

Addendum to the First Publication

In the original Policy Brief, *Cost of Achieving a Restored Chesapeake Bay - A Community Perspective*, we described a scenario for Anne Arundel County as being their “2025 WIP”. In subsequent discussions with Anne Arundel Public Works staff, it was noted that many of the BMPs factoring into the high cost of that scenario (\$250 million in annual terms) were not BMPs proposed by the County’s WIP Team. On further examination, we learned that the County’s Phase II WIP was supplemented with additional BMPs by Maryland Department of the Environment.

Given the promise of enhanced accountability attending the Chesapeake Bay TMDL, it is not apparent why these BMPs were added to Anne Arundel County’s WIP submission. However, this practice of adding BMPs to local plans was also applied to other jurisdictions in Maryland whose Final 2025 WIP did not generate modeled outcomes that achieved their load allocations.

In fairness to Anne Arundel County and with regard for reporting accuracy, we were led to recalculate our 2025 Anne Arundel Phase II WIP scenario, using the set of BMPs proposed by Anne Arundel’s WIP Team as the County’s official plan. When we subtract the BMPs inserted into the County’s plan, we find that the overall cost, as measured by CBPO cost estimates and MAST decision rules, is significantly reduced. However, edge-of-stream load reductions are also significantly lower in this revised scenario.

In **Annex Table 1**, below, we summarize our findings for Anne Arundel’s urban BMPs, costs and loads.

Annex Table 1: Comparison of Cost and Achievement between Anne Arundel County’s 2025 WIP and a MAST-wise Cost Attentive Scenario		
	CA2	WIPTeam
Annualized BMP Costs	\$48,956,228	\$119,413,498
Urban N (EoS) Loads (lbs)	642,681	832,375

The BMP *Urban Filtration Practices* is by far the largest cost factor in Anne Arundel’s WIP Team scenario. It is noted in the MAST Maryland 2017 WIP scenario that in Anne Arundel County this BMP largely applies to a specific practice called *Step Pool Storm Conveyance*. How accurately the cost estimate for the general BMP “Urban Filtration Practices” captures the specific activity “step pool storm conveyance” is uncertain. It is also possible that applications of any of the BMPs specified in Anne Arundel’s scenario provide greater load reduction benefit than shows up in their MAST scenario due to Anne Arundel’s spatial targeting of BMPs.

The Cost of Achieving a Restored Chesapeake Bay: A Community Perspective

Introduction

Thirty years after the signing of the first Chesapeake Bay Agreement, the federal government and partner states have drafted a fourth Chesapeake Bay Agreement. This draft¹ proposes 13 principles by which the partnership's efforts will be governed. Several of these principals are new and have not appeared in earlier Chesapeake Bay Agreements. One of those asserts that the partnership will “achieve goals and outcomes ... at the least possible cost to our citizens”.

While it is expected that the cost of any specific activity undertaken to meet Chesapeake Bay restoration goals will be whatever the market says it should be – that is, no greater than necessary – the idea of achieving goals and outcomes at the least possible cost to citizens implies a more rigorous standard than this. The least cost standard requires that water quality goals be met by undertaking activities that are more cost effective than their alternatives. If this principal is effective, then for any given amount of restoration spending, the partners will achieve greater progress toward their goals than if the principal were ignored.

To some, more spending for Chesapeake Bay restoration appears better than spending less.² However, it seems reasonably unlikely that that view is shared by a majority of taxpayers in counties trying to comply with watershed implementation plans (WIPs). As the potential cost of some of what must be done under the Chesapeake Bay total maximum daily load agreement (TMDL) has become clearer, the need for a consistent and transparent means for evaluating those costs has also become apparent.

This brief describes a means for evaluating the cost effectiveness of pollution reduction scenarios generated by the Maryland Assessment Scenario Tool (MAST). MAST is a web-based data management software that calculates the expected pollution reduction implied by a specific set of pollution reduction practices. As described, below, MAST is both a monitoring and a modeling tool. As such, it provides an obvious platform for evaluating the cost effectiveness of proposed restoration policies and programs.

What does cost effectiveness look like?

