STAC Independent Peer Review Panel
Questions for the 2017 Water Quality and Sediment Transport Model (WQSTM) Model Review

June 1, 2017

CBP Groups Supported: Water Quality Goal Implementation Team (WQGIT) and the Modeling Workgroup

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Introduction:

The 2017 version of the WQSTM is the most recent of a series of increasingly refined versions of coupled hydrodynamic and water quality models of the Chesapeake Bay developed since 1987. Different versions of the model have been operational for more than three decades guiding Chesapeake Bay Program (CBP) management decisions. New aspects of the current WQSTM are improved representation of the bioavailability of particulate organics and improved ability to simulate Conowingo infill and climate change in tidal waters. Refinements to the shallow water simulation include attenuation of nutrient and sediment loads through tidal wetlands, the representation of shoreline loads of nutrients, and the explicit representation of oyster aquaculture, sanctuaries, and wild populations.

Recognizing that the general approach and scientific basis of the currently used WQSTM model were reviewed more thoroughly by STAC previously (see "Prior WQSTM-related STAC Reports" noted below) and that a more complete review of best practices for CBP modeling approaches will be undertaken in the coming years, the CBP is currently requesting, through the Modeling Workgroup, a STAC review primarily of the newer WQSTM modeling aspects noted above, which are intended for implementation in the coming year and will likely be used through at least 2025. In this regard, the review requested here is intended primarily as a more focused consideration of the reasonableness and objectivity of the model within the context of available science and given the constraints associated with providing a stable, objective, and scientifically reasonable modeling environment for use toward regulatory and management purposes in the next eight years.

Prior WQSTM-related STAC Reports (for background):

The Development of Climate Projections for Use in the Chesapeake Bay Program Assessments (2016) Workshop held on March 7-8, 2016. Draft report and appendices distributed May 10, 2017.

Conowingo Infill Influence on Chesapeake Water Quality (2016) Workshop held on January 13-14, 2016. http://www.chesapeake.org/pubs/356_Linker2016.pdf

Weller, D., B. Benham, M. Friedrichs, R. Hood, R. Najjar, M. Paolisso, P. Pasquale, K. Sellner, G. Shenk. (2014). Multiple Models for Management in the Chesapeake Bay. STAC. http://www.chesapeake.org/pubs/324_Weller2014.pdf\

Pyke, C., M. Friedrichs, M. Johnston, K. Sellner. (2012). Using Multiple Models for Management in the Chesapeake Bay: A Shallow Water Pilot Project (CRC# STAC 12-03). STAC. http://www.chesapeake.org/pubs/291_Pyke2012.pdf

Friedrichs, M., C. Cerco, C. Friedrichs, R. Hood, D. Jasinski, W. Long, K. Sellner, G. Shenk. (2011). Chesapeake Bay Hydrodynamic Modeling: A Workshop Report (CRC# STAC 11-04). STAC. http://www.chesapeake.org/pubs/257_Friedrichs2011.pdf

STAC. (2010). *STAC review of the Water Clarity and SAV components of the Chesapeake Bay Program Water Quality and Sediment Transport Model*. < http://www.chesapeake.org/pubs/236_2010.pdf>

STAC. (2007). An Introduction to Sedimentsheds: Sediment and its Relationship to Chesapeake Bay Water Clarity (CRC# STAC 07-002). http://www.chesapeake.org/pubs/sedshedreportfinal.pdf

L. Sanford, C. C., C. Duffy, T. Gross, M. Kemp, L. Linker, H. Wang, D. Weller, R. Wood. (2006). Modeling in the Chesapeake Bay Program: 2010 and Beyond (CRC# STAC 06-001). STAC. http://www.chesapeake.org/pubs/modbay2010report.pdf

W.M. Kemp, D. B. (2005). *Coupling Water Quality and Upper Trophic Level Models for Chesapeake Bay* (CRC# STAC 05-002). STAC. http://www.chesapeake.org/pubs/shorelineerosreport.pdf

S. Phillips, L. S., K. Sellner,. (2003). Shoreline Erosion and Chesapeake Bay Water Quality, A Scientific Evaluation of Prediction Uncertainty, Potential for Improvement, and Management Implications. STAC. http://www.chesapeake.org/pubs/shorelineerosreport.pdf

