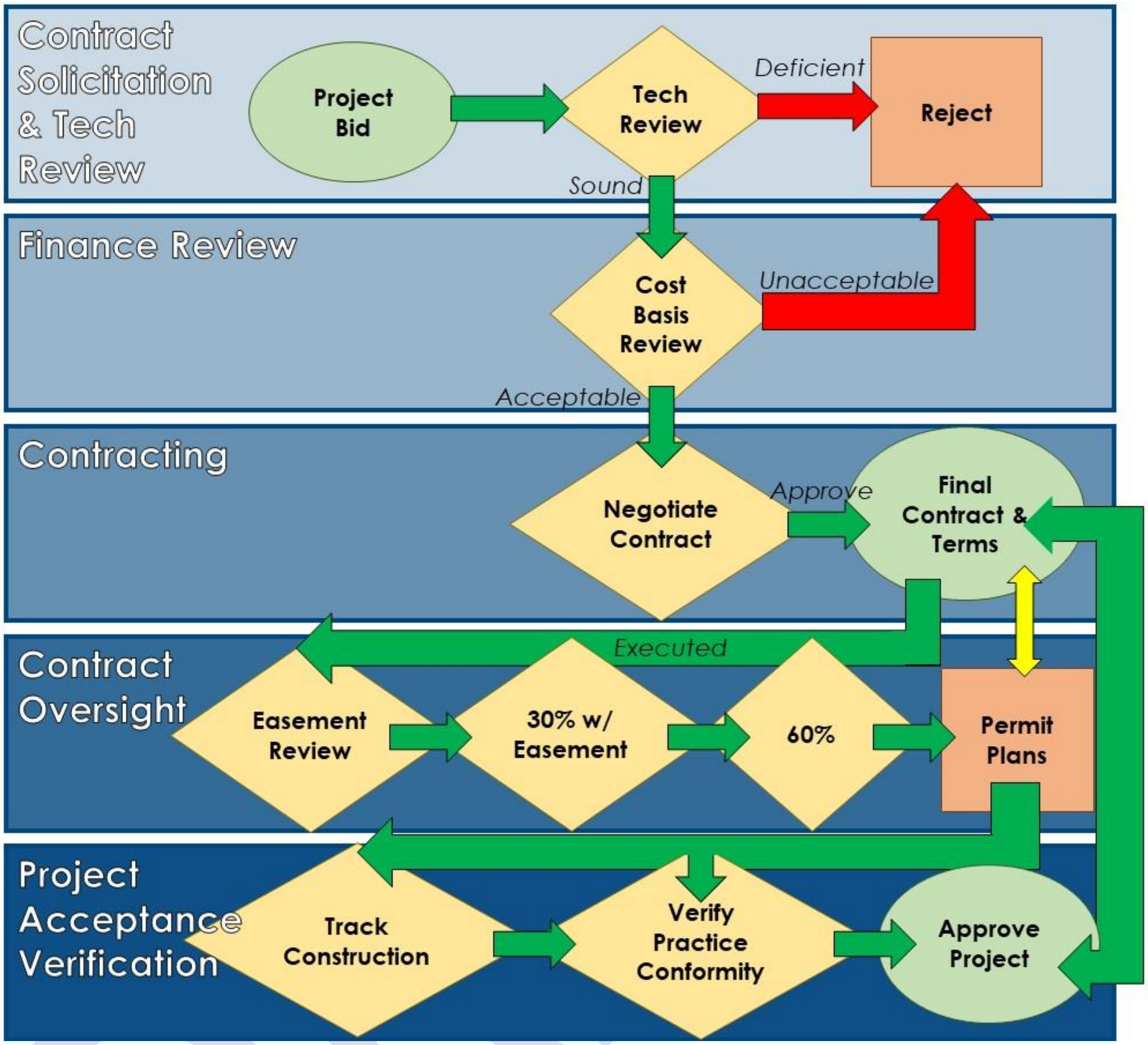

Figure 10. Pay-for-Performance project selection and verification process.

Solicitation Outreach

One time per year the Conowingo Implementation Team (CIT) in conjunction with the Financing Institution with release a solicitation for project offers using the pay for performance approach. The solicitation will clearly outline the practices that are eligible and the process to bring Tier II or Tier III projects in, that total nitrogen is the target/goal, and the methods and metrics for calculating load reductions. The solicitation will also include key contract language and provisions. The CIT will utilize existing County Action Team meetings, regional partnership meetings, WIP III meetings in Maryland, other appropriate meeting venues and webinars to raise awareness of the Conowingo Implementation Program and the PFP solicitation details and requirements.

Project Offer Review

The CIT will review all submitted project offers. Project offers will be required to provide sufficient design detail and documentation consistent with Chesapeake Bay Program standards and protocols to determine if the design approach is sound, feasible, and creditable. This process will begin with a technical review which will evaluate the technical details of all projects including project location, BMP practice(s), design, credit calculation, feasibility, risk, co-benefits (if applicable) and easements/agreements. The process may include site visits to confirm and evaluate conditions at the proposed site. Any project deemed to technically deficient in any area will be removed from consideration, project deemed technically sound will move to cost basis review. Based on the amount of funding available the CIT will award contracts to the lowest responsive and responsible bidder who proposes the Best Management Practice (BMP) to reduce the most nitrogen from the Chesapeake Bay in the most cost-effective manner.

Contract Negotiation

The project offeror, the CIT, and the Finance Institution will negotiate and enter into a contract that uses nitrogen reduction as the primary metric of concern. Co-benefits as supplemental could also be integrated into performance metric if desired. Contract language will need to be developed in conjunction with the Finance Institution to develop contract language related to payment term, transfer of lability, performance standards, etc. Additionally, provisions could be included in contracts allowing the nitrogen reduction credit to increase with documented monitoring supporting the increases (e.g. stream restoration) and allowing for adjustments in payment based on the documented increased performance metrics.

Contract Oversight

The CIT will provide administrative oversight of the contracts to ensure adhere to the contract terms and timely deliver. Oversight would occur at specific phases of the contract work plan. This oversight would focus primarily on ensuring protocols and specifications are being followed to generate the contracted performance metrics.

Project Acceptance Verification

Once operational the CIT will conduct site visits to verify that the contracted project has been implemented in manner consistent with the contract and the established standards and specifications. Once all project elements are verified the project will be accepted for payment. Projects will be re-verified on a period basis to ensure credit generation throughout the length of the contract.

Modeled Nitrogen Reduction to the Bay

The implementation scenario to demonstrate the modeled nitrogen load reduction to the Bay is based BMPs that were selected collectively by the Steering Committee as they have the most capacity for additional implementation above their Phase III WIPs' commitments. Further, the BMPs address both developed and agricultural load sources, are accepted BMPs by the Partnership and can be mapped. The exception to these criteria is bioreactors but was still identified as a viable BMP for this initial scenario given its potential to reduce agricultural nitrogen loads. This scenario is used to illustrate the ability to achieve the needed load reduction and will be used as a starting point for local stakeholder engagement, rather than a specific implementation plan. The BMPs implemented as part of the CWIP will be determined in future phases of the CWIP implementation as the financing strategy and institution become available 2022. The data sources and methods used to quantify the load reductions are included in Appendix E. The results of this initial BMP implementation strategy achieves 6 M lbs of nitrogen reduction.

Table 6. Summary of acres for BMP implementation for the Conowingo geography.

	Acres Feet of BMPs Total	**Acres of BMPs Applied in Pennsylvania Counties within the Conowingo Geography**	**Acres of BMPs Applied in Maryland Counties within the Conowingo Geography**
Forest Buffers*	164,851	140,319	24,532
Wetland Restoration*	40,903	34,318	6,585
Stream Restoration	5,063,254	4,318,875	744,379
Living Shoreline	773,023	-	773,023
Bioreactors	12,033	-	12,033
Bioswales (Developed sector, non-MS4 only)	14,552	12,137	2,415
* The datasets used to identify the opportunities for buffer and wetland restoration are not mutually exclusive and may be overlapping.			

After the CWIP is finalized in June, the CWIP Implementation Management Team will refine this coarse-scale analysis and develop a project-scale BMP Opportunity Analysis to local stakeholders to guide CWIP milestone planning

Table 7. Summary of Conowingo nitrogen load reduction goal.

