# Modeling Quarterly Review Meeting

July 22nd and 23rd, 2014

http://www.chesapeakebay.net/calendar/event/21646/

**UPCOMING MEETINGS**

**September Modeling Workgroup Conference Call**
Date: September 4th, 2014
Time: 10:00AM – 12:00PM
Location: Conference Call
Conference Line: 1-866-299-3188 code 410-267-5731
Adobe Connect: https://epa.connectsolutions.com/modeling (enter as guest)
Event webpage: http://www.chesapeakebay.net/calendar/event/21924/

**October Modeling Quarterly Review**
Date: September 30th and October 1st, 2014
Time: 10:00AM – 3:00PM
Location: Joe Macknis Memorial Conference Room (Fishshack) CBPO 410 Severn Avenue Annapolis, MD
Conference Line: 1-866-299-3188 code 410-267-5731
Adobe Connect: https://epa.connectsolutions.com/modeling (enter as guest)
Event webpage: http://www.chesapeakebay.net/calendar/event/21917/

**MINUTES: JULY 22nd, 2014**

**Review of Modeling Workgroup Priorities – Lee Currey, MDE & Dave Montali, WVDEP**
*Attachment A*

**Phase 6 Watershed Model Schedule – Gary Shenk, U.S. EPA-CBP**
*Attachment B*

Gary Shenk presented an updated development schedule with key links to the 2017 Midpoint Assessment schedule. The schedule details what is needed and when for the Phase 6 modeling effort to move forward and covers the key objectives of 1) establishing Phase 6 targets, 2) developing scenario sensitivities, and 3) Phase 6 calibration procedures. This will be presented to the Water Quality GIT at their next meeting. In addition, in preparation for the afternoon's phosphorus presentations, a review of the Phase 6 model structure as it relates to the simulation of phosphorus was presented.

**Discussion**

- **ACTION**: The Modeling Workgroup and Water Quality GIT are working to devise a document and webpage in order to keep the Chesapeake Bay Program Partnership up-to-date on mid-point assessment development of Scenario Builder and the Watershed Model. Contact: Gary Shenk.

- Need further discussion on whether or not it is appropriate to include mid-point assessment development that is not Scenario Builder and Watershed Model development (i.e. oysters, James River Watershed Model, Airshed Model, etc.).

- Discussion included roles of WQGIT and Modeling WG and resulted in the following:

  WQGIT
  - Land use (Landuse Workgroup)
  - Fertilizer and Manure Applications (Agriculture Workgroup)
  - BMP effectiveness
  - BMP implementation accounting
  - Scenario Builder Development and Code Versioning (at CBP)

  Modeling WG - Watershed Model page
  - Watershed Model Development and Code Versioning
  - Calibration Methodology
  - Land use Loading Rates (with WQGIT and WGs)
  - Sensitivities to inputs
  - Fine Scale Processes (with LUWG) - This has significant impacts for urban sector.
  - Lag Time
  - Atmospheric Data
  - Climate Change - compiling information.
  - Conowingo and other Reservoirs

*Schedule – Working 2017 Midpoint Assessment Modeling schedule*

- Oct 20, 2014 – Rough Draft of major changes to nutrient processing in Scenario Builder will need to be complete. (Examples: land use types and manure application rules)
- March 20, 2015 – All major partnership decisions are made on changes to scenario builder processing and data. Scenario builder final modifications begin.
- Oct 20, 2015 – All inputs are final and delivered to the WSM by the scenario builder team for the final calibration run
- Dec 20, 2015 - Phase 6 draft model is complete. Evaluation followed by fine tuning during this year
- September 2016 – Final comments on the draft Phase 6 model
- Dec 20, 2016 - All models are final. The partnership decision-making process begins to discuss how these new models will be used in the WIP3 process

*Small scale processes*

- **ACTION**: Request that the Center for Watershed Protection present an update on their work on the small scale between the unit land use and the $4^{th}$- $5^{th}$ order streams simulated in the Watershed Model at the October Modeling Quarterly Review.

  *Lag times and groundwater*

  - **ACTION**: Request Ciaran Harman October Modeling Quarterly to discuss gamma function and application in Phase 6.

  - The Modeling WG should contact Claire Welty about the mapped the groundwater flow paths and durations for the upper Chesapeake.

