



**(1) Simulation of Climate Change Impacts on Processes and Land Management in the Phase 6 Watershed Model Influencing Chesapeake Water Quality**

1. How do the responses to future climate forcing in the present application of the CBP Watershed Model (WSM) compare with other comparable modeling efforts and frameworks? What causes differences and how can these be tested? Which assumptions and processes (regarding, for example, temperature, precipitation, soil moisture, evapotranspiration, plant growth, etc.) are particularly sensitive with regard to delivery of fresh water, nutrients and sediments to tidal waters? Are there more defensible assumptions or formulations that could be implemented by 2019?
2. Although the CBP Watershed Model simulation of climate changes through 2025 showed only small changes in TN and TP delivery to the estuary they indicated greater increases for more soluble and bioavailable forms that exacerbate estuarine hypoxia. Are these projections of nutrient speciation reliable and appropriate?
3. For the period extending at least to 2050, how should CBP modeling and assessment efforts account for potential impacts of landscape-level changes and practices related to climate change, e.g., urban and agricultural land use, forest composition and dynamics, agricultural cropping systems, irrigation, storm-water management, etc., on nutrients and sediments loads? Specifically, how can the sensitivity of and improvements in BMPs in response to climate change be incorporated in the modeling framework?
4. From the perspective of watershed processes, how can the uncertainty in model projections best be quantified and the degree of confidence communicated effectively to decision makers, both for climate impact assessment through 2025 and, in the longer term, through 2050.
5. What are the most critical needs for information, synthesis and research?

**(2) Simulation of Climate Change Impacts on Processes in the WQSTM Influencing Chesapeake Water Quality**

1. How do the estuarine water quality responses to future climate forcing (specifically including temperature increases, sea-level rise, and changes in inputs of freshwater, nutrients, and sediment from the watershed) in the present application of the CBP Water Quality and Sediment Transport Model (WQSTM) compare with those of other comparable modeling efforts and frameworks? What causes differences and how can these be tested? Which assumptions regarding both forcing (e.g., temperature, sea-level rise, watershed inputs) and processes (e.g., hydrodynamics and biological processes) are particularly consequential for the simulated distribution, timing and severity of hypoxia? Are there more defensible assumptions or formulations that could be implemented by 2019?
2. How should the next generation of the WQSTM and other estuarine models evolve to produce reliable estimates of climate change-related risks to water quality and other Bay restoration goals for the period extending at least to 2050? How might climate change modify the estuary in ways that would require reformulation of the structure and assumptions of the modeling approaches (through, for example, changes in ocean boundary conditions, winds, and solar radiation; retreat of shorelines and wetlands; and loss or invasions of species that have large influence on ecosystem processes)?
3. From the perspective of estuarine responses, how can the uncertainty in model projections best be quantified and the degree of confidence communicated effectively to decision makers, both for climate impact assessment through 2025 and, in the longer term, through 2050.
4. What are the most critical needs for information, synthesis and research?

### **(3) Assessment of the Overall CBP Framework of Climate Change Analysis and Incorporation in the TMDL**

1. What improvements to the current framework used by the CBP to determine the nutrient load reductions needed to compensate for the effects of climate change in the Chesapeake TMDL could reasonably be implemented by 2019? Answers should take into account the workshop deliberations on both (a) the watershed and estuarine components of the current model framework and (b) the methods employed to estimate additional load reductions based on modeled changes in attainment of dissolved oxygen criteria.
2. How should the uncertainties inherent in (a) future climate projections, (b) the WSM and WQSTM, and (c) estimation of load reductions inform the degree of confidence placed by decision-makers in adjustments in the TMDL proposed to compensate for climate change through 2025?
3. Beyond 2025, in consideration of the likely host of changes in both the watershed and estuary, both due to and in response to climate change, how might the present CBP model framework be adapted to guide Chesapeake Bay restoration goals to at least 2050? Should alternative modeling approaches be employed and how might they be used to inform management decisions?
4. As extrapolation of past trends becomes increasingly unreliable into the future, what models (or ensembles) of climate and other (e.g. sea-level, shoreline and wetland changes, acidification, etc.) drivers should be considered to provide a longer-term perspective for achieving Chesapeake Bay restoration goals, including, but not limited to, water quality attainment? How should regional downscaled model projections and the "delta method" be used and how should they be represented, e.g. by central tendency, confidence intervals or ranges? Which greenhouse gas concentration pathway scenarios should be considered?
5. What societal responses to climate change (e.g., greenhouse gas emission reduction requirements, rapid transition to renewable energy, increased demand for biofuels, food supplies, transportation, flood and water management) might present risks or opportunities for water quality attainment and how might these be included in the assessment framework and iterative risk management?
6. Which of the information and research needs identified at the workshop for the watershed and estuary are most critical from a management perspective? How could these needs be met? What should be the scope and focus of the proposed STAC climate change synthesis?