	Nitrogen (pounds)
Goal	6,000,000
Amount Achieved	6,000,416
Percent Achieved	100%
The load achieved includes an adjustment factor that equates N loading to an equivalent load from the Susquehanna basin (See Appendix F)	

Summary of Priority Initiative Costs

Table 8 to 10 provide an overview of the capital BMP installation costs needed to implement the BMP scenario identified in Table 6. The annualized costs are derived from the Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST). Default costs for Pennsylvania and Maryland within the CAST tool were used to develop the cost estimates. A summary of the assumptions used to generate this estimate is provided in Appendix G.

Table 8. Summary of costs for BMPs Implemented in the Susquehanna Basin

Sector	Practice	Capital ($)	O and M ($/yr)	Opportunity ($)	Total Annualized Cost ($)
Agriculture	Forest Buffer	130,424,390	-	6,216,027	7,004,382
Agriculture	Forest Buffer-Streamside with Exclusion Fencing	1,214,774,048	4,981,833	13,378,138	67,995,317
Agriculture	Wetland Restoration - Floodplain	7,761,099	742,741	2,322,873	1,606,582
Agriculture	Wetland Restoration - Headwater	49,188,103	789,552	2,469,272	5,651,882
Natural	Non-Urban Stream Restoration	188,132,400	-	-	15,095,583
Natural	Urban Stream Restoration	554,780,577	69,347,572	-	197,483,621
Developed	Bioswale	116,684,960	3,810,092	6,161,953	10,509,824
Susquehanna Basin	**Total**	**2,261,745,577**	**79,671,790**	**30,548,264**	**305,347,191**

Table 9. Costs for BMPs Implemented Outside the Susquehanna Watershed

Sector	Practice	Capital ($)	O and M ($/yr)	Opportunity ($)	Total Annualized Cost ($/yr)
Agriculture	Forest Buffer	28,021,864	-	3,246,225	1,600,461
	Forest Buffer-Streamside with Exclusion Fencing	98,720,243	446,137	1,745,940	5,599,877
	Wetland Restoration - Floodplain	2,064,185	228,337	1,040,684	479,226
	Wetland Restoration - Headwater	4,413,141	65,682	299,358	505,819
	Bioreactor	3,699,796	9,626	-	306,471
Natural	Non-Urban Shoreline Management	65,884,664	-	-	5,287,470
	Non-Urban Stream Restoration	35,796,182	-	-	2,872,766
	Urban Stream Restoration	132,426,416	16,553,302	-	47,139,444
Developed	Bioswale	23,216,082	758,070	1,226,005	2,091,074
Other Watersheds	**Total**	**394,242,573**	**18,061,154**	**7,558,213**	**65,882,610**

Table 10. Total Costs for BMP Implementation

	Within the Susquehanna Basin	In Other Watersheds	Total
Capitol Cost ($)	2,261,745,577	394,242,573	**2,567,093,215**
O and M ($/yr)	79,671,790	18,061,154	**97,732,944**
Opportunity Cost ($)	30,548,264	7,558,213	**38,106,476**
Total Annualized Cost ($/yr)	305,347,191	65,882,610	**371,229,801**

Error! Reference source not found. and **Error! Reference source not found.** provide the annualized costs for Pennsylvania and Maryland priority geographies derived from the Chesapeake Bay Program's Chesapeake Assessment Scenario Tool (CAST) for the 2025 timeframe. An alternative scenario for a 2030 implementation is provided in Appendix H.

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. As stated in the Pennsylvania Phase III WIP, there are other important sources of cost variability.

• Changes in technology, protocols, and/or credit inputs for BMPs. The cost structure to inputs for many of these practices has changed and continues to change as protocols are updated and the cost for raw materials, transportation, labor, etc. evolve.

• Design and scale can significantly drive cost estimate variation by several orders of magnitude. The use of full deliver contracting for CWIP implementation can drive the private sector to find efficiencies through design and create scalable implementation opportunities.

• Variation in Local costs. Although the CAST includes Maryland and Pennsylvania default costs the CWIP priority geographies are spread across as large geographic area and local economic conditions as well access to labor and materials.

• O&M assumptions and real costs. Each BMP has an estimated cost associated with O&M however design, location, materials, implementation methods, and weather are just a few factors that can impact both short- and long-term O&M Costs.

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.

Financing Strategy

The Chesapeake Bay Trust is leading the effort to develop the financing strategy which will be proved as a separate document when complete. Recognizing the CWIP strategy will need to evolve with time and the completion of a comprehensive financing strategy, adjustments to the implementation efforts may need to be considered based on the innovative financing tools and ideas.

Contingency Plans and Opportunities

A contingency plan for the CWIP provides safeguards to ensure the nitrogen load reductions are achieved if the initial strategy of priority BMPs and geographies are not enough to meet the stated goals in advance of the WIP timeline. The CWIP Implementation Team will work with the Steering Committee to evaluate actions needed given the options described in this WIP. The annual reports on State-specific and Conowingo load reductions, the two-year Milestones reporting on progress, along with the adaptive management approach, provides the necessary checks and balances throughout WIP implementation to evaluate if 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 full delivery/pay-for-performance strategies to provide the opportunity for private capital to cover initial project implementation costs. This strategy maximizes CWIP resource flexibility by allowing investments to flow to new and innovative projects while requiring the project offeror to demonstrate the amount of nitrogen load reductions achieved towards CWIP and take the bulk of the risk associated with bring the load reductions "online".

Alternative 1. Implementation Efforts Do Not Meet Load Reduction Targets

1A. Dredging. While modeling results from the USACE and 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 study this action further with results expected in late summer/early fall 2020. The results of this study will evaluate the beneficial reuse of sediments as a result of dredging and help the Steering Committee to evaluate the cost-effectiveness of this activity. The CWIP can be adjusted to incorporate feasible, cost-effective, creditable, and trackable load reduction measures identified in the study.

1B. Re-evaluate Priority Watersheds. The CWIP focuses implementation on a portion of the Conowingo geographies based on their ranking of most-effective basins as well as efforts to align with existing state level planning and implementation efforts. A BMP Opportunity Blueprint will identify the extent of implementation for the priority BMPs in each of these areas (and will be used to evaluate project offers), however the actual load reductions achieved will depend on the success of the PFP approach and the type of projects implemented. If the market to support implementation does not achieve the required level of implementation, or capacity of the current geographies cannot meet the demand for implementation, the CWIP Implementation Team will work with the Steering Committee, PSC, and EPA to identify additional most effective sub-basins following the process outlined in the Framework.

1C. Other BMPs. The CWIP Implementation Management Team may utilize an extended list of BMPs that meet the Partnership requirements as a creditable and reportable practice. Additional BMPs may be desired given the response or direction indication by a market-driven approach, or if there is greater capacity for other BMPs given site-specific geographies. The CWIP Implementation Management Team expects that living shorelines and stream restoration may provide additional opportunities and may be incorporated into the CWIP as implementation funding becomes available and supported by the community engagement process.

The protocols to assign nutrient and sediment load reductions from stream restoration remain one of the most cost-effective BMPs and provide an opportunity to enhance capacity of the CWIP to achieve the required load reductions. At the time of WIP development, the protocols were under review by the Partnership and consequently provided uncertainty to quantify the benefits of practice implementation in the priority geographies. The stream restoration protocols have been recently updated to provide clarifications on how to apply the protocols, information needed to be eligible for, and quantify the credit, and changes to the protocols to include a new, eligible practice (Protocol 5, Outfall Stabilization). The CWIP Implementation Team may explore methods to account for the benefits of this practice. This would require the CWIP Implementation Team propose generalized site conditions to quantify the nitrogen load reductions, along with input from the engagement process to understand the capacity to adopt this practice. Utilization of full delivery/pay-for-performance strategies would incentivize project offerors to identify, calculate, and provide site specific stream restoration data. Further, the focus of

CWIP on nitrogen reduction will drive private sector design innovation to incorporate features that process nitrogen.