D. Breitburg, E. H., R. Newell, A. Butt, D. Orner, R. Magnien. (2002). Suspension Feeders: A Workshop to Assess What We Know, Don't Know, and Need to Know to Determine Their Effects on Water Quality (CRC# STAC 02-002). STAC http://www.chesapeake.org/pubs/fffinalreport.pdf

Reports to be Reviewed by the Panel:

Beta 4 WQSTM Documentation
http://www.chesapeakebay.net/documents/2017_WQSTM_Documentation_DRAFT_5-10-17.pdf

[Questions #1, #2, #3, #6, #7, #8, and #9]

2017 WQSTM Documentation Appendix A: Time Series of 1991-2000 Observations and Simulation Results - http://www.chesapeakebay.net/documents/Appendix_A_1991-2000_time_series_DRAFT_5-10-17.pdf

2017 Water Quality and Sediment Transport Model Documentation: Appendices B, C, and D – http://www.chesapeakebay.net/documents/Appendices_B-C-D_of_WQSTM_Documentation_DRAFT_5-10-17.pdf

Resource Materials for the Panel:

Conowingo Reservoir Sedimentation and Chesapeake Bay: State of the Science (2016) **[Question #3]** https://dl.sciencesocieties.org/publications/jeq/abstracts/45/3/882

Impact of Reservoir Sediment Scour on Water Quality in a Downstream Estuary (2016) **[Question #3]** https://dl.sciencesocieties.org/publications/jeq/abstracts/45/3/894

Influence of Reservoir Infill on Coastal Deep Water Hypoxia (2016) **[Question #3]** https://dl.sciencesocieties.org/publications/jeq/abstracts/45/3/887

Management modeling of suspended solids in the Chesapeake Bay, USA (2013) **[Question #7]** http://www.chesapeakebay.net/documents/CFC_EMECS_clean.pdf

Can Oyster Restoration Reverse Cultural Eutrophication in Chesapeake Bay? (2007) **[Question #8]** http://www.gesaq.org/P2Clew/documents/Cerco%20and%20Noel%20Chesapeake%20Bay%20oysters.pdf

Monitoring, modeling, and management impacts of bivalve filter feeders in the oligohaline and tidal fresh regions of the Chesapeake Bay system (2010) **[Question #8]** http://www.sciencedirect.com/science/article/pii/S0304380009005249

Assessing Water Quality of the Chesapeake Bay by the Impact of Sea Level Rise and Warming Assessing Water Quality of the Chesapeake Bay by the Impact of Sea Level Rise and Warming **[Questions #4 and #5]** http://www.chesapeakebay.net/publications/title/assessing_water_quality_of_the_chesapeake_bay_by_the_impact_of_sea_level_ri

2010 TMDL Documentation

The 2010 Chesapeake Bay Eutrophication Model (2010) http://www.chesapeakebay.net/content/publications/cbp_55318.pdf

Development of the Chesapeake TMDL Allocation (2013) http://www.chesapeakebay.net/documents/TMDL_Development_10-13.pdf

Evaluation of a Three-dimensional Hydrodynamic Model Applied to Chesapeake Bay through Long-Term Simulation of Transport Processes (2013) http://www.chesapeakebay.net/documents/Hydrodynamic_Model_Transport_Processes_Evaluation_10-13.pdf

Monitored and modeled correlations of sediment and nutrients with Chesapeake Bay water clarity (2013)
http://www.chesapeakebay.net/documents/Water_Clarity_Simulation_10-13.pdf

General Documentation on Chesapeake TMDL and Models:
https://www.epa.gov/sites/production/files/201502/documents/appendix_b_index_of_documents_final.pdf

The 2002 Chesapeake Bay Eutrophication Model (2004)
http://www.chesapeakebay.net/content/publications/cbp_26167.pdf

WQSTM Peer Review Questions:

General note: The questions below focus primarily on helping the CBP to identify any "fatal flaws" that you believe must be addressed before the modeling is implemented in late 2017 or early 2018. Many of these questions end by suggesting that you should please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how you believe the estimate and representation of SLR can be improved. In particular, please feel free to identify the most important shortcomings you find in the approaches and procedures used and to recommend alternative approaches, research, and data gathering to be conducted for the longer term. Given the time constraints of the review, however, such comments are not necessarily expected at this time.