Cost effectiveness can be thought of as the amount of progress toward the goal that a given restoration activity provides, per dollar spent. Progress toward Chesapeake Bay restoration goals is measured in part by reductions in the amount of nutrients and sediments flowing into the Bay. Therefore, if one knows how much nutrient and sediment reduction is achieved by a given restoration activity, that plus the total cost of the activity will tell you its cost effectiveness. Total pounds of reduction divided by total cost of the activity gives lb/\$ for the activity.

1 http://www.chesapeakebay.net/documents/Draft_Watershed_Agreement_Public_Format_1-28-14_FINAL.pdf

2 <http://www.cbf.org/Document.Doc?id=591>

If one were to rank order the cost effectiveness of the range of possible restoration activities from highest to lowest (highest implying most units of reduction per dollar), that rank ordering would provide a first approximation of the sequence in which activities should be funded until sufficient reduction is achieved and water quality goals are met. However, as we will see below, that only works if cost effectiveness of a restoration activity is independent of other restoration activities.

Over much of the history of the Chesapeake Bay restoration, for nonpoint source nutrient and sediment pollution it has been difficult to know the reduction effectiveness of any given activity in a particular application. Because of this, it has been impractical to try to apply a least cost standard to the restoration effort, at least with respect to nonpoint source reductions. However, the Chesapeake Bay TMDL requires that signatory states develop means to monitor progress toward water quality goals based on expectations about reductions from particular activities in particular applications. Without such a tool, it would be difficult to evaluate progress toward restoration goals, as these are often neither immediately or cheaply visible.

Virginia, Pennsylvania and Maryland have all adopted on-line reporting tools that aggregate the activities undertaken or proposed in each State in pursuit of restoration goals and TMDL requirements. These reporting systems compile pollution reduction activities in a state, county, municipality or any other land-river part of the drainage and evaluate their expected pollution reduction based on: pollution load estimates from the Chesapeake Bay model, a transparent and well-documented set of modeling rules and reduction activity efficiency estimates. These reporting tools also serve as means to evaluate novel configurations of restoration activities, particularly with respect to their effects on total pollution load reduction.

The use of the Chesapeake Assessment Scenario Tool (CAST) and its State-specific versions has advanced as both a monitoring tool and as a means to test scenarios for their pollution reduction potentials. In recent work, an add-on to CAST's pollution reduction assessment capability has made it a simple matter to match pollution reduction with cost estimates for the restoration activities specified in a scenario. Using this cost calculating add-on, one can compare the cost effectiveness of any scenario with that of other scenarios. Below, we describe the Calvert County cost calculator, its utility and limitations.

The Calvert County Cost Calculator

In the spring of 2013, Main Street Economics, in association with the University of Maryland's Environmental Finance Center (EFC), was funded by the National Fish and Wildlife Foundation (NFWF) to evaluate planning-level costs for Calvert County, Maryland in meeting its WIP nutrient and sediment load allocations. Under Maryland's WIP, Calvert County was granted an allocation of allowable nutrient and sediment pollution to the Chesapeake Bay. Since this load allocation was less than the amount of pollution that currently makes its way into the Chesapeake Bay from Calvert County, the County was charged with determining how they would reduce their loads to meet their allocation.

Calvert County had undertaken an evaluation of the likely costs of meeting their County WIP and had generated a total expected cost of \$1.26 billion. In a county with a population under

90,000 and an annual County budget of around \$250 million, paying the costs of its WIP in-house seemed untenable.

The Maryland Assessment Scenario Tool (MAST) provides a means to evaluate county-level progress toward pollution load allocations. It can do this for both actual, reported load reduction practices and for prospective implementation of pollution reduction practices. The great benefit of MAST is its easy-to-use on-line interface which allows the operator to experiment with a limitless number of scenarios. The pollution reduction effects of different combinations of practices have obvious relevance for county and municipal planners trying to achieve pollution reduction goals.

With respect to measuring the costs of Calvert County's WIP, the piece that needed to be added to MAST was a consistent accounting of the costs of implementing best management practices (BMPs). The Chesapeake Bay Program Office (CBPO) has had a cost evaluation of BMPs ongoing for the past several years. That effort generated annualized cost estimates for a wide range of BMPs. Since MAST calculates the pollution reduction effects of practices as yearly outcomes, the CBPO annualized estimates of BMP implementation costs provided what was needed to estimate the annual cost of scenarios.