Other BMPs like Manure Treatment Technology and manure management are BMPs with tremendous potential to reduce nitrogen, however there are many significant logistical tracking challenges, particularly related to tracking and crediting, associated with incorporating it in the CWIP strategy at this time. However, similar to other potential innovate projects the use of pay-for-performance strategies may allow opportunities for the private sector to develop sufficient assurances to allow for CWIP implementation funding.

Accountability, Tracking, Crediting

The CWIP Implementation Management Team will work with PA DEP, MDE, the Partnership and Steering Committee to track and report practices implemented and their associated load reductions for the CWIP. 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 by the Partnership and restoration practitioners (e.g. project implementer). The protocols provide assurance and accountability that load reductions associated with practices implemented in the priority 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 include Chesapeake Commons' FieldDoc; jurisdiction-specific databases and the National Environmental Information Exchange Network (NEIEN). Each of these reporting tools will include common fields or metrics to track and report projects that meet CBP requirements and are credited towards the Conowingo WIP, rather than Phase 3 WIPs. The Team 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 Pennsylvania and Maryland based on their jurisdictional 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, there will be required metrics, including the information needed for a practice to be reported to the National Environmental Information Exchange Network (NEIEN), as well as a spatial footprint of the practice and a photograph of the project. These data will be utilized for a data validation check as outlined by the Activity 3 Team in a QAPP and approved by CBPO. An intermediate step may be taken at the state level, where projects reported in FieldDocs are input to a State-specific database that is then uploaded to NEIEN. The team may work with PA DEP and MDE to ensure the projects designated for the Conowingo are translated effectively.

Adaptive Management, Milestones, and Progress Reporting

The EPA will evaluate the CWIP and provide biennial evaluations of the progress toward attaining the goals in the CWIP. 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 initial 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 Partnership related to anticipated funding levels for CWIP implementation prior to the implementation of the financing framework and may be integrated into future drafts of this plan. However, the results of the financing strategy will largely determine the rate and scale of annual implementation.

The CWIP Implementation Management Team will work with Pennsylvania and Maryland to submit draft milestones to EPA by November 2021 and a final version by January 7, 2022 . The milestone reporting is contingent upon funding available through the financing strategy or other sources to support implementation efforts.

An intermediate step may be taken at the state level, where projects reported in FieldDocs are input to a State-specific database that is then uploaded to NEIEN. In this case, the Team will work with PA DEP and MDE 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 Conowingo, rather than the Phase III WIPs, to ensure that proper crediting can be completed.

Timeline and Next Steps

The development of the CWIP is arranged to occur in stages with the Plan completed in June 2020, followed by a financing strategy in March 2021. The timeline is established to dovetail with the Phase III WIPs where the CWIP identifies priority BMPs in focal geographies to achieve the required nitrogen load reductions to ensure the health of the Chesapeake Bay remains on track. The implementation of the WIP is expected to continue beyond 2025 with opportunities to start implementation as funding becomes available. For example, implementation may begin as early as 2021 pending the availably of funding prior to the completion and implementation of the of the Conowingo financing strategy. The timeline shown in Table 9 identifies key periods of the WIP development and its implementation.

Table 9. Conowingo WIP development and implementation timeline.

Year	Key Decisions and Outcomes
2018	• October 28, 2018, the Chesapeake Bay Program (CBP) Principals' Staff Committee (PSC) approved a Framework for developing the CWIP. • Formation of the Steering Committee
2019	• Begin development of the CWIP (September) • Phase 1 Stakeholder Outreach
2020	• WIP approved with updated timeline • Conowingo Reservoir dredging analysis complete (June/July) • Finalized tracking and reporting protocols and tools (March/April) • Phase 2 Stakeholder Outreach • Draft financing framework • Begin design of the financing framework
2021	• Submit draft two milestone November 1 • Phase 3 Stakeholder Outreach • Financial strategy complete • Economic development investment plan complete • Draft plan for the financing framework • Project-specific BMP opportunity blueprint for priority geographies
2022	• Submit two-year milestones for 2022–23 incorporating climate change by January 7 • Phase 4 Stakeholder Outreach • Launch the financing framework • Implementation of investment activities (Winter)
2023	• Continued implementation of investment activities • Submit two-year milestone for 2024–2025 by November 1
2024 – 2025	• Continued implementation of investment activities • Submit two-year milestone 2024–25 by January 7

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Appendix A. Membership of the Conowingo WIP Steering Committee

JURISDICTIONAL REPRESENTATIVE	JURISDICTION
Brian Van Wye	District of Columbia
Marcia Fox/Brittany Sturgis (Alternate)	Delaware
Matthew Rowe*/Dave Goshorn	Maryland
Ken Kosinski/Lauren Townley	New York
Jill Whitcomb*	Pennsylvania
Ann Jennings	Virginia
Teresa Koon	West Virginia
Mark Hoffman/Ann Swanson (Alternate)	Chesapeake Bay Commission
*Co-chairs	

Appendix B. Conowingo Watershed Implementation Plan Steering Committee Meeting

November 21, 2019

Activity 1 Handout: Draft Conowingo WIP Outreach FAQ Document

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 percent 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 (TMDL), which set nitrogen, phosphorous, and sediment reduction goals so that the Bay would meet clean water standards by 2025. 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. 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

How Does a Watershed Implementation Plan Work?
Watershed Implementation Plans (WIPs) 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, forests, wastewater treatment plants, and septic systems); second, they identify the partners and resources that can help reduce pollution; and third, they identify the best strategies to reduce pollution to meet the 2025 goals.

Why is this WIP Focusing on the Conowingo Dam?
Jurisdictions throughout the Chesapeake Bay watershed have made progress cleaning up the Bay since the 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 serves as a sufficient sink for sediment and other pollutants and what flows in above the dam will eventually flow out. The Chesapeake Bay TMDL WIPs did not account for the Conowingo Dam's reduced ability to trap upstream pollution. To address this problem the EPA-Chesapeake Bay Program, and the Bay jurisdictions have been working since [2017] to develop a WIP specific to the Conowingo Dam.

Is the Conowingo WIP Independent from WIPs Currently in Development in Other States?
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.

How Will the Conowingo Dam 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 Environmental Protection Agency contracted with the Center for Watershed Protection, the Chesapeake Bay Trust, and the 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.

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.

How Much Nitrogen Will Need to be Reduced as Part of the Watershed Implementation Plan?
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 and partner jurisdictions are utilizing an approach called “most effective basins” that involve implementing projects on lands located both upstream and downstream of the dam. Based on the amount of pollutant load 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 Watershed Implementation Plan if the cost per pound of nitrogen reduced is similar or better than reductions associated with projects upstream of the dam.

If you would like more information about the Conowingo WIP visit ***insert website address here***.

Bay Watershed Facts (for a call-out box):
Rivers and streams from Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia drain to the Chesapeake Bay.
The largest river that flows into the Chesapeake Bay is the Susquehanna River, which starts near Cooperstown, New York.
The land draining into the Chesapeake Bay is 64,000 square miles in size.
More than 100,000 streams, creeks, and rivers drain into the Chesapeake Bay.

Maps needed for the fact sheet:
Map of the overall Bay Watershed
Map of the most effective basins

Appendix C. Framework for the Conowingo Watershed Implementation Plan

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.

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.

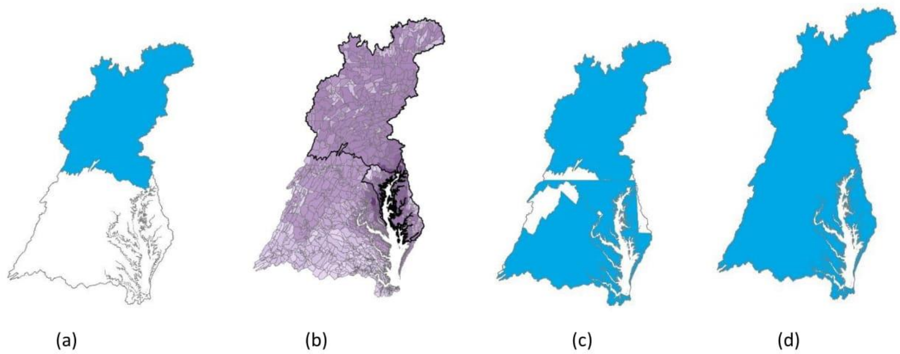

Figure 1 – Four options currently under consideration by the Bay Partnership for assigning responsibility for the additional reduction needed as a result of Conowingo infill. a) Susquehanna Basin, b) Susquehanna Basin + Most–Effective Basins (darker shades of purple = more effective basins within the 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.

