New CBP Long-Term Hydrologic Period and Three-Year Critical Period

Modeling Workgroup January Quarterly Review

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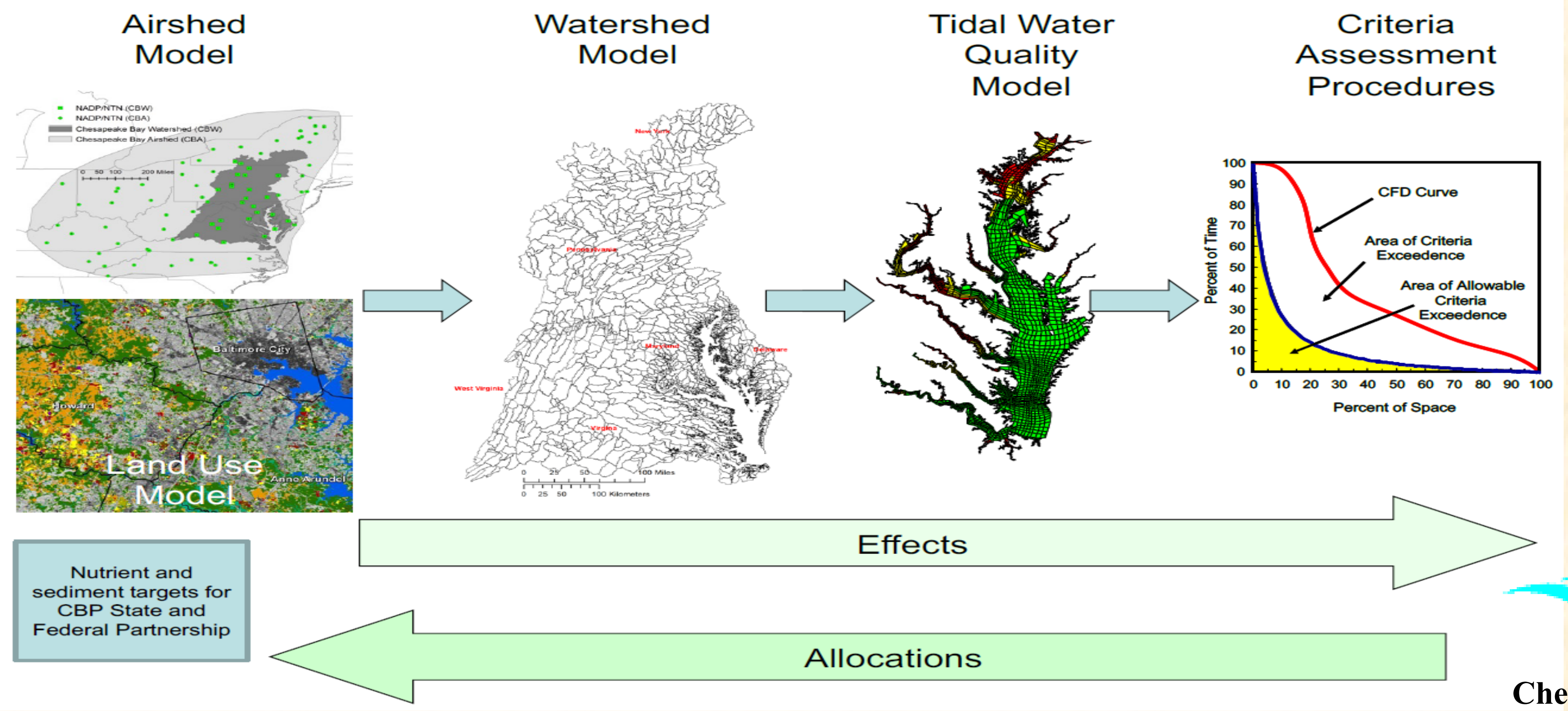

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Key Points

- There is good, clear 2010 Chesapeake Bay TMDL documentation on how to develop long-term and critical periods.
- Developing and applying new long-term and critical periods involve both a manageable, straightforward technical aspect and a policy/application aspect that could be more difficult.
- A new long-term and critical hydrologic period will redistribute flows and loads among partnership state-basins.
- Application of a new CBP hydrologic period for Phase 7 target loads will require all technical and policy decisions be complete by the close of 2026.

