

**Guidance for Developing Stormwater Wasteload Allocation
Implementation Plans for Nutrient and Sediment
Total Maximum Daily Loads**



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I. Introduction

This document provides Maryland's local jurisdictions with recommendations on specific management strategies and actions to include in Stormwater Wasteload Allocation (SW-WLA) implementation plans for nutrient and sediment Total Maximum Daily Loads (TMDLs). For permitted Phase I municipal separate storm sewer system (MS4) jurisdictions, SW-WLA implementation must be addressed as part of their permit required restoration plans. Although the intent of this document focuses on providing guidance for developing SW-WLA implementation plans to Phase I MS4s, most of the recommendations and strategies outlined here could also be applied in creating implementation plans for SW-WLAs and urban Load Allocations (LAs) assigned to other regulated stormwater dischargers and non-MS4 jurisdictions.

It is important to emphasize that the methods and strategies described in this document are merely recommendations. Local jurisdictions may apply different actions and strategies in their plans, as long as 1) their plan provides for physical action to achieve the required SW-WLA reductions, and 2) these actions and strategies are scientifically defensible and technically sound. The guidance does not include the full suite of actions and strategies available, but rather, it is intended to provide a general starting point when developing a SW-WLA implementation plan for nutrient and sediment TMDLs.

Maryland Department of the Environment (MDE) has published several other guidance documents for local jurisdictions to use as a resource, when developing SW-WLA implementation plans for nutrient and sediment TMDLs. These include the MDE Water Management Administration's (WMA) guidance on accounting for SW-WLAs (MDE 2014c) and the MDE Science Services Administration's (SSA) general guidance for developing a SW-WLA implementation plan (MDE 2014a), which expands upon the technical elements within WMA's guidance. Local jurisdictions should refer to these documents before reading this specific guidance document on developing a SW-WLA implementation plan for nutrient and sediment TMDLs. The WMA guidance document can be found on the MDE website at: <http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/SedimentandStormwaterHome/Pages/Programs/WaterPrograms/sedimentandstormwater/home/index.aspx>. SSA's guidance document can be found on MDE's TMDL Data Center website at: <http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/TMDLStormwaterImplementation.aspx>.

In addition to recommending specific strategies for reducing nutrient and sediment loads and modeling procedures for estimating nutrient and sediment load reductions, this guidance document also covers other conceptual issues related to the development of nutrient and sediment SW-WLA implementation plans. Appendices A and B provide the methods and instructions for using the Maryland Assessment Scenario Tool (MAST) and the Chesapeake Bay Facility Assessment Scenario Tool (BayFAST), respectively, to develop a SW-WLA implementation plan. Both MAST and BayFAST are web-based nutrient and sediment load estimator tools that are consistent with the Chesapeake Bay Program's (CBP) modeling framework. Appendix C discusses how to address watersheds that have multiple sets of allocations assigned, i.e., local TMDL developed as well as Chesapeake Bay TMDL allocations, and how to develop comprehensive plans and implementation scenarios to address all sets of

allocations. Appendix D discusses the development of implementation plans to address TMDLs calculated using the Vollenwieder relationship.

The following sections describe the SW-WLA implementation plan process for nutrient and sediment TMDLs, detailing suggested management strategies and the modeling and accounting of pollutant load reductions expected from these strategies. The sections cover source identification and baseline load assessment (nutrient and sediment load for the baseline year of the TMDL), estimating the target SW-WLA in the county modeling system (can be as simple as a spreadsheet) using the TMDL SW-WLA and required reduction percentage, estimating the current nutrient and sediment loading, and the nutrient and sediment load reduction from planned management strategies.

The calculations and modeling procedures described in this guidance document need only be performed for the individual urban stormwater locality developing the implementation plan. If a local jurisdiction intends to estimate their specific permit area contribution to an aggregate SW-WLA, MDE's Stormwater Toolkit methodology should be applied, which is described on MDE's TMDL Data Center at:

<http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/TMDLStormwaterToolkit.aspx>.

For example, for a Phase I MS4 county developing an SW-WLA implementation plan, the baseline loading, load reduction, etc. calculations described in the following sections need only be performed for the developed land-use/urban stormwater loads specifically associated with the Phase I County MS4. Loads associated with Phase II MS4 municipalities, industrial facilities regulated by NPDES stormwater permits, state Phase II MS4s, and federal Phase II MS4s do not need to be included. If a local jurisdiction is applying the recommended percent reduction methodology for calculating their target load, it is not necessary to apply MDE's stormwater toolkit to break out any aggregate TMDL SW-WLAs. It should be noted, however, that when estimating the load for the baseline conditions of the TMDL, and subsequently applying the reduction percentage to get the target, local jurisdictions need only estimate the loading associated with the developed land covered under their individual permit.

II. Source Identification

Identify the specific sources of nutrients and sediments and determine the baseline load. This assumes local jurisdictions are operating in the context of their own modeling systems, so specific calculations are not spelled out here. If local jurisdictions are using MAST, Appendix A outlines specific details for using MAST to develop the SW-WLA implementation plan scenarios. The following describe the general steps local jurisdictions should take when estimating their baseline loads:

- 1) Determine the baseline year for the applicable TMDL. This represents the year from which nutrient/sediment loading reductions were calculated to meet the TMDL loading caps. Baseline year information is provided for local jurisdictions in the WLA search function of MDE's TMDL Data Center: <http://wlat.mde.state.md.us/WLASEarch.aspx>.
- 2) Calculate the nutrient and sediment sources and loadings for the baseline year.
 - a) Land-Use
 - i) Determine the land-use conditions for the baseline year. As per MDE-SSA's general guidance (MDE 2014a), many local jurisdictions have high resolution land-use/land-cover data. MDE encourages local jurisdictions use this high resolution data to

estimate their baseline nutrient and sediment loads. If using MAST or BayFAST to model nutrient and sediment loads, local jurisdictions may have to modify their data for compatibility purposes (i.e., aggregating different types of impervious cover for input into CBP modeling tools, which only simulate two developed land-use/land-cover classifications: impervious and pervious). Since most nutrient and sediment TMDLs in Maryland have been developed using the CBP Phase 5.3.2 watershed model, or an earlier iteration of the watershed model, if high resolution local data is not available, MDE recommends using MAST or BayFAST, in order to provide relative consistency with the original TMDL in terms of model land-use. BayFAST not only uses CBP Phase 5.3.2 watershed model land-use classifications, but it also allows the user to define the land-use acres in a TMDL watershed. This means that a local jurisdiction can conduct its land-use assessment using its own high resolution data outside of BayFAST, then translate/aggregate land-use acres to CBP watershed model land-use classifications and insert these acres into BayFAST to conduct its loading assessment. See Appendices A and B for further details. Nutrient and sediment TMDLs in Maryland have also been developed with a variety of other land-use datasets, including Maryland Department of Planning (MDP) land-use/land-cover data and the United States Geological Survey (USGS) National Land-Cover Dataset (NLCD) series.

b) Baseline Loading Rates

- i) Determine the loading rates for the land-use classifications to be simulated. Similar to land-use data, and as per MDE-SSA's general guidance (MDE 2014a), many local jurisdictions have calculated spatially unique and highly accurate loading rates based on local water quality monitoring data. Local jurisdictions are encouraged to use locally derived loading rates, as long as they are considered by MDE to be scientifically defensible.
- ii) If locally derived loading rates are not available, or if a local jurisdiction chooses not to apply these rates, MDE encourages local jurisdictions to use baseline loading rates consistent with the rates applied in TMDL development.
- iii) As described previously, many local nutrient and sediment TMDLs in Maryland were developed using the CBP Phase 5.3.2 watershed model, or an earlier iteration of the watershed model. Modeling tools such as MAST and BayFAST use CBP watershed model loading rates, thereby providing relative consistency in term of model loading rates with many nutrient and sediment TMDLs in Maryland.
 - (1) CBP P5.3.2 watershed model post calibration land-use loading rates can be back-calculated from watershed model edge-of-stream (EOS) loading outputs. EOS loads are the loads that enter a modeled river reach (in general, streams > 100 cfs). These loading rates vary among individual watersheds due to the nature of model calibration. To easily calculate these rates for a given watershed, use the EOS loads and acres from MAST for an individual scenario.
 - (2) MDE and CBP have an extensive database of Event Mean Concentrations (EMCs) based on monitoring data collected from local jurisdictions. The urban impervious and pervious loading rates in the CBP Phase 5.3.2 watershed model were constrained based on the EMCs in this database. For ease of implementation and to provide consistency between the TMDL SW-WLA and the implementation plan, some local jurisdictions may want to apply CBP loading rates. Use of CBP

loading rates also makes tracking progress easier. If a local jurisdiction decides to use CBP loading rates to develop its implementation plan for nutrients and sediments, MDE encourages the use of MAST or BayFAST.

- c) Best Management Practices (BMP) Inventory
 - i) Determine the management practices for reducing nutrient and sediment loads that were in place (i.e., on the ground) during the TMDL's baseline conditions/year. When estimating the nutrient and sediment load reductions from these management strategies, MDE recommends that CBP approved BMP reduction efficiencies be used. These reduction efficiencies have been established via an extensive peer review process and are outlined in (MAST 2014).

III. Current Load assessment

Determine the current nutrient and sediment load. Taking into consideration the same inputs (land-use, loading rates, and BMP inventory) described in the "Source Identification" section (baseline loading assessment), estimate the current nutrient and sediment loading. Compare the current loading to the baseline loading and calculate the load reduction and reduction percentage achieved.

IV. Target Load

Translate the TMDL SW-WLA to a local implementation model target load. As per MDE-SSA's general guidance (MDE 2014a), since local implementation modeling will likely result in a different baseline loading assessment than that of the TMDL, in order to set a target load in terms of the local implementation modeling efforts, multiply the TMDL SW-WLA required reduction percentage by the locally modeled baseline load to estimate the target load.

V. Load Reduction

Once the following have been completed, local jurisdictions should begin to identify, prioritize, and select management strategies that they intend to implement to achieve the required nutrient and sediment load reductions: 1) nutrient/sediment loads consistent with TMDL baseline year have been estimated, 2) the applicable target load consistent with the SW-WLA reduction percentage in the TMDL has been calculated, and 3) current nutrient/sediment loads have been assessed. The SW-WLA implementation plan should identify the planned management strategies for reducing nutrient and sediment loads and include a schedule of when these sets of actions will be implemented. The overall, estimated load reduction from the planned set of management actions should be compared to the calculated target load, and a process for evaluating progress for achieving the targets should be described (see MDE 2014a).