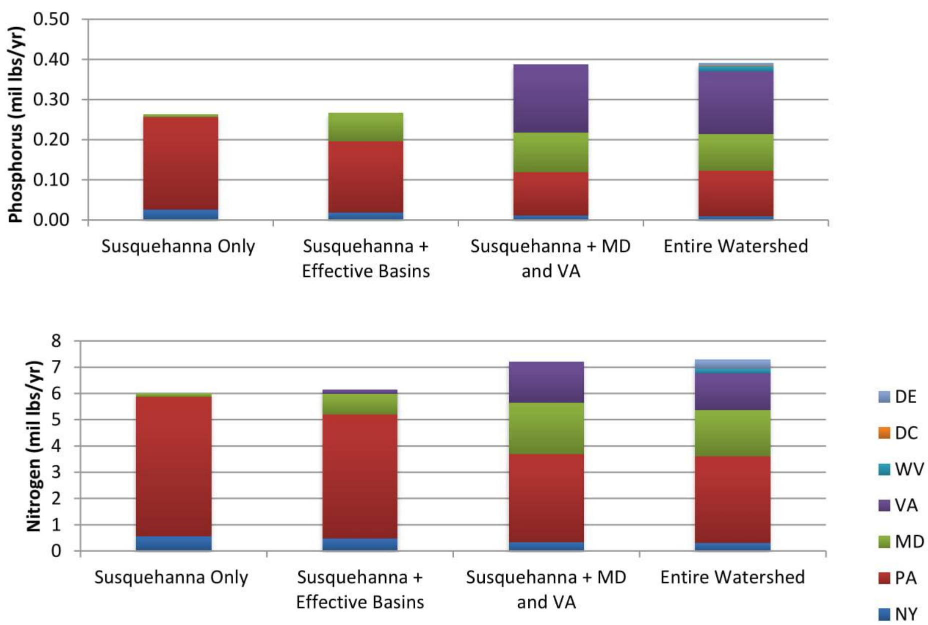

Figure 2 – Basinwide Conowingo targets developed using four different allocation options.

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 practices in 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. **Pollutant Load Targets: 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. **Funding options: 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 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 Shorelines 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 had 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 dissolved oxygen (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 3 WIP Final Scenario Report; Chesapeake Bay Program. 2019. ○ Projected nitrogen delivery to edge-of-stream after full implementation of Phase 3 WIPs. • CAST 2010 E3 Scenario Report; Chesapeake Bay Program. 2017. ○ E3 - 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	WIP 3 load - E3 load = theoretical nitrogen load available for reduction through CWIP implementation. Outputs for this layer are summed by LRS.

Appendix E. Data and Methods to Quantify the Nitrogen Load Reduction from BMP Implementation

The Chesapeake Assessment Scenario Tool (CAST) was used to model pollutant load reductions from the following BMPs: forest buffers, forest buffer-streamside with exclusion fencing, wetland restoration – floodplain, wetland restoration – headwater, urban stream restoration, nonurban stream restoration, bioswales, and non-urban shoreline management. However, the stream restoration pollutant reduction estimates were altered from CAST, and the entire bioreactor analysis was done outside of CAST.

The initial CWIP analysis included CAST runs by land river segment for the priority geography areas only. However, the limited geography achieved only achieved one third of the 6-million-pound nitrogen load reduction. To enhance the nitrogen load reduction potential, increase the time efficiency of modelling, and to benefit the financing strategy to implement the BMPs, the geography of interest was expanded to the county scale.

The current analysis began with examining the full opportunity of implementing forest buffers, forest buffer-streamside with exclusion fencing, wetland restoration – floodplain, wetland restoration – headwater, urban stream restoration, nonurban stream restoration from WIP3 to E3. That analysis yielded a 9.3-million-pound nitrogen reduction. Therefore, best professional judgement was used to scale back the implementation of forest buffers to 65%, wetlands to 65%, and stream restoration to 90%. With this reduced implementation, the nitrogen reduction was reduced to 6.2-million-pounds.

The analysis herein, was developed to that 6-million-pounds of nitrogen reduction could be achieved in the area of interest. The analysis is not a definitive commitment but rather a planning document that shows the reductions are possible but may require implementation of different strategies, such as dredging, to accomplish the pollution reduction goals. Final BMPs will determined once a financing strategy is complete.

Following the descriptions of methods used, a series of Tables is included that summarizes loads reduced and BMPs implemented under each scenario.

Determining opportunity

- An analysis of the Amount Credited in WIP3 subtracted from the Amount Credited in E3 was performed for the following practices in the Conowingo geography:
    - Forest Buffers
    - Forest Buffer – Narrow
    - Forest Buffer-Streamside with Exclusion Fencing
    - Forest Buffer-Narrow with Exclusion Fencing
    - Grass Buffers
    - Grass Buffer – Narrow
    - Grass Buffer-Streamside with Exclusion Fencing
    - Grass Buffer-Narrow with Exclusion Fencing
    - Wetland Restoration – Floodplain
    - Wetland Restoration – Headwater

    - Urban Stream Restoration
    - Nonurban Stream Restoration
- To determine the area that bioswales could be applied to, analysis of each of the load sources classified as Nonregulated Developed land use was performed for each County within the Conowingo Geography.
    - 1% of that land acreage was calculated from these load source groups as a responsible assumption for this analysis. The 1% was based upon best professional judgement and…
        - Non-Regulated Buildings and Other
        - Non-Regulated Roads
        - Non-Regulated Tree Canopy over Impervious
        - Non-Regulated Tree Canopy over Turf Grass
        - Non-Regulated Turf Grass
- An analysis of the opportunity for non-urban shoreline management was performed by the Chesapeake Conservancy using Shoreline Inventory for Maryland from the Virginia Institute of Marine Science (VIMS). This data includes visual assessments of the shorelines which occurred in a locality-based series from 2002 to 2006.
    - Analysis was performed on the following counties in Maryland:
        - Cecil
        - Dorchester
        - Harford
        - Kent
        - Queen Anne's
        - Somerset
        - Talbot
        - Caroline
        - Wicomico

Determining practices and areas for the input deck

- Acres (or feet for stream restoration) within the Conowingo Shell for WIP3 were subtracted from E3 for each of the practices excluding bioswales
    - This was done by county, practice, and load source using the Amount Credited values
- Any practice for which there were positive acres between the E3 – WIP3 analysis were kept
    - This removed all categories of grass buffers, forest buffer – narrow, and forest buffer – narrow with exclusion fencing from the analysis as there were no positive acres or feet available from E3 – WIP3.
    - The rest of the practices were kept
    - The available acres (or feet for stream restoration) for each practice by county by load source group were calculated

Creating the Model Runs

- An input deck was created using 100% of the available opportunity from the following:
    - Forest buffers
    - Forest Buffer-Streamside with Exclusion Fencing
    - Wetland Restoration – Floodplain
    - Wetland Restoration – Headwater

  - Urban Stream Restoration
  - Nonurban Stream Restoration
- Further, bioswales were entered to treat 1% of the Nonregulated Developed land use was performed for each County within the Conowingo Shell.
- Non-Urban Shoreline Management was entered based off of opportunity analysis that was performed by the Chesapeake Conservancy
  - To account for the age of the data and qualifying conditions for Living Shorelines the opportunity lengths were reduced by 50%.
  - Implementation assumed 10% of the adjusted opportunity that was determined by the Chesapeake Conservancy using VIMS data and entered as total feet into the input deck.
- The input deck was run in CAST along with the predetermined WIP3 Final deck available through the CAST administrator

Reports Generated

- Inputs were placed into the CAST model
- The CAST model determined that no BMPs in the input deck were invalid
- Reports for loads, and BMPs submitted versus credited were created for both the CWIP plus WIP3 and WIP3 runs individually

Quality Control

- Analysis of the BMPs Submitted versus Credited report was generated for both the WIP3 and the CWIP (plus WIP3) model runs. The CWIP (plus WIP3) Amount Credited values were subtracted from the WIP3 values.
- The difference in Amount Credited was compared to the values that were entered into the input deck.
- A small number of BMPs acres were not credited, primarily forest buffers. It was determined that the number of these acres were considered as insignificant.

