Modeling Quarterly Review Meeting

Watershed Modeling

CBPO Conference Room - The Fishshack
410 Severn Avenue Annapolis, MD 21403

MINUTES: November 3

Review of Modeling Workgroup Membership – Dave Montali, WVDEP - Lee Currey, MDE
Attachment A.1, *Attachment A.2*

- Lee reviewed the schedule of Phase 6 model development through 2017, as well as the schedule for final beta development through the end of 2015.
- As a reminder, several STAC reviews and workshops concerning modeling efforts will be occurring over the 2016 time period.
- The climate change workshop will deal with scenarios and forecasts, and the climate change review to follow towards the summer of 2016 will be a review of the modeling approach to climate change.
- Lee and Dave also reviewed the core values of the modeling workgroup's path forward, membership of the workgroup, and went over the requirements for workgroup consensus in model development.
- Comments regarding this document should be sent to Dave Montali, Lee Currey, or Kyle Hinson by the December meeting.

Phase 6 Watershed Model Schedule Update – Gary Shenk, USGS/CBPO
Attachment B

- Gary presented further updates of the development schedule with key links to the 2017 Midpoint Assessment schedule.
- Gary also reviewed the conceptual model for Phase 6 development, highlighting what still needed to be reviewed throughout the quarterly meeting.
- While no new information is currently coming in to the model, the remaining pieces are still being put together.

Phase 6 Reservoir Simulation Progress – Gary Shenk – Ross Mandel, ICPRB
Attachment C.1, *Attachment C.2*

- Ross provided a general overview of the representation of reservoirs in Phase 6, excluding the Conowingo, and discussed some of the motivations for changing the ways that reservoirs are represented in Phase 6. Ross also gave an overview of two different methods available for representing reservoirs, through HSPF and through SPARROW.
- Work on developing appropriate diversions to achieve a better mass balance is also proceeding, information regarding withdrawals in tidal areas should be sent to Kyle Hinson.
- The effects of reservoirs and impoundments at a finer scale have been represented in Phase 6, by taking into account the losses and reaches with stream to river delivery factors. There are over 4000 reservoirs and impoundments that are captured using SPARROW.

- SPARROW is a non-linear regression model that represents N and P loads on the scale of NHD+, and represents a coefficient of the loss in a reservoir or impoundment.
- What most distinguishes a reservoir from a river reach is an FTABLE, which is a relationship between the reservoir or impoundment volume (an independent variable) and outflow, as well as surface area and depth.
- The SPARROW model does not utilize flows that are modified by diversions, it bases its annual flow based on natural flow in the reach.
- If the reach is not represented in HSPF, the reservoir cannot be represented in the model.
    - If a reservoir impoundment is missing in SPARROW, it can be very easily added into the model (in contrast with HSPF), if the NHD+ reach on which it lies and the surface area are both known.
- Impoundments added in SPARROW only take into account the effects of nutrients. Sediment can only be simulated when reservoirs are promoted to HSPF representation.
    - Reservoir sediment dynamics are not accounted for, SPARROW represents a static picture of average effects.
- There is a proposal to remove those impoundments that are functioning as BMPs in the SPARROW calculation in order to avoid double counting.
- Norm Goulet noted that many facilities were designed for purely hydrological purposes, and some jurisdictions are trying to determine if water quality benefits can be gathered from these facilities.
- Ross needs states to respond to issues of double counting early in the process, discussion about removing reservoirs may fall to local or state jurisdictions.
- ACTION: Ross will distribute to the Modeling WG a message similar to that sent out to the WQGIT regarding decisions to be made for removal of SPARROW reservoirs in order to count them as BMPs. There was discussion regarding whether or not this decision will fall to state or local jurisdictions as well.
- Gary reviewed the efforts to represent dynamics of the Conowingo reservoir and the upper two reservoirs as well that form part of the Lower Susquehanna dam network, the scour and deposition dynamics present in the HSPF simulated reaches, and presented other options for modeling the reservoir.
- Tom Ihde asked if in the Phase 5 model there was a document that discussed the sediment and nutrient calibrations in the lower Susquehanna reservoirs.
    - Parameters can be provided, but documentation for those specific reservoirs does not exist.
- Are there some effects that can be apportioned to other reservoirs or is it all assumed to come directly from Conowingo? How can different parameterizations occur?
    - Currently there exist more parameters than operations, and these must be constrained. There may be potential to simulate the upper two reservoirs as existing in dynamic equilibrium, but it is still dependent upon the findings from the STAC Conowingo Workshop. For the December timeline, the Conowingo will be simulated in the same manner as Phase 5, modifications will occur after guidance is received in 2016.
- A further increase in 10 years of data will also be used to drive the more current calibration.