When an operator uses the Calvert County Cost Calculator, they identify scenarios that have been created for Calvert County in MAST, either singly or up to three at a time, and the calculator reports costs for the identified scenario(s). The calculator pairs the amount of a BMP applied in a scenario with its annual implementation costs, generating a total annual cost by BMP. Those total annual costs are summed for sector-specific and county-wide annual cost estimates. Thus, along with an idea of the annual load reductions achieved by any given scenario, an operator can have some idea of the annual costs associated with the scenario.

It is important to note in this respect that the annualized cost approach is quite different than the cost estimates that Calvert County developed as their costs of complying with their WIP. Those latter estimates summed capital and operation and maintenance costs into a single value. Because of uncertainty about how those estimates treated financial costs, it is difficult to compare them with the annual costs reported here. Another important aspect of annualized accounting of costs is that it assumes that these costs will need to be paid every year until cheaper solutions are found to present day nutrient and sediment pollution loading.

Scenario Comparison Example:

In Table 1, we report output from two different scenarios, (i.e., two different combinations of pollution reduction practices). Both were created in MAST and then evaluated with the cost calculator. In this table, we only show loads coming from land uses, and not animal, septic or waste water loads.

The 2025 scenario is configured according to the WIP designers' specifications³ and is expected to achieve a total load export of 400,772 pounds per year. This is about 6,000 pounds in excess of Calvert County's 2025 TMDL land use load allocation. The estimated annual cost of doing all of the things specified in this scenario is just under \$20 million.

Table 1: A Comparison of Calvert County WIP Scenarios, Land Use Nitrogen Loads and Costs

	2025 WIP by Specification	A Cost-Attentive Alternative
Edge of Stream Nitrogen Loads (lbs)	400,772	400,576
Of Agriculture	113,489	82,372
W Forest	145,605	164,940
hic Urban	124,164	136,305
BMP Costs (\$/year)	\$19,499,926	\$3,546,956

In our work for Calvert County, we presumed a cost minimization incentive on the part of planners and sought a combination of BMPs that would serve those incentives. This cost attentive scenario achieved a slightly lower overall edge of stream load, although urban and forest loads were higher than the 2025 WIP scenario loads for those sources. Most striking, however, is the significantly lower price tag for the cost attentive scenario. The same cost information was used for both scenarios.

Using the Cost Calculator for Achieving the Least Cost Standard

A cost estimating add-on to MAST provides a way to test the cost effectiveness of counties' WIP scenarios. In the same way that MAST provides operators and decision-makers with projections about the annual pollution reduction effects of a set of activities, a cost calculating tool gives projections for the annual costs of employing that set of activities. Since MAST is also used to evaluate compliance with TMDL load allocations, estimating costs in a way that is consistent with MAST serves compliance objectives and, hopefully, restoration goals.

MAST integrates BMP impacts with respect to upstream loads and upstream load reductions. Because of interactions among BMPs, the reduction effectiveness of any given BMP in a scenario is dependent on that scenario. That is, the reduction effectiveness might be different for the same BMP in a different scenario. Since cost effectiveness is a function of reduction effectiveness, it too will change across scenarios for the same BMP.

³ In fact, this scenario contains many BMPs that were inserted by Maryland Department of the Environment as noted in the addendum at the start of this Policy Brief

A simple rank-ordering of the cost effectiveness of BMPs was proposed above as a first order approximation of a least cost standard for achieving restoration goals. However, if the cost effectiveness of a BMP is dependent on the effects of BMPs upstream from it, then such ordering will not necessarily meet the least cost standard. The least cost standard requires that we care less about the cost effectiveness of individual BMPs than the cost effectiveness of the scenario as a whole. When we expand the context to a geographic area containing a range of land uses and BMPs which operate in train, rank ordering individual BMPs by cost effectiveness becomes less important and more complicated.

In the example shown above, the cost-attentive scenario shifted pollution reduction practices out of the urban source sector and into the agricultural source sector. This is apparent in the sector specific breakout of nitrogen loads. What is less visible from the data reported is that this shifting of costs across sectors provided a considerable part of the savings between the cost attentive scenario and the WIP 2025 scenario. However, inter-sectoral gains are not the only gains to be had from using the cost calculator. As multiple treatment opportunities exist for a single source sector such as Urban Stormwater, the combined pollution reduction effect of specific sets of BMPs will be significantly different from that of other combinations when evaluated by MAST. Cost effectiveness of different scenarios will also vary widely.