Bioreactors

- An analysis of the opportunity for bioreactors was performed by the Center for Watershed Protection using USGS NHDPlus HR, USDA NRCS Soils, and MD Dept of Planning 2010 Land Use Land Cover data.
- The analysis extracted Depth to Water Table from NRCS soil survey then intersected the canals/ditches from NHD within the Conowingo Geography with the depth to water table and MDP land use data.
- Results were filtered to include only canals/ditches with a depth to water table <= 12" and within agricultural land.
- The average loading from the load sources categorized as Cropland were determined by summing the acres and EOT loads individually and then dividing the load by acres for the following:
  - Double Cropped Land
  - Full Season Soybeans
  - Grain with Manure
  - Grain without Manure
  - Other Agronomic Crops

- Silage with Manure
- Silage without Manure
- Small Grains and Grains
- Specialty Crop High
- Specialty Crop Low

- This provided an EOT calculation of the reduction

Stream Restoration

- CAST currently applies a default rate of 0.075 pound of nitrogen per linear foot of stream restoration per the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" (pg. 14). However, the default rate was doubled to provide an estimate of the total nitrogen reduction. This was deemed reasonable given the update to the Stream Restoration Protocols and a new protocol that is under review by the Urban Stormwater Workgroup for Outfall Stabilization (Protocol 5).

Reducing from Full Opportunity

- Once the model results were generated, stream restoration doubled, and the reductions from bioreactors were included, there was approximately 9.3M pounds of nitrogen reduction calculated.
- An analysis was performed to reduce the suite of practices down from 100% of the opportunity from E3 – WIP3 down to a level that achieved closer to the 6M pound nitrogen goal.
- The following practices were reduced in acreage by 35% (65% of full opportunity)
    - Forest buffers
    - Forest Buffer-Streamside with Exclusion Fencing
    - Wetland Restoration – Floodplain
    - Wetland Restoration – Headwater
- The following stream restoration practices were reduced in feet by 10% (90% of full opportunity)
    - Urban Stream Restoration
    - Nonurban Stream Restoration
- The rest of the practices were unchanged.
- This resulted in the achieving a nitrogen goal of approximately 6 M pound.

Susquehanna Nitrogen Exchange Ratios

Nitrogen from the Susquehanna basin has a greater impact on dissolved oxygen in the Bay than the same nitrogen load from many other basins in the Chesapeake Bay. Table E1 summarizes the unit change in DO per million pounds of N for each of the basins considered in this study, along with the "Exchange Ratio" applied to equate loading from the Susquehanna and the geographies where each ratio is applied.

Basin	Unit Change per 1,000,000 pounds of N	Exchange Ratio (to Susquehanna N Load)	Geographies where Applied
Susquehanna	16.325	1.00	All PA Counties
Upper Eastern Shore	10.709	0.66	Kent, Queen Anne's and Cecil Counties in MD
Lower Eastern Shore	9.782	0.60	Somerset, Wicomico and Worchester Counties in MD
Middle Eastern Shore	11.244	0.69	All other MD Counties

Table E1: Change in Dissolved Oxygen per million pounds of Nitrogen

These ratios were applied to loads and load reductions included in this report. a "Susquehanna Equivalent N Load" would be calculated using the following equation:

L_{susq}=LxER

Where:

L_{susq} = Susquehanna Equivalent Nitrogen Load (pound/acre/year or pound/year)

L= Estimated Edge of Tide Load (pound/acre/year or pound/year)

ER=Exchange Ratio (From Table XX).

For example, if the loading rate for a particular land use in the Lower Eastern Shore is 10 pound/acre/year, the equivalent Susquehanna Equivalent N Load would be calculated as:

L_{susq}=10 pound/acre/yearx0.6, or 6.0 pound/acre/year

Table E-1. Edge of Tide Nitrogen Loads by Sector for WIP3 and CWIP

	WIP3	**CWIP + WIP 3**	**Reductions (CWIP)**
Susquehanna Basin			
Agriculture	40,136,333	35,748,283	4,388,050
Developed	15,061,808	14,985,437	76,371
Natural	17,652,731	17,072,084	580,648
Septic	2,041,017	2,041,017	-
Wastewater	8,394,762	8,394,762	-
Total Susquehanna	***83,286,652***	***78,241,584***	***5,045,069***
Other Watersheds			
Agriculture	11,204,911	10,012,171	1,192,740
Developed	3,198,516	3,185,197	13,320
Natural	4,235,679	4,020,098	215,580
Septic	1,315,436	1,315,436	-
Wastewater	901,709	901,709	-
Total Outside Susquehanna	***20,856,251***	***19,434,611***	***1,421,639***
Total Conowingo Geography	***104,142,903***	***97,682,902***	***6,466,708***

Table E-2. Edge of Tide Nitrogen Loads by Sector for WIP3 and CWIP with Susquehanna Equivalence Factors

	WIP3	**CWIP + WIP 3**	**Reductions (CWIP)**
Susquehanna Basin			
Agriculture	40,136,333	35,748,283	4,388,050
Developed	15,061,808	14,985,437	76,371
Natural	17,652,731	17,072,084	580,648
Septic	2,041,017	2,041,017	-
Wastewater	8,394,762	8,394,762	-
Total Susquehanna	***83,286,652***	***78,241,584***	***5,045,069***
Other Watersheds			
Agriculture	7,463,066	6,660,904	802,161
Developed	2,129,749	2,120,918	8,830
Natural	2,832,792	2,688,437	144,356
Septic	881,549	881,549	-
Wastewater	605,484	605,484	-
Total Outside Susquehanna	***13,912,640***	***12,961,567***	***951,073***
Total Conowingo Geography	**97,199,292**	**91,198,876**	**6,000,416**

Table E-3. Total (SE) Edge of Tide Nitrogen Reductions for the Proposed Scenario by County.				
	Agriculture	**Developed**	**Natural**	**Total**
Counties in the Susquehanna				
Adams, PA	162,673	2,474	21,649	186,796
Bedford, PA	97,964	2,142	29,476	129,582
Berks, PA	33,840	934	1,796	36,570
Blair, PA	63,571	1,744	11,497	76,812
Bradford, PA	121,532	2,017	35,134	158,683
Cambria, PA	22,089	981	7,195	30,266
Cameron, PA	2,074	291	8,101	10,466
Carbon, PA	71	23	(4)	90
Centre, PA	102,763	3,250	15,771	121,783
Chester, PA	65,391	1,105	5,496	71,992
Clearfield, PA	39,244	2,947	25,637	67,828
Clinton, PA	54,317	2,071	18,412	74,800
Columbia, PA	106,446	1,699	13,165	121,310
Cumberland, PA	143,154	2,771	8,428	154,354
Dauphin, PA	78,932	2,828	12,212	93,972
Elk, PA	3,450	359	6,774	10,583
Franklin, PA	584,802	3,656	48,418	636,875
Fulton, PA	65,438	1,009	24,717	91,164
Huntingdon, PA	101,632	2,253	28,095	131,980
Indiana, PA	5,746	151	2,092	7,989
Jefferson, PA	259	7	4	270
Juniata, PA	84,447	1,595	14,716	100,758
Lackawanna, PA	11,218	1,269	6,070	18,556
Lancaster, PA	1,115,558	7,065	6,642	1,129,264
Lebanon, PA	124,491	2,141	4,667	131,299
Luzerne, PA	46,239	2,789	16,614	65,641
Lycoming, PA	91,120	3,328	30,489	124,938
Mckean, PA	94	6	384	484
Mifflin, PA	82,862	2,042	10,147	95,052
Montour, PA	36,984	698	3,995	41,677
Northumberland, PA	124,445	2,884	8,623	135,951
Perry, PA	122,281	1,983	18,099	142,362
Potter, PA	12,121	519	16,493	29,133
Schuylkill, PA	55,688	2,350	8,773	66,811
Snyder, PA	86,428	2,081	12,103	100,611
Somerset, PA	19,147	311	7,133	26,591
Sullivan, PA	15,386	406	11,105	26,898
Susquehanna, PA	72,062	1,230	20,801	94,093
Tioga, PA	60,833	1,310	28,577	90,720