  - There are lag times associated with many different issues, so need to insure that when the Modeling WG discusses lag times they are specific about which type. Therefore this discussion is on groundwater lag times.

  *Conowingo, Reservoirs, and Farm Ponds*

  - The Conowingo has specific implications in regards to management. For example, changes the level of attainment in CB4, which has implications on allocations.

  - **ACTION**: Request USGS to present possibilities for reservoirs and farm ponds in the Phase 6 Watershed Model.

  - **ACTION**: Request Bob Hirsch in for discussion of increased scour and decreased trapping in the Conowingo at Tuesday Meetings after October.

  - **ACTION**: Request UMCES/USGS Conowingo study to Modeling WG October Quarterly.

  *Climate Change*

  - AGCHEM can provide more flexibility when studying climate change. PQUAL is not adequate for simulating climate change effects other than hydrology and perhaps sediment. Use AGCHEM and other models to summarize climate change findings.

**PQUAL Sensitivity to Inputs – Guido Yactayo, UMCES**
*Attachment C*

To Guido Yactayo presented recommendations for PQUAL sensitivity to nutrient inputs derived from multiple watershed models.

**Discussion**

- Please email Guido Yactayo for the documentation of the PQUAL sensitivities to inputs work. This document will be updated as the work continues.

- These results are being used as a prototype for the Phase 6 Watershed Model. Further analysis is planned including a regional analysis, further phosphorus discussion (starting after lunch), and the effect of scale between the different models.

**Customer Expectations Survey – Peter Tango, USGS**
*Attachment D – Presentation*
*Attachment E – Draft monitoring survey questions*

The Chesapeake Bay Program (CBP) is reviewing approaches to ensure the long-term sustainability of its monitoring networks. As part of the process, STAR is researching customer expectations of the monitoring networks. The survey could be useful for the Modeling WG to gain feedback on its products as well. STAR requested input from the Modeling WG on how to include modeling related questions to this survey and a specific intended audience list.

**Discussion**

*Comments on Audience*

- Tier 1 audience list:
  - 2017 Mid-point assessment and Chesapeake Bay Watershed Agreement decision makers, implementers, and organizers.
  - Should also include EPA Region 3, TMDL staff, and TMDL permitting staff.
  - The GITs are included in the audience now, but Workgroup Chairs should also be included.
- Tier 2 audience list:
  - Include local jurisdictions and groups.

- UPDATE: At the meeting, STAR requested feedback on the survey questions and a specific audience list from the Modeling WG members, but shortly after during a STAR Leadership Meeting the timeline and questions of the survey have changed drastically and STAR will likely

bring this back to the Modeling WG in 2015 before they formally request input.

**Phosphorus Modeling with Variable Source Hydrology – Zachary Easton, VT**
*Attachment F*

Zachary Easton presented on variable source hydrology and its implications for phosphorus transport in the Chesapeake region. Zachary outlined plans for two recently-funded National Science Foundation (NSF) grants involving simulation with SWAT-VSA (Soil and Water Assessment Tool – Variable Source Area).

**Discussion**

- Generalization of the denitrification and ditch control for management of saturated soils could be beneficial to the Phase 6 Watershed Model.
- Even if this cannot be incorporated into the Watershed Model, it is important to keep track of these types of tools. This tool in particular can help advisor managers on a smaller spatial scale.
- ACTION: Requested that Zachary Easton presents an update at a future Modeling Quarterly Meeting.

**STAC review of CBP Watershed Model Phosphorus Processes – Ken Staver, UMd College of Agriculture**
*Attachment G*

The findings from an upcoming Scientific and Technical Advisory Committee (STAC) review of phosphorus simulation were discussed.

*Recommendations*

- General
  - Identify the fraction of phosphorus losses associated with short- versus long-term management.
  - Model function should be capable of scaling down to provide segment and field guidance on drivers of phosphorus loss.
  - Shift away from using model logic and proxy data for key parameters.
- Soil Phosphorus Recommendations
  - Account for existing soil phosphorus reservoirs on a segment by segment basis.
  - Track segment phosphorus balances to determine whether soil phosphorus reservoirs are increasing or decreasing.
  - Describe the temporal dynamics of the effects of drawdown/buildup of soil phosphorus reservoirs on phosphorus losses.