MDE recommends taking into consideration the following when selecting management practices to meet SW-WLA targets. First, MDE-WMA's guidance document (MDE 2014c) details the full suite of CBP approved BMPs and their expected nutrient and sediment reductions. Additionally, local jurisdictions should consider relative differences between geographic locations when selecting where to place BMPs. For instance, in relation to meeting Chesapeake Bay TMDL targets, certain areas have higher delivery rates to the bay. Therefore, by placing management practices in these areas, local jurisdictions can maximize load reduction efficiency. MDE created a series of relative effectiveness maps, which indicate what zones and model

segments have a greater relative effectiveness for reducing loads to the Chesapeake Bay. These maps are located at:

<http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/MASTInformation.aspx>. In many instances, planned BMPs can also be credited toward meeting both local TMDL and Chesapeake Bay TMDL allocations (see Appendix C for further details).

MAST also includes BMP cost information for local jurisdictions to utilize in assessing the cost effectiveness of various strategies. Local jurisdictions should strive to select practices that achieve the greatest load reduction at the least cost. Since cost information varies spatially within Maryland and temporally, MAST allows user to edit BMP cost information. Lastly, in terms of location, another item to consider that the MAST cost profiles do not necessarily include is the rising cost of placing certain practices in high density developed areas. In some instance, it is not practical to place BMPs in areas where there is simply no space to do so.

- 1) Calculate the nutrient and sediment load reduction from planned management strategies and BMPs
 - a) Describe the specific set of BMPs and management actions that will be implemented to achieve the required SW-WLAs. For nutrients and sediments, some broad options for doing this include a) developing new strategies; or b) refining the Phase I and II Watershed Implementation Plan (WIP) strategy. Whether developing new strategies or refining WIP strategies, these strategies must demonstrate that the targets will be achieved¹. The management strategies submitted by local jurisdictions to MDE during the Phase II WIP process, in addition to MDE's strategies, which were submitted to CBP for assessment in the watershed model, can be found at: <http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/WIPPhaseIICountyStrategySummaries.aspx>.
 - b) CBP approved BMP reduction efficiencies should be used to estimate nutrient and sediment load reductions. These reduction efficiencies have been established via a peer review process and are outlined in (MAST 2014). Local jurisdictions may apply other efficiencies that are scientifically defensible; however, to receive credit toward Bay restoration, these practices would eventually need to be approved by the CBP.
 - c) Since local nutrient and sediment TMDLs are at a smaller scale than county WIP strategies, instead of developing new strategies, local jurisdictions could develop consolidated SW-WLA implementation plans and partition BMPs and management actions from the larger scale WIP down to the individual SW-WLA watersheds (see Appendix C for further details).
 - d) If alternative reduction methods, such as upgrading septic systems to meet SW-WLA reductions, are being considered, the jurisdiction should provide a detailed estimate of how the reductions are calculated and apportioned between sectors.
 - d) Identify hot spots and estimate load reductions from remediation
 - i) Nutrient "hot spots" can be large loading contributors to nitrogen and phosphorus impaired waters. Identification and remediation of these hot spots could provide local jurisdiction with highly efficient loading reductions.
 - ii) Identification of hot spots

¹ If achieving targets is deemed to be technically infeasible via traditional stormwater controls, the jurisdictions are encouraged to offer alternative options to MDE for consideration. Local jurisdictions should describe the pros and cons of these alternatives.

- (1) Studies have identified specific development types as having elevated nutrient loads, relative to other developed lands. For nutrients and sediments, these include car washes, restaurants, outdoor loading and storage areas, waste management areas (i.e., dumpsters), marinas, and several others (CWP 2013 and CWP 2005).
- (2) High traffic locations where cars also tend to idle for extended periods of time tend to have higher nutrient EMCs in site runoff and consequently higher nutrient loadings, i.e., fast food restaurants, gas stations, etc.
- (3) Monitoring can be used to identify areas with elevated nutrient inputs. For instance, simple in-stream bracketing studies, using field equipment to measure DO and nitrogen/phosphorus concentrations, while moving upstream in a small subwatershed, can locate elevated inputs.
 - (a) In developed watersheds, these sources of elevated nutrient inputs often include failing infrastructure (i.e., leaking sanitary sewer system pipes), failing septic systems, illicit discharges, etc. Studies in Northern Virginia were able to attribute high nutrient inputs in a small subwatershed to a singular failing septic system (Jastram 2014).
 - (b) MDE routinely performs “synoptic surveys” in Clean Water Act Section 319 funded watersheds to identify potential hot spots. The goal of the surveys is to take simple, in field measurements of nutrient concentrations at as many locations in the watershed as possible on a several different dates. The results often indicate that certain subwatersheds continually have elevated concentrations, relative to the rest of the subwatersheds, which in turn has allowed MDE to identify individual sources of nutrients within the subwatersheds and work with the landowners to remediate the sources (MDE 2014d).
- iii) Load reduction from the remediation of hot spots
 - (1) Using monitoring data, local jurisdictions can determine the current loading from hot spots.
 - (2) Remedial activities to mitigate elevated inputs from hot spots should be put in place, and subsequently, loading reductions estimated and accounted for
 - (a) See CWP 2013 and CWP 2005 for examples of potential remediation
 - i) Include provisions to assessing the effectiveness of the remediation
 - (1) The jurisdiction should conduct follow-up monitoring to confirm that the estimated load reductions from remediating the hot spot were achieved.
- 2) Schedule
 - a) For the Chesapeake Bay nutrient and sediment TMDLs, indicate the anticipated progress for each two year milestone, the 2017 interim target, and the 2025 final targets. The two year milestones can be found under the “Goals and Progress” heading at: http://www.mde.state.md.us/programs/Water/TMDL/ChesapeakeBayTMDL/Pages/programs/waterprograms/tmdl/cb_tmdl/index.aspx#. The 2017 and 2025 targets are available on the TMDL Data Center via the WLA search function.
- 3) New Development
 - a) New urban areas that have been developed since TMDL allocations were set imply nutrient and sediment sources beyond the original SW-WLA (i.e., any loads from new urban areas outside of the urban footprint used in the TMDL). This can confound the

process of accounting for load reductions to meet the allocations. MDE is working to develop methods to address this issue. However, MDE is also recommending that within the SW-WLA implementation plans, local jurisdictions estimate this additional nutrient and sediment load apart from their load reduction calculation. If the jurisdiction has information on the pre-development condition land cover, this would be valuable to include or note as available.

References

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Appendix A: Using MAST to Develop a SW-WLA Implementation Plan

Introduction

This appendix provides Maryland's local jurisdictions with recommendations on how to use MAST to develop SW-WLA implementation plans for local nutrient and sediment TMDLs. MAST is one option/tool available for local jurisdictions to use when developing SW-WLA implementation plans. For permitted Phase I MS4 jurisdictions, SW-WLA implementation must be addressed as part of their permit required restoration plans. Although the intent of this appendix focuses on the use of MAST by Phase I MS4s for developing SW-WLA implementation plans, most of the technical recommendations outlined here could also be applied in creating implementation plans for SW-WLAs and urban LAs assigned to other regulated stormwater dischargers and non-MS4 jurisdictions.

This appendix describes the MDE's recommended approach for using MAST to create SW-WLA implementation plans. It is important to emphasize that both the use of MAST and the methodology described herein are recommendations. Local jurisdictions may use other technically sound and acceptable models and approaches to develop SW-WLA implementation plans to best address their needs.

MAST is a web-based nutrient and sediment load estimator tool that is consistent with CBP's modeling framework. It was created to streamline and facilitate the development of TMDL watershed management plans. The tool is used for building management scenarios, as well as providing initial estimates of nitrogen, phosphorus, and sediment load reductions from user specified implementation practices. General information about how MAST works and what it can do are further described in the "Help" section of the website. The web address for the tool is: <http://mastonline.org/>.

The following steps describe one potential method for using MAST to develop implementation strategies for achieving local nutrient and sediment TMDL SW-WLAs.

I. Translating a TMDL target loads into a MAST-compatible target load

Because all of Maryland's approved local nutrient and sediment TMDLs were developed using watershed models other than MAST, the baseline and target loads from these TMDLs need to be translated into MAST loadings. This adjustment is required to account for potential differences between models. This is a two step process that involves 1) creating a MAST scenario that models the nutrient or sediment loadings for the baseline year of the TMDL, and 2) applying the load reduction percentage from the TMDL to the MAST loading for the baseline year.

Before creating any new MAST scenarios, local jurisdictions need to gather necessary background information and perform calculations outside of MAST in order to accurately estimate nutrient and sediment load reductions. This background information can be gathered from MDE's TMDL Data Center website (<http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/index.aspx>) (MDE 2014b) or from the applicable TMDL reports and documentation. The following bullets describe the specific steps that local MS4s need to take before taking any action in MAST:

- **Determine if the applicable TMDL was written at an Maryland 8-Digit (MD 8-Digit), or similar, watershed scale:** If the TMDL was written at a different scale, another tool, such as BayFAST, might be more appropriate for developing the SW-WLA implementation plan
- **Find the Baseline Year:** Determine the year associated with the baseline load estimate for the applicable TMDL
 - a) The WLA query function on MDE’s TMDL Data Center website includes information on the year(s) associated with the baseline conditions for individual TMDLs/WLAs.
- **Find the load reduction required to meet the SW-WLA:** Determine the SW-WLA reduction percentage from the baseline load estimate specific to the applicable MS4
 - a) The required reduction percentage can be gathered from the WLA query tool on MDE’s TMDL Data Center webpage, or the TMDL documentation itself. If this reduction percentage is not directly specified in the TMDL documentation, or MDE’s TMDL Data Center, there is likely a complication with determining an exact baseline load for a particular source/jurisdiction. If this is the case, contact MDE (see TMDL Data Center website contact information). Once the baseline load and required reduction percentage have been determined, MAST scenarios can be created to estimate nutrient and sediment load reductions for expected management actions.
- **Calculate the SW-WLA target in terms of MAST loadings**
 - a) Navigate to MAST online, and once logged in, do the following:
 - i) Under the *Scenarios* menu, select *Compare Scenarios* (see Figure 1)
 - ii) For the *Geographic Scale*, select the *HUC 8 with County Split* scale (see Figure 2)
 - iii) For the *Geographic Area*, select your watershed-county (*HUC 8-County*) unique combination (see Figure 2)
 - iv) For *Scenario 1*, select the scenario that corresponds to the applicable TMDL’s baseline year (see Figure 2)
 - (1) For example, if the applicable TMDL’s baseline load year is 2005, select the *2005 Local TMDL Base*. All of the 2000 – 2008 scenarios that have been added to MAST, so that local jurisdictions could apply them in developing implementation plans for local TMDLs, have the suffix “Local TMDL Base”.
 - v) For *Scenario 2* and *Scenario 3*, select any other scenario of interest (any scenario can be selected here since it will have no effect on the final result, but a scenario must be chosen for Scenarios 2 and 3) (see Figure 2).
 - vi) Check “Compare to allocations”. Checking that option allows you to compare to the 2025 WIP load. Since those WIP allocations did not differentiate between pervious and impervious, you will not be able to see the urban loads for your baseline year as separate loadings for pervious and impervious land uses (see Figure 2).
 - vii) For *Load Type*, select *Landuse*, then click on the *Compare* button (see Figure 2)
 - viii) A new page will appear presenting loading results for the selected scenarios. Find the urban sector loads and expand the results of the loadings for the applicable SW-WLA pollutant (nitrogen, phosphorus, or sediments) (see Figure 3)

- ix) Next, find and record the individual urban sector edge-of-stream (EOS) loads (e.g., County Phase I/II MS4²) for the baseline year scenario (see Figure 3).
 - (1) Some MAST scenarios identify non-regulated urban acres in Phase I MS4 jurisdictions. These scenarios are incorrect. These non-regulated urban acres should be considered regulated, and they should be associated with the county Phase I MS4 permit. Therefore, any non-regulated urban loads within in a Phase I MS4 county in a MAST scenario should be added to the county’s Phase I MS4 load.
- b) Once the individual urban sector loads have been recorded or downloaded from this page using the download link button under each table, perform the following calculations outside of MAST:
 - i) Apply the reduction percentage from the previous section (Step I.(3)(a)(i)) to the summed impervious/pervious loads to calculate the SW-WLA target load from MAST
 - (1) This is the target that must be achieved by the MAST BMP strategy scenario. This target will differ from the SW-WLA in the TMDL documentation or on the TMDL Data Center website.