Table E-3. Total (SE) Edge of Tide Nitrogen Reductions for the Proposed Scenario by County.				
	Agriculture	**Developed**	**Natural**	**Total**
Union, PA	62,485	1,476	8,076	72,037
Wayne, PA	2,364	48	858	3,270
Wyoming, PA	30,191	1,000	8,692	39,883
York, PA	276,217	5,130	13,529	294,877
Total In Susquehanna	**4,388,050**	**76,371**	**580,648**	**5,045,069**
Counties Outside Susquehanna				
Calvert, MD	28,187	970	10,457	39,613
Caroline, MD	95,868	1,043	11,131	108,042
Cecil, MD	107,111	115	12,067	119,294
Dorchester, MD	98,345	972	24,560	123,877
Harford, MD	88,624	229	11,148	100,001
Kent, MD	102,496	630	13,849	116,976
Queen Annes, MD	98,991	860	16,022	115,874
Somerset, MD	9,564	593	10,083	20,240
St. Marys, MD	38,258	1,354	12,557	52,168
Talbot, MD	98,937	742	15,976	115,655
Wicomico, MD	23,392	815	3,625	27,832
Worcester, MD	12,389	507	2,880	15,776
Total Outside Susquehanna	**802,161**	**8,830**	**144,356**	**955,347**
Total Conowingo Geography	**5,190,211**	**85,201**	**725,004**	**6,000,416**

Table E-4. Agricultural Sector BMPs Under CWIP					
Practice	**Bioreactor**	**Forest Buffer**	**Forest Buffer with Exclusion Fence**	**Wetland Rest. (Floodplain)**	**Wetland Rest. (Headwaters)**
Units	**Acres**	**Acres of Buffer**		**Acres of Wetland**	
Counties in the Susquehanna					
Adams, PA	-	3,213	2,766	773	785
Bedford, PA	-	1,937	6,569	700	756
Berks, PA	-	258	317	120	121
Blair, PA	-	949	899	360	397
Bradford, PA	-	3,019	6,034	1,127	1,217
Cambria, PA	-	432	623	166	172
Cameron, PA	-	62	-	15	17
Carbon, PA	-	1	1	0	0
Centre, PA	-	1,369	3,756	506	568
Chester, PA	-	476	1,154	214	219
Clearfield, PA	-	810	1,504	247	259
Clinton, PA	-	474	1,794	177	198
Columbia, PA	-	1,286	1,728	536	578
Cumberland, PA	-	1,691	2,529	648	706
Dauphin, PA	-	818	1,489	352	379
Elk, PA	-	61	172	22	22
Franklin, PA	-	5,104	5,882	1,196	1,159
Fulton, PA	-	1,053	2,911	351	379
Huntingdon, PA	-	1,294	3,536	401	524
Indiana, PA	-	99	311	40	40
Jefferson, PA	-	4	14	1	1
Juniata, PA	-	779	2,367	327	354
Lackawanna, PA	-	214	844	105	111
Lancaster, PA	-	4,105	12,743	1,745	1,777
Lebanon, PA	-	917	1,798	416	440
Luzerne, PA	-	519	1,148	240	258
Lycoming, PA	-	1,233	2,365	491	540
Mckean, PA	-	2	11	1	1
Mifflin, PA	-	728	2,488	323	348
Montour, PA	-	434	1,057	166	210
Northumberland, PA	-	1,003	2,212	513	555
Perry, PA	-	1,114	3,346	478	516
Potter, PA	-	314	789	116	123
Schuylkill, PA	-	577	723	258	269
Snyder, PA	-	841	1,991	343	376
Somerset, PA	-	212	627	74	75
Sullivan, PA	-	314	560	125	134
Susquehanna, PA	-	1,721	4,807	584	628

Table E-4. Agricultural Sector BMPs Under CWIP					
Practice	**Bioreactor**	**Forest Buffer**	**Forest Buffer with Exclusion Fence**	**Wetland Rest. (Floodplain)**	**Wetland Rest. (Headwaters)**
Units	**Acres**	**Acres of Buffer**		**Acres of Wetland**	
Tioga, PA	-	2,003	4,976	681	736
Union, PA	-	675	1,025	294	318
Wayne, PA	-	74	198	26	26
Wyoming, PA	-	638	992	209	226
York, PA	-	1,690	4,748	1,167	1,165
Total In Susquehanna	**-**	**44,515**	**95,804**	**16,635**	**17,683**
Outside Susquehanna					
Calvert, MD	-	517	462	122	41
Caroline, MD	1,213	1,581	839	648	39
Cecil, MD	-	1,643	1,504	399	335
Dorchester, MD	3,271	2,126	295	573	169
Harford, MD	-	1,183	2,127	341	252
Kent, MD	-	2,808	518	612	305
Queen Annes, MD	145	2,416	605	743	27
Somerset, MD	1,068	14	362	223	14
St. Marys, MD	-	958	752	244	222
Talbot, MD	440	2,476	407	537	12
Wicomico, MD	3,127	231	573	385	46
Worcester, MD	2,769	-	136	287	9
Total Outside Susquehanna	**12,033**	**15,952**	**8,580**	**5,114**	**1,471**
Total Conowingo Geography	**12,033**	**60,467**	**104,384**	**21,749**	**17,683**

Table E-5. Natural Sector BMPs Implemented Under CWIP			
Practice	Non-Urban Shoreline Mgmt.	Non-Urban Stream Rest.	Urban Stream Restoration
Units	feet	feet	feet
Counties in the Susquehanna			
Adams, PA	-	95,119	52,611
Bedford, PA	-	136,738	73,146
Berks, PA	-	13,023	5,065
Blair, PA	-	48,082	32,778
Bradford, PA	-	162,841	77,264
Cambria, PA	-	48,239	20,264
Cameron, PA	-	66,286	26,229
Carbon, PA	-	-	-
Centre, PA	-	74,309	61,278
Chester, PA	-	24,411	9,520
Clearfield, PA	-	165,428	64,157
Clinton, PA	-	103,498	44,074
Columbia, PA	-	62,519	26,563
Cumberland, PA	-	60,365	24,990
Dauphin, PA	-	74,179	30,972
Elk, PA	-	50,701	19,455
Franklin, PA	-	104,205	51,323
Fulton, PA	-	91,536	35,021
Huntingdon, PA	-	124,374	58,310
Indiana, PA	-	12,716	4,865
Jefferson, PA	-	103	39
Juniata, PA	-	69,163	26,461
Lackawanna, PA	-	58,335	22,703
Lancaster, PA	-	33,725	52,564
Lebanon, PA	-	37,574	18,885
Luzerne, PA	-	97,299	40,733
Lycoming, PA	-	171,754	66,350
Mckean, PA	-	4,557	1,772
Mifflin, PA	-	49,421	23,890
Montour, PA	-	21,438	9,755
Northumberland, PA	-	44,842	24,686
Perry, PA	-	88,358	33,958
Potter, PA	-	114,445	46,755
Schuylkill, PA	-	55,201	21,359
Snyder, PA	-	62,380	25,052
Somerset, PA	-	24,438	9,350
Sullivan, PA	-	73,084	28,111
Susquehanna, PA	-	126,917	53,098

Table E-5. Natural Sector BMPs Implemented Under CWIP			
Practice	Non-Urban Shoreline Mgmt.	Non-Urban Stream Rest.	Urban Stream Restoration
Units	feet	feet	feet
Tioga, PA	-	169,790	71,511
Union, PA	-	34,834	19,975
Wayne, PA	-	8,429	3,225
Wyoming, PA	-	45,967	19,651
York, PA	-	49,292	21,187
Total In Susquehanna	**-**	**2,959,918**	**1,358,957**
Outside Susquehanna			
Calvert, MD	-	33,537	27,162
Caroline, MD	-	46,398	39,157
Cecil, MD	55,322	36,883	7,819
Dorchester, MD	155,671	65,261	66,448
Harford, MD	44,684	12,500	15,383
Kent, MD	85,803	31,070	23,799
Queen Annes, MD	107,498	33,403	35,474
Somerset, MD	122,121	27,078	21,170
St. Marys, MD	-	51,398	33,519
Talbot, MD	154,679	24,341	20,794
Wicomico, MD	19,228	33,967	14,769
Worcester, MD	28,017	24,159	18,888
Total Outside Susquehanna	**773,023**	**419,995**	**324,384**
	-		
Total Conowingo Geography	**773,023**	**3,379,913**	**1,683,341**