Developing Information for Phase 6 Conowingo Calibration – Bruce Michael, MDNR
Attachment D

- Bruce discussed the monitoring program that was developed for Lower Susquehanna assessments of high flow events to better understanding of scour events and provided updates on research efforts that have taken place to date.
- There is a need to develop a better understanding of materials behind other dams, and this information may be able to be collected in the spring after the ponds thaw. There is work underway with Mike Mallonee to get the data to the Bay program in the correct format by the end of November 2015.
- Jeff Cornwell noted that core samples will be collected in the spring, and there is a possibility that in the short timeframe there could be results produced regarding comparative reactivity across the three reservoirs. However, in the short time left in the project, a determination of long term partitioning into the G1, G2, and G3 components is not feasible.
- All sediment exchange networks will likely be available at around the time of the STAC Conowingo workshop.

A Multiple Model Approach to Conowingo Simulation – Jim Fitzpatrick, HDR HydroQual
Attachment E

- Jim outlined the format of the existing model for the Conowingo Reservoir, and proposed further refinements to modeling what occurs behind Conowingo Dam which could also be extended to other ponds and reservoirs behind the dam.
- There is no mass balance currently and there is no split among labile, refractory, and inert sediments trapped in the reservoir.
- The goal is to combine information coming out of the WSM with an explicit hydrodynamic sediment transport model that would calculate movement through the reservoir as well as deposition. This could then be tied to a water quality/sediment flux model.
- HSPF treats the reservoir as a single box but the CPMBM is much finer as a 2-D model throughout the pond.
- There was discussion regarding whether or not the Conowingo model would act as a direct replacement or be used to inform HSPF, and generate the same outputs required for the WQSTM run by Carl Cerco.
- The Conowingo model under development contains both a hydrodynamic and sediment transport model within the water column, which act as the drivers for scour and deposition, and determine where these actions occur in the pond. There is no eutrophication component in the model, and is similar to the operation of Carl Cerco's model in that hydrodynamic output is fed to water quality where labile organics can be partitioned.
    - Would flux coming out of the sediments affect the amount of algae and labile organics existent in the Conowingo?
        - If in moving forward the model is linked in one direction, then the method proposed above may work best to address this issue.
- Exelon is willing to fund the project with the following caveats:
    - The extended simulation of Conowingo Pond will be used and incorporated into the Phase 6 Model.
    - The model will be developed in consultation with members of the Modeling WG.
    - The model will be subject to peer reviews by STAC and/or other parties before final approval.
- Although the development of Phase 6 rejects the notion of modeling to learn things in favor of a simplified model that supports greater partner collaboration, the modeling team

has in fact ended up learning through the process of employing multiple models. In a similar manner, this Conowingo approach could not feasibly be implemented for 1000 different scenarios with reasonable run times, but it is also necessary to have models that learn something in order to build that knowledge into Phase 6 and help efforts to simplify and determine emergent behaviors.

- ACTION: There will be a follow up call with modeling leadership, Jim, and other Exelon partners and contractors involved with the development of the Conowingo model.
- There may also be a need to bring this up to the WQGIT, and more opportunities to inform the partnership will benefit future modeling efforts.
- Carl Cerco noted that the interpretation of what's going on at Conowingo should be very data driven, and could be thought of as a sort of statistical analysis. Models may be inconsistent with what is occurring without sufficient data.