II. Developing Implementation Scenarios

The previous series of steps enabled local jurisdictions to determine their SW-WLA target in terms of MAST loadings. This allows jurisdictions to create BMP strategy scenarios that can be compared to an applicable target, in order to assess SW-WLA achievement. The next series of steps describes how to develop the actual BMP strategy scenario in MAST.

- **Develop SW-WLA BMP implementation strategy scenario**
 - a) Under the *Scenarios* menu, select *Add Scenario* (see Figure 4)
 - b) Name the new scenario (*Scenario Name**) and add a description for the new scenario (*Description**) (see Figure 5)
 - i) For example, “Cabin John Creek Sediments SW-WLA BMP Scenario 1” and “Planned management strategies and BMPs for achieving the Cabin John Creek sediment TMDL SW-WLA”
 - c) In the *Share this scenario with* box, select what other users you want to be able to view your scenario (Does not matter for analysis) (see Figure 5)
 - d) For the *Geographic Scale* and *Geographic Area* options, select the same scale and area as was done previously when determining the MAST target (see Figure 5)
 - e) For *Initial Conditions Year*, select the most appropriate watershed model, progress scenario year (credits any restoration that has taken place since the baseline year of the TMDL). This might be the most up-to-date progress year, but it could be the year when the MS4 permit was issued. This will provide the best estimate of current BMP implementation in the TMDL watershed. Ignore the statement in MAST that says “Use

² For the 2010 and 2011 scenarios in MAST, there are non-regulated urban impervious and pervious land-use acres in MS4 counties. This is not correct based on current MDE SW-WLA methods, and this was corrected in the 2013 and 2014 scenarios. If using the 2010 and 2011 scenarios in MAST to develop an SW-WLA implementation plan, local Phase I MS4 jurisdictions should account for this non-regulated urban land.

2010 for all WIP scenarios. Use same year as your scenario for Milestone or Progress scenarios”. The baseline year for the Phase II WIP and Chesapeake Bay TMDLs is 2009. MAST was originally developed as a tool for local jurisdictions to use to create their Phase II WIP scenarios. The referenced notation was added to MAST to inform the local jurisdictions what initial conditions should to use when developing their Phase II WIP scenarios. Thus, this is only applicable to scenarios being developed for the Bay TMDLs/WIPs (see Figure 5).

- i) For example, if a local jurisdiction were putting together their scenario/implementation plan in 2013, and the watershed model 2013 progress scenario was available and has been input into MAST, select “2013”
- f) For *Processed Water Base Data* and *Combined Sewer Overflow Connections*, select “Cap Loads” and “2025 WIP”, respectively, since these represent known implementation levels for these sectors (see Figure 5)
- g) The next option allows the user to select between using either *Chesapeake Bay Program approved BMPs only* or *All BMPs, including Maryland specific*. Select *All BMPs, including Maryland specific*, since this allows the user to input BMPs that the jurisdiction may intend to implement, and should be credited for relative to meeting local TMDL SW-WLAs, but the Chesapeake Bay Program has not approved yet, and for which credit cannot be given relative to meeting the Chesapeake Bay TMDLs (see Figure 5).
- h) In the *Copy BMP data from another scenario*, select *choose one scenario for all source sectors*. Then, a drop down menu titled *All BMPs* will appear. Select the progress scenario from the drop down list that corresponds to the year selected for the *Initial Conditions Year*, then click the *Add* button (see Figure 5)
 - i) For example, if you set your *Initial Conditions Year* to “2013”, in the *All BMPs* drop down list, select “2013 Progress”
- i) A new screen will then appear which will display the current BMP implementation levels in the watershed. At this point, the user should begin to edit/add to the BMP implementation levels as desired (see Figure 6)
- j) When BMPs are at desired level, select *Calculate Summary* from the top menu. This will provide the user with a summary of loads associated with the new BMP scenario (see Figure 7).
- k) Under the Calculate Summary menu, the user may select the Download Files option to download the BMPs and/or the loads estimated.
- l) Outside of MAST, the user should now record the results of the pollutant load summary and compare the results to the MAST SW-WLA target that was calculated in Step I.(4)(b)(ii). This will require summing up the pervious and impervious urban land uses.
- m) If the MAST SW-WLA target is not met, iteratively go back and refine the BMP implementation levels until the target is achieved

MAST Updates

Appendix A of MDE’s guidance document, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* identifies MAST as one of several models that can be used to develop implementation plans for meeting SW-WLAs. It is available online for all users at no cost, is based off CBP’s modeling framework, and has already been used for this purpose. Jurisdictions in Maryland used MAST to create scenarios that were used to inform its watershed implementation plan (WIP) for the meeting Chesapeake Bay TMDLs.

Local jurisdictions that use MAST to develop SW-WLA plans should keep in mind that MAST is continually updated to reflect CBP modeling protocol and procedures. These changes will reflect a better understanding of environmental nutrient and sediment dynamics; however any jurisdictions that choose to use this model may need to revise targets and scenarios with these ongoing refinements. For example, following the adoption of the Phase 6 Chesapeake Bay Watershed Model, MAST will be significantly updated. This will probably occur in 2017 or 2018, and pollution targets and implementation plans that were developed using previous versions of MAST should be revisited at this time to determine if changes are needed. A record of all changes to MAST is recorded under the Upgrade History link in the footer of every page on MAST.