Table E-6. Developed Sector BMPs Implemented Under CWIP	
Practice	**Bioswale**
Units	**Acres Treated**
Counties in the Susquehanna	
Adams, PA	485
Bedford, PA	507
Berks, PA	105
Blair, PA	272
Bradford, PA	467
Cambria, PA	208
Cameron, PA	58
Carbon, PA	1
Centre, PA	532
Chester, PA	138
Clearfield, PA	538
Clinton, PA	286
Columbia, PA	233
Cumberland, PA	462
Dauphin, PA	397
Elk, PA	75
Franklin, PA	585
Fulton, PA	179
Huntingdon, PA	371
Indiana, PA	33
Jefferson, PA	1
Juniata, PA	222
Lackawanna, PA	285
Lancaster, PA	765
Lebanon, PA	257
Luzerne, PA	412
Lycoming, PA	495
Mckean, PA	2
Mifflin, PA	292
Montour, PA	100
Northumberland, PA	363
Perry, PA	262
Potter, PA	125
Schuylkill, PA	273
Snyder, PA	265
Somerset, PA	37
Sullivan, PA	95

Table E-6. Developed Sector BMPs Implemented Under CWIP	
Practice	**Bioswale**
Units	**Acres Treated**
Susquehanna, PA	298
Tioga, PA	442
Union, PA	208
Wayne, PA	14
Wyoming, PA	184
York, PA	805
Total In Susquehanna	12,137
Outside Susquehanna	
Calvert, MD	293
Caroline, MD	218
Cecil, MD	34
Dorchester, MD	225
Harford, MD	76
Kent, MD	203
Queen Annes, MD	240
Somerset, MD	188
St. Marys, MD	419
Talbot, MD	166
Wicomico, MD	218
Worcester, MD	133
Total Outside Susquehanna	**2,415**
Total Conowingo Geography	**14,552**

Appendix F. A summary of assumptions used to provide the cost estimates for the CWIP implementation strategy.

Cost Assumption were developed using data found with in CAST and summarized below (https://cast.chesapeakebay.net/Documentation/CostProfiles).

Stream restoration

- MD
    - Urban & Non-Urban Stream Restoration Protocols
        - $408.24/ft
        - O&M: $51.03/ft/yr
        - Total annualized cost per unit: $145.32
- PA
    - Urban & Non-Urban Stream Restoration Protocols
        - $408.24/ft
        - O&M: $51.03/ft/yr
        - Total annualized cost per unit: $145.32
- Stream Restoration Averaged
    - Urban & Non-Urban Stream Restoration Protocols
        - $408.24/ft
        - O&M: $51.03/ft/yr
        - Total annualized cost per unit: $145.32

Living shorelines

- MD
    - Urban Shoreline Management
        - $435.07/ft
        - O&M: $21.75/ft/yr
        - Total annualized cost per unit: $50.05
    - Non-Urban Shoreline Management
        - $85.23/ft
        - O&M: $0/ft/yr
        - Total annualized cost per unit: $6.84
    - Urban Shoreline Erosion Control Non-Vegetated
        - $856.33/ft
        - O&M: $42.82/ft/yr
        - Total annualized cost per unit: $98.53
    - Urban Shoreline Erosion Control Vegetated
        - $82.87/ft
        - O&M: $4.14/ft/yr
        - Total annualized cost per unit: $9.53
    - Non-Urban Shoreline Erosion Control Non-Vegetated

- $117.19/ft
    - O&M: $5.86/ft/yr
    - Total annualized cost per unit: $15.26
- Non-Urban Shoreline Erosion Control Vegetated
    - $15.20/ft
    - O&M: $0.76/ft/yr
    - Total annualized cost per unit: $1.98

▪ PA

- Urban Shoreline Management
    - $435.07/ft
    - O&M: $21.75/ft/yr
    - Total annualized cost per unit: $50.05
- Non-Urban Shoreline Management
    - $63.56/ft
    - O&M: $0/ft/yr
    - Total annualized cost per unit: $5.10
- Urban Shoreline Erosion Control Non-Vegetated
    - $856.33/ft
    - O&M: $42.82/ft/yr
    - Total annualized cost per unit: $98.53
- Urban Shoreline Erosion Control Vegetated
    - $82.87/ft
    - O&M: $4.14/ft/yr
    - Total annualized cost per unit: $9.53
- Non-Urban Shoreline Erosion Control Non-Vegetated
    - $139.66/ft
    - O&M: $6.98/ft/yr
    - Total annualized cost per unit: $18.19
- Non-Urban Shoreline Erosion Control Vegetated
    - $30.54/ft
    - O&M: $1.53/ft/yr
    - Total annualized cost per unit: $3.98

▪ Living Shorelines Averaged

- Urban Shoreline Management
    - $435.07/ft
    - O&M: $21.75/ft/yr
    - Total annualized cost per unit: $50.05
- Non-Urban Shoreline Management
    - $74.40/ft
    - O&M: $0/ft/yr
    - Total annualized cost per unit: $5.97
- Urban Shoreline Erosion Control Non-Vegetated
    - $856.33/ft
    - O&M: $42.82/ft/yr

        - Total annualized cost per unit: $98.53
    - Urban Shoreline Erosion Control Vegetated
        - $82.87/ft
        - O&M: $4.14/ft/yr
        - Total annualized cost per unit: $9.53
    - Non-Urban Shoreline Erosion Control Non-Vegetated
        - $128.43/ft
        - O&M: $6.42/ft/yr
        - Total annualized cost per unit: $16.73
    - Non-Urban Shoreline Erosion Control Vegetated
        - $22.87/ft
        - O&M: $1.15/ft/yr
        - Total annualized cost per unit: $2.98

Buffers

- MD
    - Agriculture
        - Grass Buffer
            - $250.55/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $40.97
        - Grass Buffer, Narrow
            - $250.55/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $40.97
        - Grass Buffer, Streamside with Exclusion Fencing
            - $1,550.52/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $261.32
        - Grass Buffer, Narrow with Exclusion Fencing
            - $4,152.49/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $702.37
        - Forest Buffer
            - $1,756.64/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $100.33
        - Forest Buffer, Narrow
            - $1,756.64/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $100.33
        - Forest Buffer, Streamside with Exclusion Fencing
            - $11,506.45/ac
            - O&M: $52/ac/yr

      - Total annualized cost per unit: $652.70
    - Forest Buffer, Narrow with Exclusion Fencing
      - $31,021.16/ac
      - O&M: $156.08/ac/yr
      - Total annualized cost per unit: $1,758.31
    - Saturated Buffer
      - $4,676.50/ac
      - O&M: $78.06/ac/yr
      - Total annualized cost per unit: $453.32
  - Developed
    - Forest Buffer
      - $1,790.67/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $91.90
    - Grass Buffer
      - $430.51/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $55.75
- PA
  - Agriculture
    - Grass Buffer
      - $385.86/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $56.95
    - Grass Buffer, Narrow
      - $385.86/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $56.95
    - Grass Buffer, Streamside with Exclusion Fencing
      - $1,685.83/ac
      - O&M: $52/ac/yr
      - Total annualized cost per unit: $277.30
    - Grass Buffer, Narrow with Exclusion Fencing
      - $4,287.79/ac
      - O&M: $156.08/ac/yr
      - Total annualized cost per unit: $718.35
    - Forest Buffer
      - $2,929.92/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $157.35
    - Forest Buffer, Narrow
      - $2,929.92/ac
      - O&M: $0/ac/yr
      - Total annualized cost per unit: $157.35