A 2025 STAC Workshop Report

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"The 1991-2000 CBP base hydrology has been agreed to by the CBP partners to be equitably poised between flood and drought loads. We don't want to disrupt management decisions during Phase 7, but at some point after Phase 7, a 1991-2000 CBP average hydrology will be seen to be less relevant and more disconnected from future hydrology in the Chesapeake Bay region.

It takes a long time to find and approve an agreed-to CBP base hydrology approach. Looking forward, a potential next phase of CBP modeling could be aimed at an assessment of climate change beyond 2035. Starting now to update the 10-year average hydrology for the next phase of CBP modeling makes sense. This would provide a long runway for analysis and agreement and an opportunity to examine alternate CBP base hydrologies without immediate management consequences."

Source: Shenk, G., M. Bennett, Z. Easton, M. Friedrichs, R. Hood, J. Keisman, L. Linker, R. Najjar, R. Sabo, and C. Stock. 2024. A Path Forward in Considering Future Environmental Scenarios in Chesapeake Bay Restoration Efforts. STAC Publication Number 25-004, Edgewater, MD. 46pp.

Chesapeake Bay TMDL Critical Condition

"All approvable TMDLs must be established in a manner that reflect critical conditions. Critical conditions are represented by the combination of loading, waterbody conditions, and other environmental conditions that result in impairment and violation of water quality standards. Critical conditions for an individual TMDL typically depend on applicable water quality standards, characteristics of the observed impairments, source type and behavior, pollutant, and waterbody type."

The 1993-1995 critical condition sets the carrying capacity of the Bay for nitrogen, phosphorus, and sediment.

Source: Chesapeake Bay TMDL Appendix G. Determination of Critical Conditions for the Chesapeake Bay TMDL

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CB TMDL Critical Condition *(continued)*

- For DO and clarity the Chesapeake Bay Program's WQGIT previously selected a 3-year period from a long-term ten-year hydrologic period within the model calibration period.

- Preliminary analysis pre-2010 included an exploration of the nine major river's flow and different combinations of monthly flow durations, i.e., January to May, January to September, or other monthly duration combinations.

- The analysis was run with and without tributary multipliers, which the CBP developed because flows from different tributaries unequally affect conditions in the Bay.

Source: Chesapeake Bay TMDL Appendix G. Determination of Critical Conditions for the Chesapeake Bay TMDL

CB TMDL Critical Condition (*continued*)

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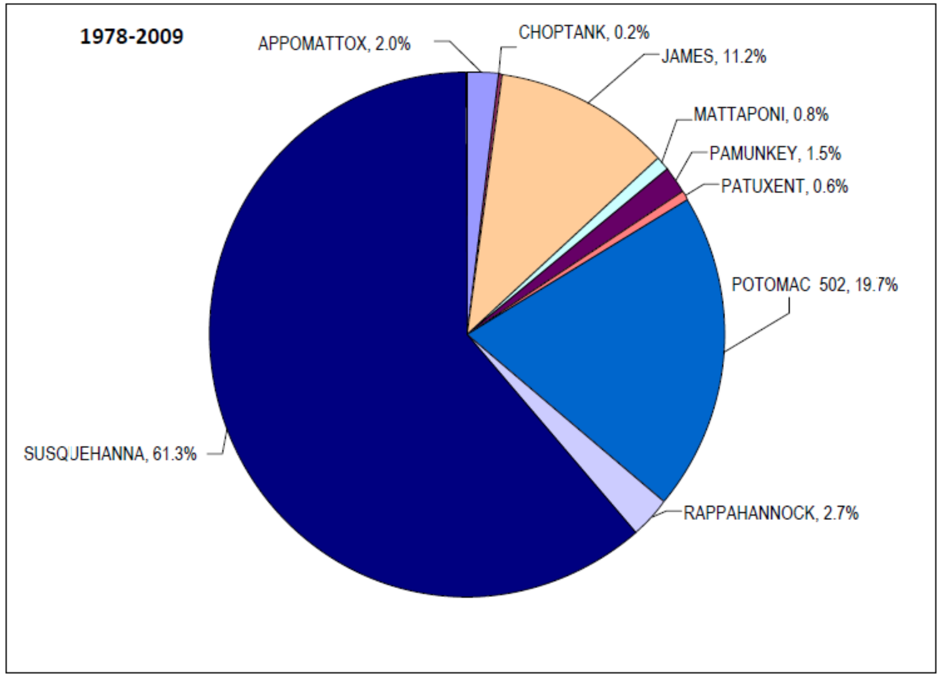

Figure G-1. Tributary flow contributions without multiplier ratios.