Figures

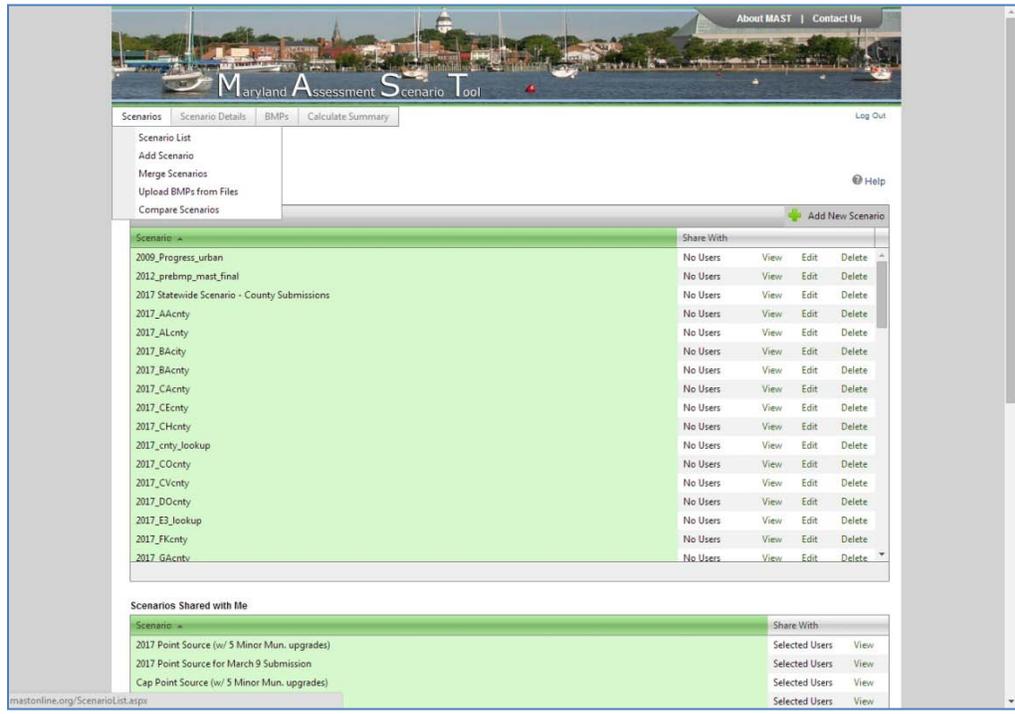


Figure 1: Compare Scenarios

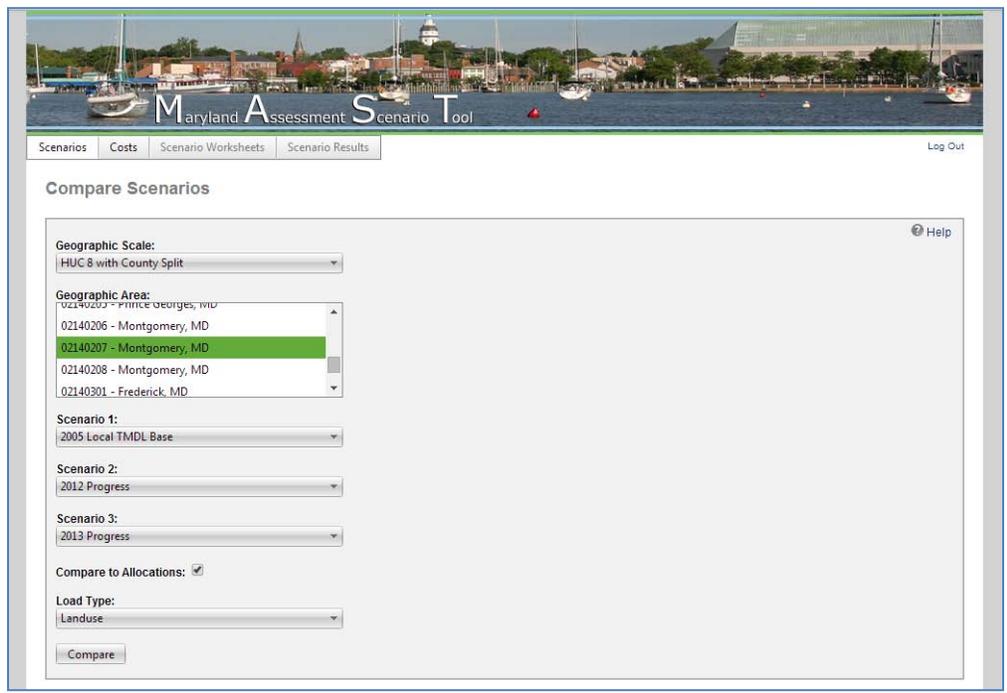


Figure 2: Selecting Parameters for Compare Scenarios

Nitrogen Landuse Loads (lbs)								
Landuse	2005 Local TMDL Base (Edge of Stream)	2012 Progress (Edge of Stream)	2013 Progress (Edge of Stream)	Allocation (Edge of Stream)	2005 Local TMDL Base (Delivered)	2012 Progress (Delivered)	2013 Progress (Delivered)	Allocation (Delivered)
> Sector: Agriculture	355.4	242.6	246.7	282.2	139.9	95.5	97.1	111.1
> Sector: Forest	18,601.5	17,682.3	18,081.9	17,617.4	7,320.8	6,959.0	7,116.3	6,933.5
✓ Sector: Urban								
Combined Sewer Systems Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	15,699.7	19,355.3	14,194.0	20,278.0	6,178.8	7,617.5	5,586.2	7,980.6
County Phase I/II MS4	200,774.4	185,349.8	182,403.9	172,253.0	79,016.8	72,946.3	71,786.9	67,791.9
Extractive	701.2	619.6	619.6	557.2	276.0	243.8	243.8	219.3
Federal Developed	36.1	30.8	32.0	29.1	14.2	12.1	12.6	11.5
Municipal Phase II MS4	50,636.6	38,778.8	40,777.0	36,168.0	19,928.5	15,261.8	16,048.2	14,234.3
Non-regulated	0.0	0.0	0.0	111.2	0.0	0.0	0.0	43.8
Regulated Industrial Facilities	385.5	304.2	279.2	282.7	151.7	119.7	109.9	111.3
SHA Phase I/II MS4	20,853.9	15,807.8	13,846.6	14,699.0	8,207.3	6,221.3	5,449.5	5,784.9
State Phase II MS4	486.7	411.4	395.1	385.7	191.5	161.9	155.5	151.8
	289,574.0	260,657.8	252,547.4	244,763.9	113,964.7	102,584.5	99,392.6	96,329.3
> Sector: Water								
	139.4	102.4	102.4	102.4	54.9	40.3	40.3	40.3
Total Lbs:	308,670.2	278,685.1	270,978.3	262,765.9	121,480.3	109,679.3	106,646.2	103,414.2

Figure 3: Finding Applicable loads in Compare Scenarios Function

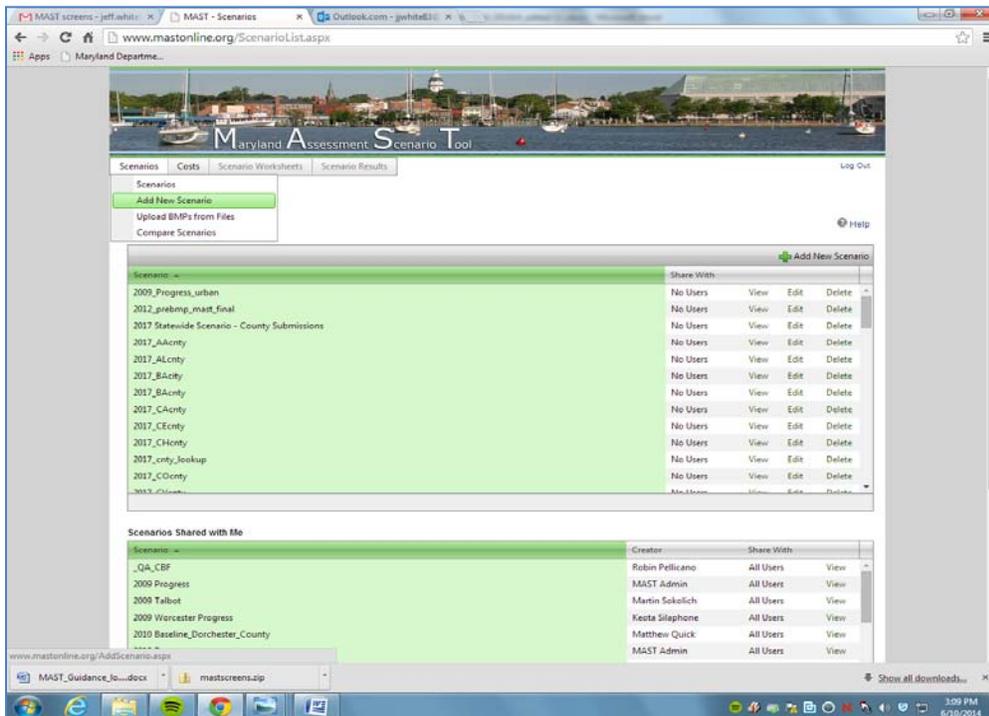


Figure 4: Select Add a New Scenario

Scenario Name*: Cabin John Creek Sediments SW-WLA BMP Scenario 1

Description*: Planned management strategies and BMPs for achieving the Cabin John Creek Sediment TMDL SW-WLA

Initial Conditions Year*: 2013

Processed Water Base Data*: Cap Loads

Combined Sewer Overflow (CSO) Connections*: 2025 WIP2

Cost Profile*: Maryland Default Costs

Geographic Scale*: HUC 8 with County Split

Geographic Area*: 02140203 - Montgomery, MD
02140205 - Prince Georges, MD
02140206 - Montgomery, MD
02140207 - Montgomery, MD
02140208 - Montanmer, MD

Share this scenario with: No Users All Users Selected Users

Initial Conditions Year*: 2013
(Use 2010 for all WIP scenarios. Use same year as your scenario for Milestone or Progress scenarios.)

Chesapeake Bay Program approved BMPs only:
All BMPs, including Maryland specific:

Copy BMP data from another scenario: Choose one scenario for all source sectors
 Choose different scenarios for source sectors

All BMPs: -- Please Select a Scenario to Copy --

Buttons: Add, Cancel, Merge

Figure 5: Select Parameters for New Scenario

Urban Land BMP Worksheet

Select the BMP you would like to add: - Please Select a BMP -

Select the land use or land use group you would like to apply the BMP to: - Please Select a Land Use or Land Use Group -

Select the geographic scale you would like to use to determine the area for the BMP: - Please Select a Geographic Scale -

Specify which geographic area you would like the BMP applied to:

Enter an amount and select a unit for the BMP:

Notes:

Buttons: Add, Cancel

Urban Land Pre-BMP Acres

Landuse	Non-Federal	Federal
County Phase I/II MS4 Impervious	2,398.3	0.0
County Phase I/II MS4 Pervious	8,355.2	0.0
CSS construction	0.0	0.0
CSS extractive	0.0	0.0
CSS impervious developed	0.0	0.0
CSS pervious developed	0.0	0.0
Federal Impervious	0.0	0.3
Federal Pervious	0.0	1.4
Municipal Phase II MS4 Impervious	894.4	0.0
Municipal Phase II MS4 Pervious	1,216.8	0.0
nonregulated extractive	0.0	0.0
nonregulated impervious developed	0.0	0.0
nonregulated pervious developed	0.0	0.0
regulated construction	311.4	0.0
regulated extractive	20.5	0.0
Regulated Industrial Facility Impervious	5.8	0.0
Regulated Industrial Facility Pervious	9.0	0.0
SHA Phase I/II MS4 Impervious	325.7	0.0
SHA Phase I/II MS4 Pervious	372.4	0.0
State Phase II MS4 Impervious	4.0	0.0
State Phase II MS4 Pervious	20.2	0.0
Total:	13,933.7	1.7

BMP Data Submitted

Buttons: Edit Records, Delete Selected Records, Download BMPs

BMP	Land Use Group	Geography	Unit	Total Amount	Notes	Annualized Cost Per Unit

No records to display.

Figure 6: Add Desired BMPs to Scenario

Landuse Loads		Info on agreement with the Chesapeake Bay Program's Watershed Model						
Landuse	Pre-BMP Acres	Post-BMP Acres	Lbs Nitrogen Edge of Stream	Lbs Nitrogen Delivered	Lbs Phosphorus Edge of Stream	Lbs Phosphorus Delivered	Lbs Sediment Edge of Stream	Lbs Sediment Delivered
> Sector: Agriculture								
	8.8	8.8	303.4	119.5	32.8	15.4	17,456.3	11,309.8
> Sector: Forest								
	2,470.7	2,470.7	14,791.0	5,821.2	294.9	138.4	445,665.1	288,743.5
▼ Sector: Urban								
County Phase I/II MS4 Impervious	2,398.3	2,398.3	44,773.5	17,621.1	4,223.8	1,981.5	3,376,671.0	2,187,722.5
County Phase I/II MS4 Pervious	8,355.2	8,355.2	145,631.3	57,314.7	3,556.1	1,668.3	2,968,527.8	1,923,289.3
CSS construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CSS extractive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CSS impervious developed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CSS pervious developed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal Impervious	0.3	0.3	9.8	3.9	1.0	0.5	792.7	513.6
Federal Pervious	1.4	1.4	28.0	11.0	0.6	0.3	510.1	330.5
Municipal Phase II MS4 Impervious	894.4	894.4	25,676.1	10,105.1	2,517.5	1,181.0	2,073,136.9	1,343,171.5
Municipal Phase II MS4 Pervious	1,216.8	1,216.8	21,208.0	8,346.6	517.9	242.9	432,300.8	280,084.8
nonregulated extractive	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nonregulated impervious developed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nonregulated pervious developed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
regulated construction	311.4	311.4	18,363.3	7,227.1	3,232.3	1,516.4	3,927,630.8	2,544,685.8
regulated extractive	20.5	20.5	619.6	243.8	108.7	51.0	116,049.0	75,187.4
Regulated Industrial Facility Impervious	5.8	5.8	165.2	65.0	16.2	7.6	13,336.6	8,640.7
Regulated Industrial Facility Pervious	9.0	9.0	157.4	62.0	3.8	1.8	3,209.0	2,079.1
SHA Phase I/II MS4 Impervious	325.7	325.7	9,348.3	3,679.1	916.6	430.0	754,801.2	489,030.6
SHA Phase I/II MS4 Pervious	372.4	372.4	6,491.7	2,554.9	158.5	74.4	132,326.2	85,733.2
State Phase II MS4 Impervious	4.0	4.0	116.0	45.7	11.4	5.3	9,368.5	6,069.8
State Phase II MS4 Pervious	20.2	20.2	352.9	138.9	8.6	4.0	7,194.3	4,661.1
	13,935.4	13,935.4	272,941.1	107,418.9	15,273.0	7,165.0	13,815,854.9	8,951,199.9
> Sector: Water								
	10.9	10.9	102.4	40.3	6.5	3.0	0.0	0.0
Total:	16,425.8	16,425.8	288,137.9	113,399.9	15,607.2	7,321.8	14,278,976.3	9,251,253.2