        - Forest Buffer, Streamside with Exclusion Fencing
            - $12,679.72/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $709.73
        - Forest Buffer, Narrow with Exclusion Fencing
            - $32,194.44/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $1,815.33
        - Saturated Buffer
            - $4,660.61/ac
            - O&M: $78.06/ac/yr
            - Total annualized cost per unit: $452.04
    - Developed
        - Forest Buffer
            - $2,986.67/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $153.28
        - Grass Buffer
            - $524.44/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $67.92
- **Buffers Averaged**
    - Agriculture
        - Grass Buffer
            - $318.21/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $48.96
        - Grass Buffer, Narrow
            - $318.21/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $48.96
        - Grass Buffer, Streamside with Exclusion Fencing
            - $1,618.18/ac
            - O&M: $52/ac/yr
            - Total annualized cost per unit: $269.31
        - Grass Buffer, Narrow with Exclusion Fencing
            - $4,220.14/ac
            - O&M: $156.08/ac/yr
            - Total annualized cost per unit: $710.36
        - Forest Buffer
            - $2,343.28/ac
            - O&M: $0/ac/yr
            - Total annualized cost per unit: $128.84
        - Forest Buffer, Narrow

        - $2,343.28/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $128.84
    - Forest Buffer, Streamside with Exclusion Fencing
        - $12,093.09/ac
        - O&M: $52/ac/yr
        - Total annualized cost per unit: $681.22
    - Forest Buffer, Narrow with Exclusion Fencing
        - $31,607.80/ac
        - O&M: $156.08/ac/yr
        - Total annualized cost per unit: $1,786.82
    - Saturated Buffer
        - $4,668.56/ac
        - O&M: $78.06/ac/yr
        - Total annualized cost per unit: $452.68
- Developed
    - Forest Buffer
        - $2,388.67/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $122.59
    - Grass Buffer
        - $477.48/ac
        - O&M: $0/ac/yr
        - Total annualized cost per unit: $61.84

Wetlands

- MD
    - Agriculture
        - Wetland Restoration, Floodplain
            - $403.64/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $93.71
        - Wetland Restoration, Headwater
            - $3,000/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $343.85
        - Wetland Creation, Floodplain
            - $3,228/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $365.82
        - Wetland Creation, Headwater
            - $3,228/ac
            - O&M: $44.65/ac/yr

        - Total annualized cost per unit: $365.82
  - Developed
    - Wet Ponds and Wetlands
      - $4,411.42/acre treated
      - O&M: $62.92/acre treated
      - Total annualized cost per unit: $329.91
    - Floating Treatment Wetland, 10% Coverage of Pond
      - $3,707/ac
      - O&M: $185/ac/yr
      - Total annualized cost per unit: $1,546.24
    - Floating Treatment Wetland, 20% Coverage of Pond
      - $7,415/ac
      - O&M: $371/ac/yr
      - Total annualized cost per unit: $3,093.85
    - Floating Treatment Wetland, 30% Coverage of Pond
      - $11,122/ac
      - O&M: $556/ac/yr
      - Total annualized cost per unit: $4,640.09
    - Floating Treatment Wetland, 40% Coverage of Pond
      - $14,829/ac
      - O&M: $741/ac/yr
      - Total annualized cost per unit: $6,186.34
    - Floating Treatment Wetland, 50% Coverage of Pond
      - $18,536/ac
      - O&M: $927/ac/yr
      - Total annualized cost per unit: $7,733.58
  - Natural
    - Wetland Enhancement
      - $726.45/ac
      - O&M: $44.65/ac/yr
      - Total annualized cost per unit: $124.81
    - Wetland Rehabilitation
      - $2,545.85/ac
      - O&M: $44.65/ac/yr
      - Total annualized cost per unit: $300.10
- PA
  - Agriculture
    - Wetland Restoration, Floodplain
      - $466.56/ac
      - O&M: $44.65/ac/yr
      - Total annualized cost per unit: $96.58
    - Wetland Restoration, Headwater
      - $2,781.64/ac

- O&M: $44.65/ac/yr
- Total annualized cost per unit: $319.62

- Wetland Creation, Floodplain
  - $2,776.65/ac
  - O&M: $44.65/ac/yr
  - Total annualized cost per unit: $318.72
- Wetland Creation, Headwater
  - $2,907.81/ac
  - O&M: $44.65/ac/yr
  - Total annualized cost per unit: $331.78

- Developed
  - Wet Ponds and Wetlands
    - $4,418.64/acre treated
    - O&M: $63.02/acre treated
    - Total annualized cost per unit: $330.44
  - Floating Treatment Wetland, 10% Coverage of Pond
    - $3,707/ac
    - O&M: $185/ac/yr
    - Total annualized cost per unit: $1,546.24
  - Floating Treatment Wetland, 20% Coverage of Pond
    - $7,415/ac
    - O&M: $371/ac/yr
    - Total annualized cost per unit: $3,093.85
  - Floating Treatment Wetland, 30% Coverage of Pond
    - $11,122/ac
    - O&M: $556/ac/yr
    - Total annualized cost per unit: $4,640.09
  - Floating Treatment Wetland, 40% Coverage of Pond
    - $14,829/ac
    - O&M: $741/ac/yr
    - Total annualized cost per unit: $6,186.34
  - Floating Treatment Wetland, 50% Coverage of Pond
    - $18,536/ac
    - O&M: $927/ac/yr
    - Total annualized cost per unit: $7,733.58
- Natural
  - Wetland Enhancement
    - $1,145.41/ac
    - O&M: $44.65/ac/yr
    - Total annualized cost per unit: $161.98
  - Wetland Rehabilitation
    - $2,781.64/ac
    - O&M: $44.65/ac/yr

        - Total annualized cost per unit: $319.62

- **Wetlands Averaged**
    - Agriculture
        - Wetland Restoration, Floodplain
            - $435.10/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $95.15
        - Wetland Restoration, Headwater
            - $2,890.82/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $331.74
        - Wetland Creation, Floodplain
            - $3,002.33/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $342.27
        - Wetland Creation, Headwater
            - $3,067.91/ac
            - O&M: $44.65/ac/yr
            - Total annualized cost per unit: $348.80
    - Developed
        - Wet Ponds and Wetlands
            - $4,415.03/acre treated
            - O&M: $62.97/acre treated
            - Total annualized cost per unit: $330.18
        - Floating Treatment Wetland, 10% Coverage of Pond
            - $3,707/ac
            - O&M: $185/ac/yr
            - Total annualized cost per unit: $1,546.24
        - Floating Treatment Wetland, 20% Coverage of Pond
            - $7,415/ac
            - O&M: $371/ac/yr
            - Total annualized cost per unit: $3,093.85
        - Floating Treatment Wetland, 30% Coverage of Pond
            - $11,122/ac
            - O&M: $556/ac/yr
            - Total annualized cost per unit: $4,640.09
        - Floating Treatment Wetland, 40% Coverage of Pond
            - $14,829/ac
            - O&M: $741/ac/yr
            - Total annualized cost per unit: $6,186.34
        - Floating Treatment Wetland, 50% Coverage of Pond
            - $18,536/ac
            - O&M: $927/ac/yr

            - Total annualized cost per unit: $7,733.58
  - Natural
    - Wetland Enhancement
      - $935.93/ac
      - O&M: $44.65/ac/yr
      - Total annualized cost per unit: $143.40
    - Wetland Rehabilitation
      - $2,663.75/ac
      - O&M: $44.65/ac/yr
      - Total annualized cost per unit: $309.86

<u>Bioswales</u>

- MD
  - Developed
    - Bioswale
      - $9,598.47/acre treated
      - O&M: $313.42/acre treated/year
      - Total annualized cost per unit: $864.54
- PA
  - Developed
    - Bioswale
      - $9,614.18/acre treated
      - O&M: $313.93/acre treated/year
      - Total annualized cost per unit: $865.95
- Bioswales Averaged
  - Bioswale
    - $9,606.33/acre treated
    - O&M: $313.68
    - Total annualized cost per unit: $915.25

<u>Bioreactors</u>

- MD
  - Agriculture
    - Bioreactors
      - $85.23/acre treated
      - O&M: $0/acre treated/year
      - Total annualized cost per unit: $6.84

Appendix G. An alternative cost scenario for a 2030 implementation of the CWIP

This information will be provided upon the request of US EPA as part of the scope of work for the Conowingo WIP.