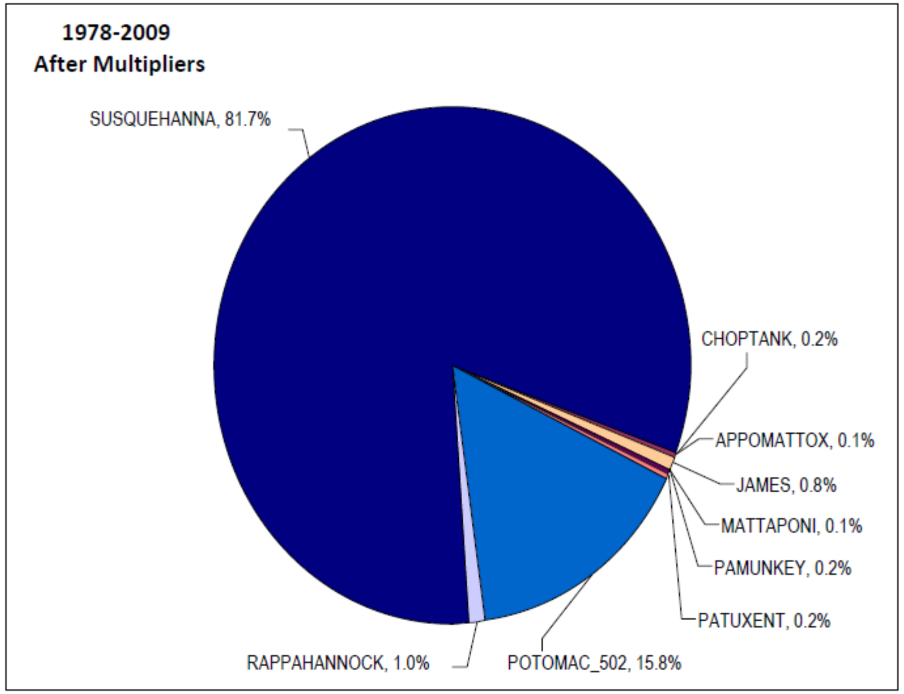

Figure G-2. Tributary flow contributions with the multiplier ratios.

Table G-2. Chesapeake Bay tributaries flow multiplier ratios

Major river basin	Multiplier	Adjusted ratio
Appomattox	0.533111028	0.017
Choptank	6.929861533	0.217
James	0.533111028	0.017
Mattaponi	0.798423188	0.025
Pamunkey	0.798423188	0.025
Patuxent	3.093385849	0.097
Potomac	6.188243619	0.193
Rappahannock	2.809613056	0.088
Susquehanna	10.3187158	0.322
		1.000

Source: EPA Chesapeake Bay Program Office

Source: Chesapeake Bay TMDL Appendix G. Determination of Critical Conditions for the Chesapeake Bay TMDL

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CB TMDL Critical Condition (*continued*)

- For a DO critical period aim for a ten-year return period of a three-year relatively high flow conditions while avoiding extreme high flow events such as hurricanes.

- Apply statistical approaches of evaluation including the Log Pearson III Method, LOWESS Polynomial Regression, and others.

- Development of the analysis to be shared with the WQGIT for management application and the Modeling Workgroup and other technical workgroups for technical review.

- Ultimately the recommendation of how and when to apply a new CBP hydrologic period could be made by the WQGIT to the PSC.

- Separate critical periods might be needed for SAV/clarity and chlorophyll WQSs.