Figure 7: Finding Applicable loads in New Scenario

Appendix B: Using BayFAST to Develop a SW-WLA Implementation Plan

Introduction

Appendix A of MDE's guidance document, *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE 2014c), identifies BayFAST as one of several models that can be used to develop implementation plans for meeting SW-WLAs. It is available online for all users at no cost and is based off CBP's modeling framework. This appendix provides Maryland's local jurisdictions with recommendations on how to use BayFAST to develop SW-WLA implementation plans for local nutrient and sediment TMDLs. For permitted Phase I MS4 jurisdictions, SW-WLA implementation must be addressed as part of their permit required restoration plans. Although the intent of this document focuses on the use of BayFAST by Phase I MS4s for developing SW-WLA implementation plans, most of the technical recommendations outlined here could also be applied in creating implementation plans for SW-WLAs and urban LAs assigned to other regulated stormwater dischargers and non-MS4 jurisdictions. It is important to emphasize that both the use of BayFAST and the methodology described herein are recommendations. Local jurisdictions may use other technically sound and acceptable models and approaches to develop SW-WLA implementation plans to best address their needs.

BayFAST is a web-based nutrient and sediment load estimator tool that is consistent with the CBP's modeling framework. It was initially created to streamline and facilitate the development of TMDL management plans for federal facilities. The tool is used for building management scenarios, as well as providing initial estimates of nitrogen, phosphorus, and sediment load reductions from user specified implementation practices. General information about how BayFAST works and what it can do are further described in the "Help" section of the website. The web address for the tool is: <http://www.bayfast.org/>.

BayFAST is similar to MAST, in that it calculates nutrient and sediment loads using CBP modeling framework loading rates, approved BMPs, BMP reduction efficiencies, and BMP sequencing. However, BayFAST allows users to change model inputs, i.e., land-use, and it is not scale dependant. There are inputs in the tool related to "facility" information. For the purposes of local jurisdictions, the "facility" in BayFAST correlates to the applicable TMDL watershed.

Although BayFAST was developed for the federal facilities to use, it is a versatile tool that also has applications for local jurisdictions, especially in small, sub MD 8-Digit TMDL watersheds. In order to use BayFAST to its full potential, a local jurisdiction should have an accurate accounting of land-use conditions and BMP implementation through time, i.e., when certain structures were built, practices were implemented, and land was developed, within the locality. If a local jurisdiction does not have the data needed to provide this accurate accounting, it might be more applicable to use another model, such as MAST. BayFAST does not include any of the official CBP scenarios (BMPs and land-use) for local jurisdictions to build off or run comparisons with.

If a local jurisdiction has the data to provide an accurate accounting of BMP implementation and land-use over time, BayFAST has several key functionalities that make the tool very appealing for localities:

- BayFAST does not have any scale limitations (unlike MAST, where scenarios can only be developed at scales such as the MD 8-Digit watersheds, County, Chesapeake Bay TMDL Segment-Shed, etc.). Therefore, BayFAST is very useful for TMDLs developed at a sub MD 8-Digit scale.
- BayFAST allows users to specify the land-use acres in the watershed. Users digitize their watershed (facility) boundaries and subsequently edit the default land-use acres that are calculated by tool.

I. Translating a TMDL target load into a BayFAST-compatible target load

Because all of Maryland's approved local nutrient and sediment TMDLs were developed using watershed models other than BayFAST, the baseline and target loads from these TMDLs need to be translated into BayFAST loadings. This adjustment is required to account for potential differences between models. This is a two step process that involves 1) creating a BayFAST scenario that models the nutrient or sediment loadings for the baseline year of the TMDL, and 2) applying the load reduction percentage from the TMDL to the BayFAST loading for the baseline year.

Before creating any planning scenarios in BayFAST, local jurisdictions need to gather the necessary background information. Some of this background information (TMDL baseline year and required SW-WLA reduction percentage) can be gathered from MDE's TMDL Data Center website (<http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/index.aspx>) (MDE 2014b) or from the applicable TMDL reports and documentation. For information on how to use the TMDL Data Center to identify SW-WLAs, reductions, baseline years, etc., see the presentation, *TMDL Data Center: A New Resource for Developing SW-WLA Implementation Plans*, located at:

http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Documents/tmdl_data_center_webinar_mde_bkgrnd.pdf. The other information should come from the local jurisdictions themselves, i.e., land-use and BMP implementation levels. The following bullets describe the specific steps that local MS4s need to take before creating any future, implementation planning scenarios in BayFAST:

- **Find the Baseline Year:** Determine the year associated with the baseline load estimate for the applicable TMDL
 - a) The WLA query function on MDE's TMDL Data Center website includes information on the year(s) associated with the baseline conditions for individual TMDLs/WLAs.
- **Find the load reduction required to meet the SW-WLA:** Determine the SW-WLA reduction percentage from the baseline load estimate specific to the applicable MS4
 - a) The required reduction percentage can be gathered from the WLA query tool on MDE's TMDL Data Center webpage, or the TMDL documentation itself. If this reduction percentage is not directly specified in the TMDL documentation, or MDE's TMDL Data Center, there is likely a complication with determining an exact baseline load for a particular source/jurisdiction. If this is the case, contact MDE (see TMDL Data Center website contact information).
- **Determine the land-use conditions and level of BMP implementation in the watershed using local data**

- a) Using the best available data, estimate the historic land-use acres and level of BMP implementation in the watershed during the TMDL baseline year (no need to account for loads from new development post TMDL baseline year, see the document *General Guidance for Developing a Stormwater Wasteload Allocation Implementation Plan* for further details) (MDE 2014a). Since local MS4s are only concerned with the SW-WLA portion of a TMDL, the locality need only estimate the developed acres in a TMDL watershed. Further, the local jurisdiction should only be concerned with estimating the developed acres associated with their specific MS4. For instance, if a county Phase I MS4 is using BayFAST, they need not include the developed acres associated with other regulated stormwater entities in the TMDL watershed, i.e., permitted industrial facilities, state and federal MS4s, etc.
 - b) BayFAST uses the CBP Phase 5.3.2 watershed model land-use classification scheme. The Phase 5.3.2 watershed model only simulates two developed/urban land-use classifications – urban impervious and urban pervious (turf grass and landscaped areas). Therefore, local jurisdictions need to translate local data into terms of the bay model framework. For instance, if local jurisdictions have land-use/land-cover data that differentiates between impervious surface associated with residential parcels, commercial parcels, industrial parcels, etc., the acres associated with these classifications would need to be summed to provide one total estimate of impervious surfaces (for TMDL baseline year).
- **Create a new facility (watershed) for analysis**
 - a) Navigate to BayFAST online, and once logged in, do the following:
 - i) Select the *Facilities* tab, and once on the *Facilities* page, select *Add New Facility*
 - (1) A pop-up window, *Facility State*, will appear asking the user to select the state the facility is in. Select *Maryland*.
 - (2) Next, a new page will appear with an interactive map, which the user will use to digitize the watershed area.
 - (a) In the top left of the map, click on the box *Click to add a parcel* to begin digitizing the watershed polygon. To complete the watershed polygon, double click. Then, click *Save* (see Figure 1).
 - (i) The watershed boundary does not have to be exact. It only has to be a rough approximation, since the user can edit both the individual and total land-use acres in the next step.
 - (3) A new page will open. Provide a name and description for the facility, *Facility Name** and *Description**, and select whether not the facility will be shared with other users in the *Share this facility with* box. It is possible the local jurisdiction may want to share the facility with *Selected Users*, i.e., MDE. In this case, share the facility with the *MDE_swvla_review* user and notify MDE that the facility has been shared. Once finished, click *Add* (see Figure 2).
 - (4) A new page will open. This page allows the user to specify/adjust the land-use acres at the facility (in the watershed). For MS4 jurisdictions, the only land-use classifications of concern are *regulated impervious developed* and *regulated pervious developed* (for non-MS4s, use the nonregulated classifications). The additional urban land-uses are not needed for the analysis (e.g., extractive, construction, etc.), so the user does not need to adjust these acres. Enter the correct number of impervious and pervious developed acres, as per **Step #3**

above. Click *Save* once done (See Figure 3). The user will then be taken back to the *Facilities* main page. Once the facility has been added, it will be available for scenario analysis. For each watershed/SW-WLA the user is developing an implementation plan for, a new facility/watershed must be created (digitized).

- **Calculate the SW WLA target in terms of BayFAST loadings**

- i) Go to the *Scenarios* tab, and select *Add New Scenario*.
 - (1) A new page will open. Select the facility that was just created (*Facility**). Then, provide a name for the scenario (*Scenario Name**) (Suggested name is “Baseline – TMDL Baseline Year”, i.e., “Baseline – 2000”), provide a description for the scenario (*Description**), select whether or not the scenario will be shared with other users (*Share this scenario with*) (see previous notes about sharing facility with other users), and select a cost profile (*Cost Profile**) (select “Maryland Default Costs”). There will also be an option to copy BMP data from another scenario (*Copy BMP data from another scenario*). The user will not select anything for this option, since the user has not created any previous scenarios, and unlike MAST, there are no CBP model scenarios available in BayFAST to use as a starting point. Finally, click *Add* (See Figure 4).
 - (2) A new page will open. On this page, the user will enter the BMP implementation levels associated with the TMDL baseline year (as determined in step I(1)). To add a BMP and its treatment level, in the *Urban Land BMP* worksheet, select the type of BMP from the first drop down menu (*Select the BMP you would like to add*), then select the land-use the BMP is applied to (i.e., the land-use the BMP is treating) (*Select the BMP you would like to add*), and finally enter the land-use acreage, or the percent of total land-use acres, the BMP is treating (*Enter an amount and select a unit for the BMP*) (See Figure 5).
 - (a) For MS4 jurisdictions, similar to editing the land-use acres, the only land-use classifications that BMPs should be applied to are *regulated impervious developed* and *regulated pervious developed*. The user can also choose to add any applicable notes for a given BMP entry (*Notes*). Once done, click *Add*. The BMP entry will then appear below under *BMP Data Submitted*. Continue to add BMPs associated with the implementation level at the time of the TMDL baseline year.
 - (i) For example, if the TMDL baseline year is 2000, and a local jurisdiction knows that there were five wetponds in the watershed treating 50 impervious acres and 50 acres of turf grass in 2000, then, in the *Urban Land BMP Worksheet*, the user would select *wetponds and wetlands* as the type of BMP, then select *regulated impervious developed* as the land-use to apply the BMP to, and lastly, enter 50 as the number of acres treated. Then, after the BMP record is added, add another entry for *wetponds and wetlands*, but this time, select *regulated pervious developed* as the land-use to apply the BMP to (treatment level still equals 50 acres).
- ii) Once BMP entries are added, they are automatically saved to the scenario. Once all BMP data for the baseline year has been entered, click on the *Scenario Results* tab to view the estimated loads. The only land-use loads of concern are those associated with the *regulated impervious developed* and *regulated pervious developed* land-uses. To view these loads, under the *Land-Use Loads* table, click

the arrow next to the urban sector to expand the results and view the individual urban land-use loads (see Figure 6).