    - Vary soil phosphorus isotherms based on soil type.
- Management of Phosphorus Inputs
    - Account for variations in phosphorus application method and if manure is incorporated.
    - Apply manure at rates and times based on watershed or regional information.
    - Account for phosphorus stratification that develops in soils in continuous no-till.
    - Account for interaction effect between tillage and manure application on potential for phosphorus losses.

*Future Data Needs*

- Segment baseline soil P levels.
- Information on P application methods.
- Spatial and temporal data on manure application.
- Inorganic P application rates.
- More systematic storm water sampling in predominantly agricultural watersheds for use in model calibration.

**Discussion**

- **ACTION**: STAC sent a letter to the Management Board associated with these recommendations. The Modeling WG and the Agriculture WG will be working closely on the Chesapeake Bay Program response to these STAC recommendations.

- The three Chesapeake Bay Watershed areas analyzed were PA dairy – Bradford county, Lower Susquehanna mixed – Lancaster county, and Delmarva poultry – Somerset county. All are manure-rich areas. Were any non-manure amended soil/areas analyzed?
    - No. The implications of this need to be considered.

- Manure application is highly variable and that is not captured in the current model. STAC recommendation is consistent with this concern. This is still being discussed during Agriculture WG meetings to determine land-uses for Phase 6 Watershed Model.

**APLE implementation in the Chesapeake Bay watershed – Alisha Mulkey, UMd-ENST**
*Attachment H*

A description of the Annual Phosphorus Loss Estimator (APLE) model and it's calculation of loads in the Chesapeake watershed will be provided.

**Discussion**

- Nutrient management vs. non-nutrient management land-uses
    - Why are the nutrient management loads higher than the non-nutrient management loads? The transport factors are essentially the same. The uptake factors are slightly lower for nutrient management land-uses. There are also fewer acres for nutrient management land-uses, which seems to be the driver for the higher average and median loads. This is still being investigated.

- Losses estimated for sediment-bound P are especially high for some land segments due to high RUSLE soil erosion rates, e.g. southern Maryland counties .

- APLE is on a different spatial scale than the Watershed Model, this analysis is showing edge of field loads (before BMPs are applied, variable hydrology, other dynamics between edge of field and edge of stream that would capture a percentage of the load, etc.), while the Watershed Model is showing edge of stream. APLE can help determine sensitivities and provide a spatial breakdown.

- The spatially variable distribution of APLE vs. the homogenous distribution of Watershed Model needs to be considered. This is new information that is important to include in the discussions of the Phase 6 Watershed Model.

- The APLE model was validated by using measured sediment, flow, and soil phosphorus and then the model was predicting the change in soil phosphorus and total flux of phosphorus.

- The Modeling Team is working to determine whether or not using APLE's spatial distribution vs. the spatial distribution of the Watershed Model reduce the regional factors.

**Spatial Estimates of Phosphorus Transport in the Chesapeake Watershed Using Sparrow – Scott Ator, USGS**
*Attachment I*

The spatial patterns and causes of differences in phosphorus fate and transport in the Chesapeake watershed were discussed.

*Summary*

- Review of the delivery variation factor (i.e. "delivery factor", "relative upland erosion vulnerability", or $DVF_i$) allows visualization and explanation of why and how different areas of the watershed process or transmit nitrogen and phosphorus from uplands to streams differently.
- Allows quantification of relative upland processing retention in different areas.

- Limitations of this method were also discussed.

**Discussion**

- USGS is preparing a paper for JAWRA presenting the approach and demonstrating it for the case of total nitrogen in the Chesapeake Bay Watershed.

- After the plan is published, USGS can then try different calibrations of the Bay total nitrogen and total phosphorus models to provide the most useful output for understanding fate and transport and other applications.

**Application of SPARROW for Target Load Specification – Ross Mandel, ICPRB**
*Attachment J*

An application of SPARROW output to potentially decrease the degree of Watershed Model regional factor application was presented.

**Phosphorus Discussion – All**

The Modeling WG discussed the emerging science of phosphorus dynamics in the Chesapeake watershed and its implications for Phase 6 Model development.

- **ACTION**: Need a conceptual diagram to help visualize where all of these models/studies are fitting into the Phase 6 Watershed Model.

- **ACTION**: The Chesapeake Bay Program Modeling Team will continue to work with today's presenters to include these phosphorus models/studies.

- Two extremely high STAC recommendations are to consider soil phosphorus storage as a factor and short term management effects.