Phase 6 Lag Time Simulation Progress – Gopal Bhatt, PSU/CBPO – Gary Shenk
Attachment F.1, *Attachment F.2*

- Gary reviewed the motivations for incorporating lag times into the Phase 6 model, and Gopal discussed further the technical aspects of lag time simulations as well as the progress made in development.
- Hydraulic conductivity data is used as a proxy to create spatial variability across the watershed with regards to lag times.
- We have an estimate of depth to water table for the entire basin as well as an estimate of groundwater recharge
- Jim asked about the process by which initial conditions are set further back in the record, e.g. 50-80 years.
    - It is easier with phosphorus, because in a way the history is measured with the soil Mehlich values. We don't need to go back in time for the records, rather soil Mehlich values (the soil application rates) become the initial condition.
    - Nitrogen may necessitate the development of a similar method, but comparable lag times may not be required.
- Using data from Ward Sanford's model regarding depth to groundwater and its relationship to recharge, it is possible to determine median lag time at specific locations.
- For major river systems, do we currently have a mechanism for determining surface lag in dissolved systems?
    - Yes we do, from the field to the edge of stream.
- Attempts to translate NY's soil phosphorus test results to Mehlich values may result in further complications, and NY may have artificially low Mehlich scores.
- It may be found that if as lags are shortened or lengthened, there will be improvements in matching the frequency distributions of concentrations. This may also help to provide insight for the relative dearth of information regarding lags currently available.

Update on Phase 6 Inputs - Matt Johnston, UMD – Jeff Sweeney, EPA/CBPO
Attachment G

- Jeff provided an overview of motivations for improving the watershed model inputs as well as the numerous different tools used and what is currently available.
- Revisions have been completed for several different inputs including manure and wastewater discharge, among others.

- April is the set timeframe for a preliminary calibration. If partners wish to include BMPS that would require difficult reprogramming, then it has a much lower chance of being implemented.
- Will uncertainty in inputs be factored into the STAC workshop?
  - It is likely that it will be brought up, and it is a large task to undertake to fully quantify the model uncertainty. It is unlikely that the workshop will conclude with an exact number specifying the total model uncertainty.

Estimating Edge-of-Field Erosion from Cropland and Pasture using RUSLE2 – Peter Claggett, USGS/CBPO
Attachment H

- When using RUSLE in a lumped parameter model, the land use team is using higher resolution (spatial and temporal) land use data and survey soils information.
- The methods employed also account for floodbank erosion and floodplain deposition.
- The length-slope factor outlined in the presentation is the most influential factor controlling sediment erosion in the land use model.
- An estimate of field erosion is translated to the edge of small streams through existing sediment delivery ratios used in the Phase 5 model.
- Tom Sullivan asked if the land source is more or less treated as an infinite source of sediments.
  - This is true, so that even with a high land-slope factor there is no limit. In response to the question regarding the likelihood of a deep soil profile existing in perpetuity in a highly erodible location, it was determined that this may not be currently possible from a management perspective, but is worth keeping in mind for the future.

MINUTES: November 4

WQSTM Calibration Status – Carl Cerco, U.S. CoE ERDC
Attachment I.1, *Attachment I.2*, *Attachment I.3*, *Attachment I.4*

- A three phase study is currently underway investigating marsh loss and transition due to SLR, the reactivity of material eroded from marshes in the Chesapeake Bay, and quantifying effects of marsh loss on water quality and its corresponding implications for the TMDL.
- There is a need to quantify loss of wetlands in the Bay and considerations of the loss of wetlands' function in addition to loadings to the Bay. A better understanding of wetlands' function within the model can also help provide insight into processes and feedbacks.
- Development to complete this will require a great deal of effort in gathering GIS and DEM data. A DEM in the near-shore area would be critical since most uncertainty is around the 0-2 meter depth marks, but is difficult to obtain due to the necessary specific picture timing.
  - There may be a possibility of piggybacking these efforts onto the Phase 3 Land Use model with its DEM efforts.