- (1) Find and record the individual urban sector EOS loads (regulated impervious and pervious developed,) for the scenario.
- b) Once the individual urban sector loads have been recorded or downloaded (download link button under each table on the *Scenario Results* page), perform the following calculations outside of BayFAST:
 - i) Apply the reduction percentage from the previous section, Step I(2)(a), to the summation of the regulated impervious and pervious developed loads to calculate the SW-WLA target load from BayFAST
 - (1) This is the target that must be achieved by the BayFAST future, planned BMP scenario. This target will differ from the SW-WLA in the TMDL documentation or on the TMDL Data Center website.

II. Developing Future Implementation Scenarios

The previous series of steps enabled local jurisdictions to determine their SW-WLA target in terms of BayFAST loadings. This allows jurisdictions to create BMP strategy scenarios that can be compared to an applicable target, in order to assess SW-WLA achievement. The next series of steps describes how to develop the future BMP strategy scenario in BayFAST.

• **Develop future SW-WLA BMP implementation strategy scenario**

- a) Under the *Scenarios* menu, select *Add Scenario*
 - i) Select the applicable facility/watershed (*Facility**)
 - ii) Name the new scenario (*Scenario Name**) and add a description for the new scenario (*Description**)
 - (1) For example, “Lower Monocacy River Sediments SW-WLA Future BMP Scenario 1” and “Planned management strategies and BMPs for achieving the Lower Monocacy River sediment TMDL SW-WLA”
 - iii) In the *Share this scenario with* box, select what other users you want to be able to view your scenario. This does not affect the analysis, but local jurisdictions may want to share these scenarios with MDE (user: *MDE_swvla_review* - notify MDE that the scenario has been shared)
 - iv) For the *Cost Profile**, select the *Maryland Default Costs*
 - v) In the *Copy BMP data from another scenario* menu, select *choose one scenario for all source sectors*. Then, a drop down menu titled *All BMPs* will appear. Select the baseline scenario created for the facility/watershed in Step I(4), then click the *Add* button
 - vi) A new page will then appear. This page will display the current BMP implementation levels in the watershed at the bottom. The user should now begin to edit/add to the BMP implementation levels as desired, using the *Urban Land BMP Worksheet*. The user can also delete BMPs copied over from the baseline scenario or increase/decrease the level of treatment (e.g., number of acres), by clicking *Edit Records* in the *BMP Data Submitted* table (See Figure 7).
 - (1) For example, users may want to delete BMP records from the BMP data copied from the baseline scenario if a local jurisdiction planned to retrofit all of its dry detention ponds to wetponds/wetlands. In this the case, the user would want to

delete the BMP record for dry detention ponds from the scenario, then add the *wetponds and wetlands* BMP to the scenario with the same level of treatment as the previous dry detention BMP.

- b) When BMPs are at desired level, select *Scenario Results* from the top menu. This will provide the user with a summary of loads associated with the new BMP scenario.
 - i) Outside of BayFAST, the user can record the results of the pollutant load summary (regulated impervious and pervious developed land-use loads) and compare the results to the BayFAST SW-WLA target that was calculated in Step I(4)(b)(i). This will require summing up the pervious and impervious urban land uses.
 - (1) If the BayFAST SW-WLA target is not met, iteratively go back and refine the BMP implementation levels until the target is achieved.

BayFAST Updates

Local jurisdictions that use BayFAST to develop SW-WLA plans should keep in mind that BayFAST is continually updated to reflect CBP modeling protocol and procedures. These changes will reflect a better understanding of environmental nutrient and sediment dynamics; however any jurisdictions that choose to use this model may need to revise targets and scenarios with these ongoing refinements. For example, following the adoption of the Phase 6 Chesapeake Bay Watershed Model, BayFAST will be significantly updated. This will probably occur in 2017 or 2018, and pollution targets and implementation plans that were developed using previous versions of BayFAST should be revisited at this time to determine if changes are needed. A record of all changes to BayFAST is recorded under the Upgrade History link in the footer of every page on BayFAST.

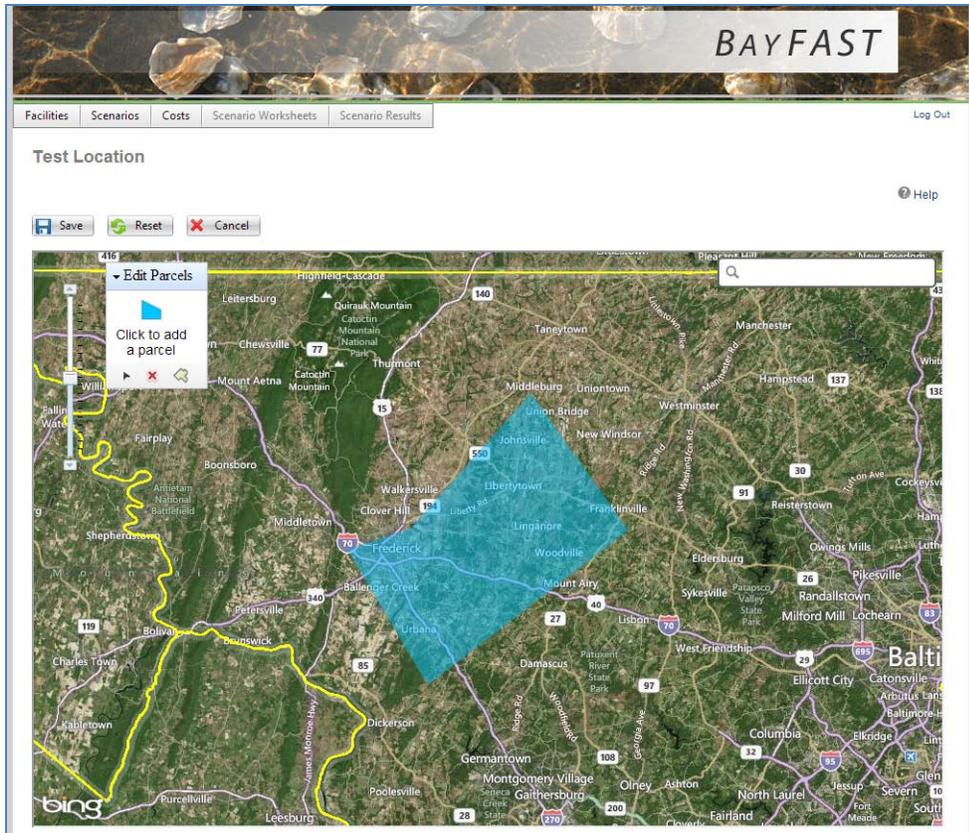


Figure 1: Digitize Watershed

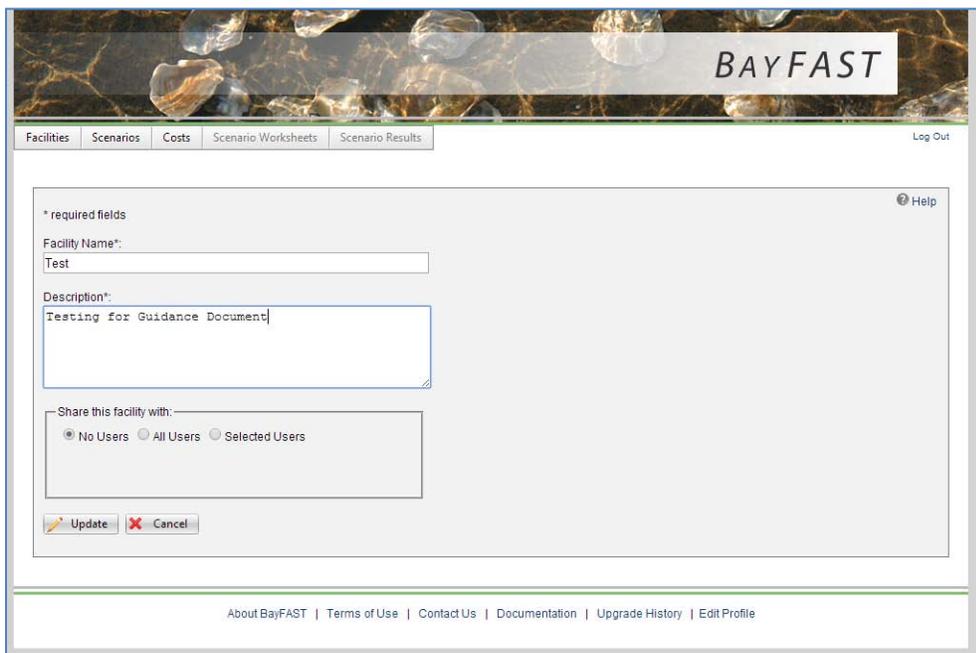


Figure 2: Enter Facility Information

BAYFAST

Facilities | Scenarios | Costs | Scenario Worksheets | Scenario Results | Log Out

Test Initial Conditions

Urban Land Uses

regulated pervious developed	15000.000
nonregulated pervious developed	5000.000
regulated impervious developed	7427.734
nonregulated impervious developed	522.718
regulated construction	967.219
regulated extractive	129.450
nonregulated extractive	288.193
CSS pervious developed	0.000
CSS impervious developed	0.000
CSS construction	0.000
CSS extractive	0.000

Agricultural Land Uses

animal feeding operations	98.713
concentrated animal feeding operations	15.524
hightill with manure	28442.268
hightill without manure	624.147
hay with nutrients	12837.080
hay without nutrients	3384.581
alfalfa	3458.417
pasture	10289.801
degraded riparian pasture	48.801
nursery	103.381

Forest Land Uses

forest	40036.275
harvested forest	404.406

Water Land Use

water	835.093
-------	---------

Total Acres **129913.801**

Download Land Use

Septic Systems

Critical Area	0.000
Within 1000 ft of a perennial stream	6945.451
Other	8425.354

Population on Septic

Total Population on Septic	39118.699
----------------------------	-----------

Save Reset

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Figure 3: Edit Land-Use Inputs for Facility