- Johns Hopkins added that further analysis of sediment transport and erosion should also be an extremely high recommendation.

- Johns Hopkins is working on a grant that considers climate change effects on farming decisions (i.e. double and triple cropping).

**MINUTES: JULY 23rd, 2014**

**Announcements and Amendments to the Agenda – Montali-Currey**

**Phase 6 Prototype – Gopal Bhatt, Penn State**
*Attachment K*

A prototype of the Phase 6 Watershed Model based on the HSPF PQUAL simulation and with an updated precipitation input dataset, hydrology, and sediment simulations was presented.

*Conclusions – Sensitivity Prototype (first approach):*

- Calibration run was de-trended to create a baseline scenario to be used for running management scenarios.
- Sensitivity based accounting of nutrient export was implemented.
- Sensitivity algorithm was developed to offer maximum flexibility.
- Sensitivity code was verified.
- Code offers ability to incorporate appropriate sensitivity functions.

*Limitations of the framework of the first approach:*

- Currently PQUAL calibration does not account for seasonality of input (+/-)
- Export estimated from 'sensitivities' using this method would not be able to account for changes in input pattern, if any.

*Advantages of the BTC Approach (alternative approach):*

- Proposed framework is simple, easy to understand; and offers accounting of management scenarios.
- Offers ability to incorporate evidence based understanding of the watershed response.
    - E.g., Sensitivity, Residence time
- Framework ensures consistency between long-term export estimated from 'sensitivity' and export from hourly outputs.
- Framework is directly related to inputs. It provides ability to handle scenarios with not only changes in application rate, but application pattern.

*Next Steps:*

- Continue with the implementation of Breakthrough Curve (BTC) Approach.
- Combine sensitivities with BTC Approach for running management scenarios.

**Discussion**

- **ACTION**: Gopal Bhatt will continue this work with the BTC Approach (alternative approach).

- **ACTION**: The BTC Approach (alternative approach) directly relates to the proposal that Ciaran Herrman (Johns Hopkins). Request Harman to attend the October Modeling Quarterly to discuss gamma function and application in Phase 6 Watershed Model.

- The Modeling Team could use AGCHEM to compute the components, but the Modeling Team is interested in investigating empirical response functions from studies, such as the one from Johns Hopkins because it could better capture groundwater lag times and other factors.

**Calculation of Oyster Benefits with a Bioenergetics Model of the Virginia Oyster – Carl Cerco, U.S. CoE ERDC**
*Attachment L*

Carl presented a bioenergetics model that is formulated and validated for the Virginia oyster (*Crassostrea virginica*). The model considers two basic properties of a bivalve population: number of individuals and individual size. Individuals are represented as three energy stores: soft tissue, shell, and reproductive material. The bioenergetics model is coupled to an oyster benefits module. Calculated benefits include various aspects of carbon removal, nitrogen removal, phosphorus removal, solids removal, and shell production. The bioenergetics model is coupled with a representation of the physical environment based on the tidal prism approach and with eutrophication kinetics from the CE-QUAL-ICM model.

*Advantages of the Bioenergetics Approach*

- Representation of three energy pools (soft tissue, shell, reproduction).
- Population dynamics.

*Disadvantages of the Bioenergetics Approach*

- Highly parameterized.
- Requires population-specific information (mortality, recruitment).
- The conversion between energy and mass is clumsy (and unnecessary).

*The Next Steps*

- Oysters were "downplayed" in the development of the 2010 TMDL. We know we want to investigate oyster refuges and aquaculture operations in the 2017 reassessment. Is this approach desirable for the 2017 reassessment?
- Explore application to the Chesapeake Bay.
- Compare with previous model.
- Improve parameterization. Apply to additional data sets, locations.
- Couple to ICM diagenesis model and resuspension algorithms.
- Investigate potential for use in aquaculture applications.

**Discussion**

- **ACTION**: The draft report Calculation of Oyster Benefits with a Bioenergetics Model of the Virginia Oyster is posted on the Modeling WG webpage.