Source: Chesapeake Bay TMDL Appendix G. Determination of Critical Conditions for the Chesapeake Bay TMDL

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Long Term 10-Year Hydrology

"The hydrologic period for modeling purposes represents a typical or representative long-term hydrologic condition for the waterbody. The hydrologic period is used for expressing average annual loads from various sources. It is not to be confused with the critical period, which defines a period of high stress.

It is important that the selected hydrologic period is representative of the long-term hydrology in each area of the Chesapeake Bay watershed so that no one area is modeled with a particularly high or low loading or an unrepresentative mix of point and nonpoint sources. The selection of a representative hydrologic averaging period ensures that the balance between point and nonpoint source loading and the balance between different geographic areas are appropriate."

The long-term hydrologic period determines the controllable load (No Action – LOT Scenario) and the N and P geographic influence scenarios.

Source: Chesapeake Bay TMDL Appendix F. Determination of the Hydrologic Period for Model Application

Long Term 10-Year Hydrology (*continued*)

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6.1.1 Hydrologic Period

The long-term hydrologic period provides the temporal boundaries on the model scenario runs from which the critical period is determined (see Section 6.2.1). To identify the appropriate hydrologic period, EPA analyzed decades of historical stream flow data. In the course of evaluating options for the TMDL, the CBP ran numerous modeling scenarios through the with varying levels of management actions (e.g., land use, BMPs, wastewater treatment technologies) held constant against an actual record of rainfall and meteorology to examine how those management actions perform over a realistic distribution of simulated meteorological conditions."

Source: Chesapeake Bay TMDL Documentation SECTION 6. ESTABLISHING THE ALLOCATIONS FOR THE BASIN-JURISDICTIONS, 2010.

Long Term 10-Year Hydrology *(continued)*

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"Two extreme conditions occurred during the 21-year (1985-2005) model simulation period for the Chesapeake Bay models: Tropical Storm Juan in November 1985, and the Susquehanna *Big Melt* of January 1996. In the Chesapeake Bay region, Tropical Storm Juan was a 100-year storm primarily affecting the Potomac and James River basins. In the case of the Susquehanna Big Melt in January 1996, a warm front brought rain to the winter snowpack in the Susquehanna River basin and caused ice dams to form in the lower reaches of the Susquehanna.

From the 21-year period, EPA selected a contiguous 10-year hydrologic period because a 10-year period provides enough contrast in different hydrologic regimes to better examine and understand water quality response to management actions over a wide range of wet and dry years. Further, a 10-year period is long enough to be representative of the long-term flow (Appendix F). The annualized Bay TMDL allocations are expressed as an average annual load over the 10-year hydrologic period."

Source: Chesapeake Bay TMDL Documentation SECTION 6. ESTABLISHING THE ALLOCATIONS FOR THE BASIN-JURISDICTIONS, 2010.

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Long Term 10-Year Hydrology *(continued)*

“Which 10-year period to use was determined by examining the statistics of long-term flow relative to each 10-year period at nine USGS gauging stations measuring the discharge of the major rivers flowing to the Bay (Appendix F). All the contiguous 10-year hydrologic periods from 1985 to 2005 appeared to be suitable because quantifiable assessments showed that all the contiguous 10-year periods had relatively similar distributions of river flow.

The 10-year hydrologic assessment period from 1991 to 2000 from the 21-year flow record for the following reasons:

- It is one of the 10-year periods that is closest to an integrated metric of long-term flow.
- Each basin has statistics for this period that were particularly representative of the long-term flow.
- It overlaps several years with the previous 2003 tributary strategy allocation assessment period (1985–1994), which facilitated comparisons between the two assessments.
- It incorporates more recent years than the previous 2003 tributary strategy allocation assessment period (1985–1994).
- It overlaps with the Bay Water Quality Transport Model calibration period (1993–2000), which is important for the accuracy of the model predictions.
- It encompasses the 3-year critical period (1993–1995) for the Chesapeake Bay TMDL as explained in Section 6.2.1 below.

Source: Chesapeake Bay TMDL Documentation SECTION 6. ESTABLISHING THE ALLOCATIONS FOR THE BASIN-JURISDICTIONS, 2010.

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Conclusions:

- There is good, clear 2010 Chesapeake Bay TMDL documentation on how to develop long-term and critical periods.
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