BAYFAST

Facilities | Scenarios | Costs | Scenario Worksheets | Scenario Results | Log Out

Edit Scenario

* required fields

Facility*: Test

Cost Profile*: Maryland Default Costs

Scenario Name*: Test Baseline Scenario

Description*: Testing baseline scenario for guidance writeup

Share this scenario with:

No Users All Users Selected Users

Next Cancel

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Figure 4: Edit Basic Information for Baseline Scenario

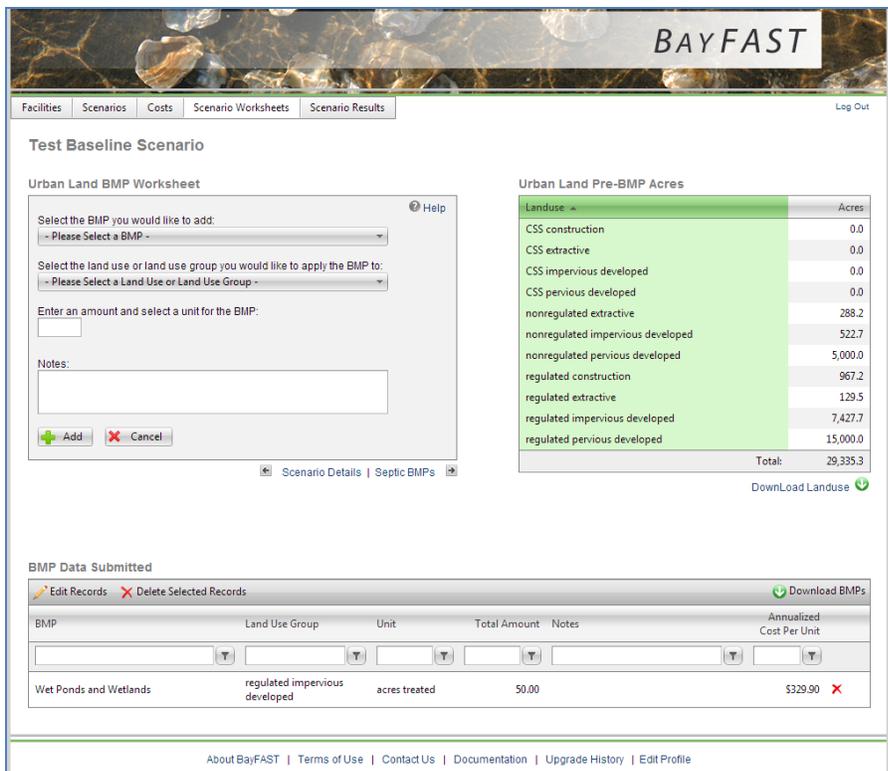


Figure 5: Edit BMP Information for Baseline Scenario

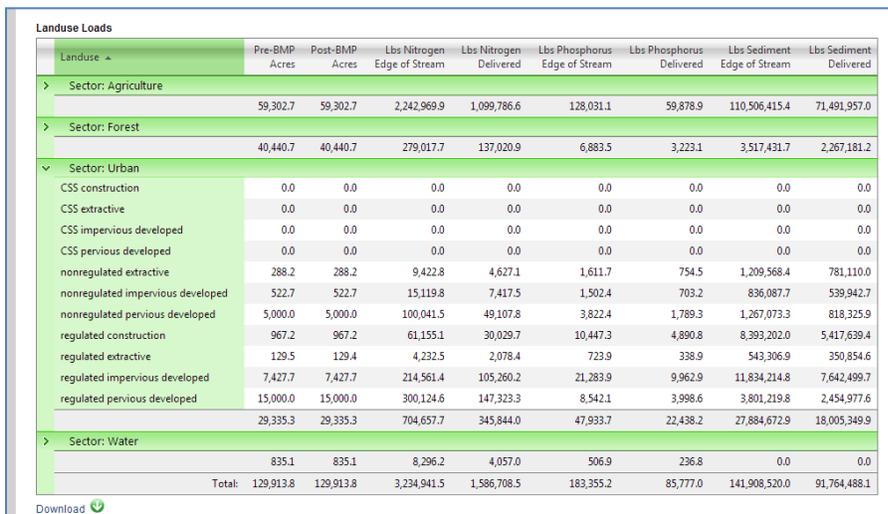


Figure 6: View Loading Results – Urban Sector

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Facilities Scenarios Costs Scenario Worksheets Scenario Results Log Out

Test Future BMPs

Urban Land BMP Worksheet

Select the BMP you would like to add:
 - Please Select a BMP -

Select the land use or land use group you would like to apply the BMP to:
 - Please Select a Land Use or Land Use Group -

Enter an amount and select a unit for the BMP:

Notes:

Scenario Details | Septic BMPs

Urban Land Pre-BMP Acres

Landuse	Acres
CSS construction	0.0
CSS extractive	0.0
CSS impervious developed	0.0
CSS pervious developed	0.0
nonregulated extractive	288.2
nonregulated impervious developed	522.7
nonregulated pervious developed	5,000.0
regulated construction	967.2
regulated extractive	129.5
regulated impervious developed	7,427.7
regulated pervious developed	15,000.0
Total:	29,335.3

Download Landuse

BMP Data Submitted

BMP	Land Use Group	Unit	Total Amount	Notes	Annualized Cost Per Unit
Bioswale	regulated impervious developed	acres treated	50.00		\$864.53
Wet Ponds and Wetlands	regulated impervious developed	acres treated	50.00		\$329.90

Figure 7: Edit BMP Information for Future Scenario

Appendix C: Local TMDLs vs. Chesapeake Bay TMDLs and Comprehensive SW-WLA Implementation Scenarios

Nutrient and sediment TMDLs present several challenges to implementing SW-WLAs, since multiple, overlapping sets of allocations at varying spatial scales that address varying designated uses can apply within a jurisdiction. This section describes MDE's recommendations for conducting SW-WLA implementation planning specific to the Chesapeake Bay TMDL, and it describes a process whereby the Chesapeake Bay TMDL and local, non-Bay TMDLs can be addressed within one set of comprehensive planning scenarios.

Local jurisdictions need to demonstrate achievement of Chesapeake Bay TMDL county allocations by the year 2025, and it is recommended that these implementation plans provide a summary of the impacts of restoration efforts at a county/segment-shed scale so that, in aggregate, the segment-shed reductions meet the county-wide Chesapeake Bay TMDL SW-WLAs. A list of these Chesapeake Bay segment-sheds, by county, is provided on the TMDL Data Center through the WLA Search tool. For consistency with Phase 5.3.2 of the Chesapeake Bay Watershed Model (P5.3.2 Model) and for ease of use, these SW-WLAs have been provided as Phase II WIP targets, however, jurisdictions may develop their plans based off of reductions from the 2010 Chesapeake Bay TMDL as long as these loads are estimated in an equitable and scientifically defensible manner (i.e., using MDE's stormwater toolkit: <http://www.mde.state.md.us/programs/Water/TMDL/DataCenter/Pages/TMDLStormwaterToolkit.aspx>).

Many watersheds throughout Maryland have multiple, overlapping sets of SW-WLAs, for which local jurisdictions have to develop implementation plans. For example, a watershed may have a local phosphorus TMDL developed to address a water quality impairment in its non-tidal stream system caused by excessive nutrient inputs, and that same watershed may also be part of a larger watershed, to which SW-WLAs were assigned and reductions required, to meet downstream water quality as part of the Chesapeake Bay TMDL or a drinking water reservoir. Since BMPs implemented to achieve Chesapeake Bay TMDL WLAs also have co-benefits for achieving local TMDL targets, in watersheds where multiple sets of SW-WLAs apply, MDE recommends that each local jurisdiction develop a comprehensive plan to address all of its nutrient and sediment SW-WLAs.

The comprehensive plan should include any implementation to achieve local, non-Bay TMDLs that is planned to be completed before 2025 and also implementation planned for post 2025.

2025 is the target year for full Chesapeake Bay TMDL implementation, as agreed upon by the Chesapeake Bay Partnership. Beyond just looking at 2025 implementation, the plan would also include a scenario that includes 100% of implementation for meeting all of the local, non-Bay TMDL SW-WLAs. This is implementation that would go above and beyond the county-wide Chesapeake Bay TMDL allocations, and no specific end date would need to be assigned to this scenario.

MDE recommends that these implementation scenarios be developed at a scale consistent with all existing nutrient and sediment TMDLs within the jurisdiction so that adequate determination

of the sufficiency of the plan to meet the WLA can be determined. It is also important to recognize that plans developed at this fine scale may assist with more cost effective targeting due to differences in nutrient delivery rates from in-stream attenuation.

MDE recommends that plans be developed at the MD 8-Digit watershed scale because this is the common watershed scale for water quality impairment listing and local TMDL development. MDE worked closely with EPA CBP to align the CBP P5 modeling segments to the MD 8-Digit watersheds. In most cases, Chesapeake Bay segment-sheds are composed of one or more MD 8-Digit watersheds, thus segment-shed loads can be calculated by summing MD 8-Digit watershed loads. Some exceptions to this rule exist, such as the West and Rhode Rivers and the Western Branch of the Patuxent River, where the segment-sheds are actually smaller than their corresponding MD 8-Digit watersheds. In some cases, it may be more practical for a local jurisdiction to develop its implementation scenarios at an even smaller scale, such as the MD 12-Digit watershed scale, when local TMDLs have been developed at this level.

When developing a comprehensive plan, MDE recommends that local jurisdictions use a common nutrient and sediment modeling system for all sets of SW-WLAs that apply within their jurisdiction. This would involve translating the local TMDLs and Chesapeake Bay TMDL into a common currency. MDE recommends that local jurisdictions use MAST to do develop this scenario as this is consistent with the Chesapeake Bay TMDL and also many of the local TMDLs. Although MDE believes that a comprehensive MAST scenario would facilitate the process of reporting and assessing a county's SW-WLA implementation plans, it is not a requirement, and there are a variety of other ways that this information can be submitted.

It is also recognized that while MAST might not be the most appropriate tool for doing site level planning, it offers a lot of strengths as a crediting and reporting tool for showing achievement of Chesapeake Bay TMDL SW-WLAs. This is due to the fact that the assumptions that underlie MAST have been thoroughly reviewed and approved by the Chesapeake Bay Partnership, and they are consistent with those used in the Chesapeake Bay Watershed Model.

For local jurisdictions that do not wish to use MAST, a reasonable approach might be to use one model to develop site-level implementation plans and subsequently translate this implementation plan into a MAST scenario for reporting to MDE. Credit for any scientifically sound nutrient reduction practices that are not currently included in MAST could be provided in a table outside of MAST. If a local jurisdiction does decide to use MAST, the county's scenario should be shared with MDE's TMDL Implementation account (*MDE_swwla_review*).