- STAC Report recommendation to NOT use natural oyster population as a reduction credit for water quality until the appropriate data is available. This recommendation and others from the study must also be considered. http://www.chesapeake.org/pubs/307_Luckenbach2013.pdf
    - Could focus Carl Cerco's work on the Great Wicomico, Horn Point aquaculture, and Harris Creek data for application of oyster models for initial analysis. Concern from STAC members in attendance: These numbers should not then be adopted bay wide.
    - Johns Hopkins also expressed concern with a bay wide recruitment. This information could instead drive and target monitoring data. The models should not be applied or used in a TMDL scenario until the appropriate data is available.
    - Clarification: In order to receive credit for oyster harvest or anything that could be considered a BMP or reduction towards the TMDL, the practice would have to travel through the CBP BMP protocol.

- There are existing modeling frameworks to do much the same thing as the model Carl Cerco presented. They seem to be less dependent on local empirical parameterizations. However, they should at least be studied and compared to Carl Cerco's model as alternative approaches.
    - One specifically for aquaculture operations considers bioenergetics, growth, and environmental impacts of shellfish aquaculture from a variety of points of view (www.shellsim.com).
    - Margaret Dekshenieks, Eileen Hoffman, and co-authors have published other oyster population models (e.g., Dekshenieks, M. M., E. E. Hofmann, J. M. Klinck and E. N. Powell (2000). "Quantifying the effects of environmental change on an oyster population: A modeling study." Estuaries 23(5): 593-610.).

- There is a lot of recent, and in some cases underway, research on these and related issues. If oyster resurgence, oyster sanctuaries and aquaculture are important to consider for 2017, then a workshop focusing on them sometime in the next year or two would be timely and valuable.

**Extension of the WQSTM WQ Simulation to 2011 – Carl Cerco, U.S. CoE ERDC**
*Attachment M*

To support the shallow water multiple model simulations of the Chester River Carl Cerco presented plans to extend the water quality simulation to 2011 by the close of July.

**Discussion**

- Lewis Linker will discuss conducting a comparison between the years that the overlap for the hydrodynamic simulations with Marjy Friedrichs and other members of the shallow water modeling analysis teams.

- What is meant by shoreline erosion averages? That is up to the PIs of the analysis; can provide annual, seasonal, or daily average. It was suggested that the PIs would want the climatology with seasonally varying loads.

- In the latest bay simulation, shoreline erosion does not include associated nutrients.
    - May want to include the default values from the recent shoreline erosion BMP team for consistently with model applications and management actions.
    - As follow-up, the Modeling Team will confirm: Were shoreline nutrient inputs included in the Phase 5.3.2 version of the modeling system?
        - The Modeling WG will need to determine whether it should be included in the current version with a supporting rationale.

**Progress in Shallow-Water Modeling Application in Chester River – Richard Tian UMCES**

*Attachment N*

Richard Tian presented an overview of the shallow water analysis using FVCOM (Finite Volume Coastal Ocean Model) and ICM (Integrated Compartment Model) in the shallow waters of the Chester River.

**Discussion**

- Richard Tian is one of the lead support members for the Shallow-Water Modeling Application. Different PIs will be presenting progress at every upcoming Modeling WG Meeting.

**Multiple Model Assessment of Shallow Water Systems – Jeremy Testa, UMCES**

*Attachment O*

Jeremy Testa presented an overview of the work UMCES is doing in the shallow water model application and analysis of a coupled hydrodynamic- biogeochemical model using ROMS (Regional Ocean Modeling System) and RCA (Row Column AESOP) in the shallow water habitats of the Chester River.

**Discussion**

- The group briefly discussed many questions/possibilities for this analysis. These topics included groundwater input (suggested that Scott Ator and Judy Denver are contacted to determine if there are wells monitoring in the area), oxygen consumption, nutrient uptake from benthic algae, phosphorus release/flux at higher pH levels, and the possible effects on criteria assessment. No decisions were made in regards to these issues.

- Maryland conducted a site specific nutrient TMDL for the Corsica in 1997.

**James River Chlorophyll – Arthur Butt, VADEQ**

The status of the James River chlorophyll analysis was reviewed.

**Discussion**

- Presented the modeling framework in May: James River Chlorophyll – Chesapeake Modeling Symposium 2014.

- Arthur Butt will send Kevin Sellner the new dates for the STAC review of the James River Chlorophyll analysis.

- When the James River Model is calibrated and scenarios are able to be run, there will be a deeper discussion on how this model could be incorporated into the work at the Chesapeake Bay Program. The Chesapeake Bay Program Modeling Team is available to provide boundary conditions when they are requested.