



Chesapeake Bay Program
SCIENTIFIC AND TECHNICAL ADVISORY COMMITTEE
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September 1, 2017

RE: STAC Chesapeake Bay Watershed Model Phase 6 Review

Nicholas DiPasquale, Chair, Chesapeake Bay Program Management Board
U.S. Environmental Protection Agency
410 Severn Avenue, Suite 109
Annapolis, MD 21403

Cc: Management Board; Water Quality Goal Implementation Team; Scientific Technical Assessment and Reporting (STAR); Modeling Workgroup

Dear Director DiPasquale,

I am pleased to attach for your consideration the STAC review report: *Scientific and Technical Advisory Committee Chesapeake Bay Watershed Model Phase 6 Review*.

Phase 6 (P6) is the most recent of a series of increasingly refined iterations of the Chesapeake Bay Watershed Model (WSM) developed since 1982. Different versions of the model have been operational for more than three decades, serving to guide management and decision making across the CBP partnership. However, the P6 WSM is a major departure from previous deterministic and mechanistic versions, specifically in a new approach to water quality simulation that relies on integration of multiple models for different biogeochemical processes in the watershed. The CBP, through the Modeling Workgroup, requested a STAC-sponsored independent review of the P6 WSM with particular emphasis on the new multiple model aspects of the watershed simulation. This multiple model approach stemmed from recommendations from several previous STAC workshops and reviews on earlier versions of the watershed model.

In addition to addressing twelve main charge questions, the review panel was also encouraged to make recommendations for future work by the CBP partnership that built on the questions or were related to the scientific or management issues raised in the review. A panel of eleven individuals with appropriate expertise in management-focused watershed modeling, nutrient dynamics, lag time estimation, and large scale sediment modeling was formed in August 2016. The team conducted their review of the model documentation in two distinct phases. Responses to all questions except those focused on Conowingo reservoir modeling and WSM-related aspects of climate change assessment were completed by December 2016. Responses to remaining questions were completed in the summer of 2017 once the designated approaches were finalized and documented by the CBP.

Overall, the review panel as a whole was favorably impressed with the integrated P6 WSM framework. Recommendations from the review panel focus largely on future actions such as a suggestion for the CBP to more fully exploit the multiple model framework and incorporate

estimates of uncertainty into the output. Other recommendations are for better justification and documentation of approaches taken.

The summary recommendations identified by the panel are:

- A more detailed and comprehensive description and rationale of model structure and linkages is needed to support decision-making.
- The precise role that multiple models play in influencing P6 WSM results and the methodology that is used to accommodate multiple models needs to be clarified.
- An accuracy or skill assessment of the underlying individual models used in the multiple model approach is warranted to better constrain model uncertainty.
- The panel encourages the CBP to transition from a multi-level model approach (e.g., several models providing a single point of input to the larger watershed model, which results in a single model realization) to a true ensemble model approach, which would allow for a Bayesian model analysis and a more thorough quantification of uncertainties.
- Uncertainty analyses should be developed for each P6 WSM model component; the panel believes this would be a natural extension of the ensemble model approach.
- Use of expert panels for establishing BMP (best management practices) efficiencies should develop an explicit basis/approach to evaluating and applying uncertainty.
- The CBP should commit to a process for improving the model's capability to represent processes of particle transport, storage, and reworking in the Chesapeake Bay watershed, as the Revised Universal Soil Loss Equation 2 (RUSLE2) foundation is questionable at the river basin scale.
- The CBP should encourage the development of sub-models that attempt to down-scale the watershed models while also exploring process-based mechanisms affecting water quality to help inform local decisions to target conservation and manage inputs.

We hope the Management Board, Goal Implementation Teams, and various workgroups find the recommendations outlined in this review report to be useful, and we look forward to your feedback. STAC respectfully requests a written response from the Modeling Workgroup by December 1, 2017.

Please direct any questions you may have about this report and its recommendations to Rachel Dixon, Coordinator of the Chesapeake Bay Program's Scientific and Technical Advisory Committee, or Zachary Easton (Virginia Tech) and Don Scavia (University of Michigan), co-chairs of the review panel.

On behalf of the entire STAC, thank you again for your consideration.

Sincerely,



Lisa Wainger

Chair, Chesapeake Bay Program's Scientific and Technical Advisory Committee