Once a common modeling system has been established, local jurisdictions should develop separate implementation plans for each local SW-WLA and aggregate to the county scale Chesapeake bay target loads.

A baseline year represents the pollution reduction progress up to and including that year. This means that practices that were implemented prior to this year will not be included in progress towards meeting the WLAs. The baseline year for the Chesapeake Bay TMDLs is 2010. The baseline year for the Chesapeake Bay Phase II WIP targets is 2009. Since the Phase II WIP loads reflected a refinement to the Chesapeake Bay TMDL loads, 2009 effectively serves as the

baseline conditions for Chesapeake Bay restoration. Any applicable, local nutrient or sediment TMDLs will likely have a baseline year prior to 2009. Therefore, in order to ensure the attainment of all applicable allocations in a watershed and to facilitate the process of future Chesapeake Bay WIP refinements, MDE recommends the following procedure for developing one comprehensive implementation plan. This procedure is designed to be generic to any modeling system the local jurisdiction is using, but it is largely based around the functionality of MAST. It should, however, apply to any modeling system being used by the local jurisdiction.

1. Model the nutrient/sediment loadings for 2009 for all watersheds in the county. MDE suggests modeling the watershed loads at the MD 8-Digit scale, since this is the most common scale at which nutrient and sediment TMDLs are developed in Maryland (See Figure 1).
2. Apply BMPs to watersheds to meet the Chesapeake Bay Phase II WIP countywide targets (required reduction percentage). This includes any BMPs that have already been implemented by the local jurisdiction post 2009 (i.e., current progress scenario + planned BMPs) (See Figure 1)
3. Model the watershed nutrient/sediment loading for the baseline year of any local TMDLs (See Figure 1)
4. Multiply the local TMDL SW-WLA reduction percentage by the modeled baseline load to get the target SW-WLA for the local TMDL in the new modeling system. For example, if using MAST, see the description in Appendix A, *Using MAST to Develop a SW-WLA Implementation Plan*, for calculating a new SW-WLA target in MAST. The same process still applies if using any other modeling systems, i.e., the WTM, spreadsheets, etc. (See Figure 1)
5. Compare the 2009 load to the load for the baseline year of the local TMDL and calculate (See Figure 1):
 - a. achieved reduction percentage, and
 - b. remaining reduction percentage
6. Compare the remaining reduction percentage for the local TMDL to the planned load reduction for the watershed as per the Chesapeake Bay Phase II WIP countywide target achievement scenario (see Figure 1)
 - a. This allows for an assessment of which requirement is associated with the greater reduction (the local TMDL SW-WLA or the planned reduction for meeting the Chesapeake Bay TMDL) using a consistent baseline (2009)
7. If the planned reductions for meeting the Chesapeake Bay TMDL do not result in achievement of the local TMDL SW-WLA, local jurisdictions should create a new scenario adding BMPs to the watershed until the local SW-WLA is achieved (See Figure 1)
 - a. If the planned reductions for meeting the Chesapeake Bay TMDL do result in achievement of the local SW-WLA, then no further planning is necessary in the watershed

Once additional BMPs have been added to all watersheds with local TMDLs, as needed, the local jurisdiction should aggregate the load reductions for the applicable MD 8-Digit watersheds, or sub MD 8-Digit watersheds, within a Chesapeake Bay segment-shed to estimate load reductions achieved at this scale as well. Not only does MDE ask that local

jurisdictions provide the implementation modeling scenarios described in Steps 1-6 above to the Department, but also MDE would ask that local jurisdictions please describe the implementation specific to the given time frames and watersheds corresponding to their scenarios within their actual implementation plans.

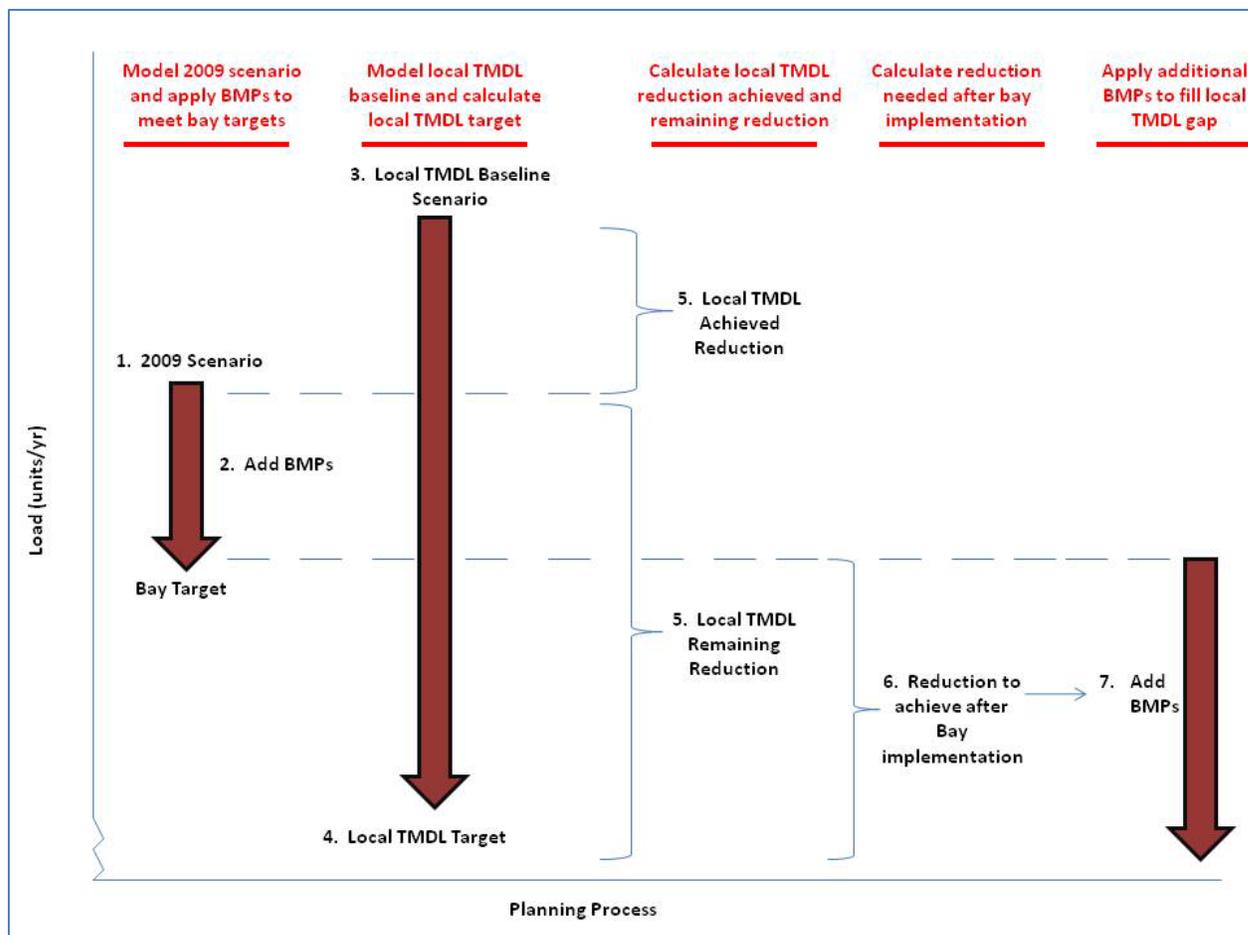


Figure 1: Procedure for Developing a Comprehensive Nutrient or Sediment Implementation Plan or Scenarios Addressing Chesapeake Bay TMDL and Local TMDL Allocations

As part of the effort to improve the accuracy of the Chesapeake Bay Watershed Model in its Phase 6 iteration, MDE and CBP are soliciting data from local governments to refine both the model land use data and inventory of existing stormwater management practices. The objective is to improve the model's accuracy and resolution so that it can be better used as a tool for local watershed planning. This work is being done, in part, to address concerns of local governments about the accuracy of the P5.3.2 Model at a local scale, which were voiced during the Chesapeake Bay Phase II WIP development process. In addition to soliciting data from local jurisdictions to improve model accuracy and resolution, MDE also intends to improve the detail of its statewide implementation scenario for meeting the 2025 Chesapeake Bay targets. Since Maryland will need to refine its statewide implementation plan to include more accurate local data, MDE would like to incorporate local plans into the statewide

scenario to the fullest degree possible. The incorporation of countywide comprehensive nutrient and sediment implementation scenarios, described in this appendix, would be a major achievement toward improving local accuracy of statewide implementation plans within the Chesapeake Bay Watershed Model.

Appendix D: Developing Implementation Plans for TMDLs Using the Vollenweider Relationship

Maryland has developed phosphorus and sediment TMDLs for many small impoundments throughout the state. The watersheds draining to these impoundments are generally at a smaller scale than Maryland's 8-Digit watersheds. The impoundments vary in why they were created and their current designated uses. While smaller in size than Maryland's large drinking water reservoirs, some of these smaller impoundments were created to for public drinking water supply. Others were created for recreational purposes. For the most part, these small impoundment TMDLs were developed using the Vollenweider relationship and Carlson's Trophic Index (TSI).

The Vollenweider Relationship establishes a linear relationship between the log of the phosphorus loading and the log of the ratio of the lake's mean depth to its hydraulic residence time. Table 1 below presents the TSI values for various trophic states. A TSI represents the lower limit of a eutrophic state and the upper limit of a mesotrophic state. Therefore, a TSI of 60 is selected as the endpoint for most of the small impoundments TMDLs. The total phosphorus concentration can be back calculated from a TSI value using the equation 1 below. Then, using an impoundment's mean depth and residence time, and the total allowable phosphorus concentration, total allowable phosphorus loading to an impoundment can be calculated.

Table 1: TSI Values and Trophic Status

TSI	Trophic Status
TSI < 35	Oligotrophic
35 < TSI < 55	Mesotrophic
TSI > 55	Eutrophic
TSI > 70	Hypertrophic

Equation 1: $TSI = 4.15 + 14.42 \ln (TP)$, where
 TSI = Carlson's Trophic Index
 TP = Total phosphorus concentration

For TMDLs developed using the Vollenweider relationship and Carlson's Trophic Index, the allowable loading is independent watershed modeling efforts and baseline loading assessments. The allowable load is solely based on the mean depth of the impoundment, the hydraulic residence of the impoundment, and the phosphorus concentration associated with the endpoint TSI. Therefore, if a jurisdiction is developing an SW-WLA implementation plan for a small impoundment TMDL, it is not necessary to use the TMDL SW-WLA reduction percentage and calculate a new target load in the county's implementation plan. Rather, to demonstrate achievement of the target, a local jurisdiction should simply compare their modeled, implementation scenario loads to the SW-WLA in the TMDL, since this represents an absolute loading threshold, independent of watershed modeling efforts.