Intra-Source Sector Savings Opportunities

Developed counties, such as Anne Arundel County, Maryland, have less opportunity for achieving efficiency gains by trading off urban load reductions for agricultural load reductions. As shown in Table 2, the cost improvements achieved in the cost attentive scenario involved changing the application of urban BMPs and increasing load reductions. Three scenarios are reported in that table, one accounting progress through 2012, one developed as cost attentive, and a third scenario specified for Anne Arundel County’s WIP⁴. While agricultural BMP costs were significantly less in the cost attentive scenario, it is the drop in urban land use BMP costs that catches ones attention. A drop of almost \$200 million in annual costs seems too good to believe.

Sector	AA 2012 Costs	CA Scenario Costs	AA 2025 WIP Costs	AA 2012 Loads (LB N)	CA Loads (LB N)	AA 2025 WIP Loads (LB N)
Agriculture	\$371,442	\$418,285	\$1,248,640	169,634	166,369	140,337
Forest	\$64,939	\$64,939	\$65,151	254,648	328,989	269,741
Urban	\$36,721,932	\$48,932,458	\$247,827,760	1,005,508	664,104	704,699
Total Landuse BMP	\$37,158,313	\$49,415,682	\$249,141,551	1,429,790	1,159,462	1,114,777

⁴ Please see the addendum at the start of this Policy Brief

Within each source sector summarized in the table, there are a number of land uses. And, for each land use, there are a range of different BMPs that can be applied. The loss of a large share of the \$200 million in costs between the 2025 WIP scenario and the CA scenario derives from shifting out of Urban Filtering Practices (\$105 million) and Impervious Surface Reduction (\$68 million) and shifting up the application of Wet and Dry Detention Ponds, Buffers and Tree Planting.

The extent to which the cost estimates used here reflect the actual annualized costs of these practices is an obvious concern. The cost for Urban Filtering Practices is based on the cost of creating a storage/filtering facility capable of treating water from an impervious up-gradient source and its median annualized estimated cost is \$2,321/acre treated. If redirecting a gutter downspout qualifies as an Urban Filtering Practice, this cost estimate will not reflect actual costs.

In using the cost calculator, improvements in the accuracy of cost estimates will always be possible. The utility of a set of default costs used in these Calvert and Anne Arundel County examples is that they are well-documented in calculation and data sources, and they can be re-estimated consistently, as new or better information becomes available.

Caveats and Limitations

CBPO is currently supporting an effort to provide Maryland with a cost calculating add-on to MAST. Although the tool has not yet been rolled-out, it is highly likely that it will operate very much like the Calvert County Cost Calculator. A prospective improvement will allow operators to replace default BMP cost estimates with estimates that are more appropriate to their expectations. Better precision and accuracy of cost estimates will vastly improve the cost calculator's utility.

An important caveat for calculating direct costs of a large-scale effort such as restoring Chesapeake Bay water quality is that the analysis is partial. The cost calculator does not distinguish payers of the restoration costs it sums. It therefore cannot analyze how changes in costs might affect decisions of those who have to pay them. That is, it is not an economic impact study. However, it provides information that would be relevant to an economic impact study.

A final caveat has less to do with costs and more to do with objectives. By using CAST as guide for achieving restoration goals, we limit our focus to CAST's factors of concern, namely; annual nitrogen, phosphorous and sediment loads. Uphoff and others, 2011⁵ report evidence suggesting that past a threshold percentage of impervious area in a small drainage, aquatic ecosystems provide significantly poorer habitat for fish and shellfish. It is possible that the focus on annual loads of nutrients and sediments misses the environmental harm caused by stormwater runoff from manmade impervious surfaces. If pulses of stormwater have temperature, water clarity or

⁵ Uphoff, J. , M. McGinty, R. Lukacovic, J. Mowrer, & B. Pyle. 2011. Impervious Surface, Summer Dissolved Oxygen and Fish Distribution in Chesapeake Bay Subestuaries: Linking Watershed Development, Habitat Conditions and Fisheries Management. *North American Journal of Fisheries Management*, 31:554 – 566.

toxics transport effects which are not captured in estimates of annual nutrient and sediment transport, then a CAST-based estimate of cost effectiveness will underestimate the value of stormwater BMPs. While the Cost Calculator is a useful tool, it is important to consider these caveats, moving forward.