1) Please comment on the WQSTM documentation. Is it clear, well organized, and complete (Taking into account that it is largely based on the fourth Beta release of Phase 6 Watershed Model and 4 months ahead of final release)?
(Note: This is a question that can perhaps best be addressed after other review questions have been considered, but early feedback is welcome through on-going discussions with CBP personnel for purposes of clarification regarding other peer review questions.)

2) Please comment on the overall appropriateness of the approach taken in the application of G1, G2, and G3 organic behavior in the water column and sediment of the WQSTM. Is the applied approach appropriate? What could be done to improve the representation of the various organic decay rates in the WQSTM?

3) Given the current state of modeling, research, and monitoring on the increased net transport of nutrients and sediment out of the Lower Susquehanna reservoir system please comment on the scientific rigor of the WQSTM approach used to represent the increased nutrient and sediment loads on Chesapeake water quality standards of DO, chlorophyll, and clarity/SAV. Is the representation of nutrients and sediment under all states of flow, including moderate and extreme flow events, sufficiently well simulated for the condition of reservoir infill?

4) Please comment on the overall appropriateness of the approach taken for estimating and representing future sea level rise (SLR). Is the approach sufficiently scientifically defensible and appropriate for preliminary application? Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how you believe the estimate and representation of SLR can be improved.

5) Please comment on the overall appropriateness of the approach taken for estimating and representing future temperature changes and their impact on Chesapeake water quality standards of DO, chlorophyll, and clarity/SAV and key living resources. Is the approach sufficiently scientifically defensible and appropriate for preliminary application? Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how you believe the estimate and representation of future estuarine temperature and effects can be improved.

6) Please comment on the overall appropriateness of the approach taken for estimating and representing SLR tidal wetland loss and its impact on Chesapeake water quality standards of DO, chlorophyll, and clarity/SAV and key living resources. Is the approach sufficiently scientifically defensible and appropriate for preliminary application? Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how you believe estimates and model representation of future tidal wetland loss can be improved.

7) Is the approach taken in the estimates of shoreline erosion nutrient loads and the simulation of nutrient attenuation by tidal wetlands supportive of an improved representation of shallow water dynamics? Are they scientifically defensible and appropriate for preliminary application? Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how the shallow water simulation approach can be improved going forward. For example, what science is missing from our current analysis in regard to shallow water dynamics and the effective simulation of shallow water DO, chlorophyll, and clarity throughout the Chesapeake? Given the findings of the multiple model shallow water assessment, how can future representations of the water quality in small tidal embayments and tidal rivers be improved? (As examples of additional issues worthy of further consideration, one might consider the use of variable model grids, wind resuspension of phytoplankton and sediment, phytoplankton behavior to avoid self-shading, and improvements to modeling of phosphorus/pH and redox dynamics. How critical do you consider these components for the scientific validity of future shallow-water modeling and how are they best addressed?)

8) Please comment on the scientific rigor of the methods used to estimate oyster biomass in sanctuaries, aquaculture, and natural bars and simulate their influence of on water quality. Is the approach to the simulation sufficiently scientifically defensible and appropriate for preliminary application? Are you aware of additional scientific information that should be included? Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how you believe estimates and model representation of these issues can be improved

9) Please feel free (but not obligated) to also comment, for the longer term consideration of the CBP, on how future Chesapeake water model structures and processes can be modified to better represent the tidal water quality standards of DO, chlorophyll, and clarity/SAV in the face of challenges of climate change, growth, and other future impacts. For the longer term consideration of the CBP, what major shortcomings you find in the overall approaches and procedures used and what alternative approaches might you recommend?

Proposed Peer Review Schedule and CBP Partnership Response

The CBP partnership requests that the requested STAC-coordinated independent scientific peer review panel complete their review and deliver a panel report reflecting the Panel's collective written responses to above questions by July 1, 2017 The CBP partnership is committed to providing written responses to the Panel's collective responses to above questions by July 31, 2017.

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