- SLAMM (Sea Level Affecting Marshes Model) is being used in MD to project marsh migration and marsh loss. The question to be answered revolves around whether or not there is utility in using this application.
    - For Carl's team to obtain and use SLAMM is beyond their scope. If someone had the results from those SLAMM projections mapped into a GIS format, then that could be taken to the team.
        - GIS outputs exist in MD, but may not exist in VA.
        - ACTION: Zoe Johnson to help provide SLR projection materials for Maryland to Carl.
- Scott discussed the tool being used by the North Atlantic Conservation Cooperative that may help summarize and inform the discussion of SLR and accretion rates. This will be sent to Zoe, Carl, Lew, Larry Sanford, and any others who are interested.
- Carl presented estimates of nitrogen and phosphorus load removal by wetlands, as calculated by WQGIT estimates of those rates.
    - Wetland losses resulted in chlorophyll increases seen in areas relatively distant from the usual culprits, e.g. point sources.
- As a first look at wetlands removal, changes are predicted to be relatively small but may occur in areas that are critical to TMDL attainment.
- Raleigh Hood pointed out that it may be beneficial to consider accounting for changes in DOM fluxes associated with marsh loss. Specifically, fluxes of DOC and DOM from marshes would be reduced as a result of marsh loss, and lessen oxygen demand.
    - Carl noted that it would be optimal to have a wetlands module that accounts for more than just denitrification and P values, avoids excessive complexity, and produces more effects than what have been seen thus far.
    - This version of the wetlands module will also be ready to incorporate into the Phase 6 model by May/June 2016.
- The Climate Change Workgroup will be examining goal attainment through a matrix framework for the Wetlands Workgroup. The first two elements of the project include a literature search and a collection of tools, data, and resources to analyze the findings of wetlands vulnerability to SLR. This may also be helpful with the discussion regarding SLAMM modeling.
- Raleigh is involved in a NASA funded project at SERC that models marsh biogeochemical cycling explicitly related to carbon and nutrient fluxes that could also help to inform Carl's efforts.
- Ping noted that an approach utilizing the wetlands module may be better because in that way the loads captured by wetlands can be lessened by different rates of SLR.
- Carl also reviewed some of the WQSTM calibration results, outlining significant progress made in DO predictions.
- Other issues were also discussed including: a persistent oxygen "bubble" consistently seen in the upper tidal fresh portions of modeled rivers in the WQSTM, chlorophyll loads not accounted for from non-simulated WSM rivers, the ratio of carbon to chl-a, and extreme chlorophyll growth conditions.
- Fishing bay is associated in the model with a significant number of wetlands, and the observations of DO don't crash to zero as the model suggests would result from the influence of wetlands. Carl is not currently available to develop an entire biogeochemical model, but there needs to be some sort of change.
- Currently there are no differences in the inputs from Conowingo in Phase 6, but they will be incorporated as model development continues

Conowingo Infill Studies – Jeff Cornwell, Jeremy Testa, and Larry Sanford –UMCES
Attachment J

- Jeremy first introduced efforts being undertaken regarding sediment biogeochemical modeling.
  - Two primary boundary conditions need to be established in order to run this model: the depositional flux of particulate organic material and the overlying water conditions.
- Hamlet Perez presented work that has been completed in the Cornwell Lab regarding sediment fluxes in the Conowingo Pond and the Upper Chesapeake Bay, and pointed out drivers and obstacles to nitrification and denitrification efficiencies.
- Jim Fitzpatrick asked what ideas are leading to the conclusion that denitrification is occurring from the water column in Conowingo compared to the sediment nitrate in the upper Bay.
  - The assumption is that the flux is downwards in Conowingo pond, unlike what occurs in the Bay.
- Ming Li and Xiaohui Xie are using an enhanced version of ROMS that is coupled with the SWAN wave model for circulation. Together these efforts are referred to as COAWST, and the next steps involve coupling these models with an atmospheric wind model and a sediment transport model.
- It is important to recall that in seeing an aerial photo of a sediment plume there is a very thin layer of freshwater carrying those fine particles which is not necessarily mixing well throughout the water column.
- It is as yet unclear how much of the information will be ready to transfer to the Bay Program modeling efforts by May 2016.
- Under low TSS conditions, there were virtually no flocculation effects. This may change in the presence of higher concentrations in the reservoir.
- The change in the distribution of different size class inputs is not accounted for in the Bay Program model.
  - There are relationships and mechanisms related to particle size and TSS in the WSM, but verifying the data has not been done to date.
- Weighting classes of sediment particles spatially may help to better develop specific processes in the WQSTM. Currently it is not possible to modify changes in sediment speed over time in the model.
- Carl Cerco noted that he was reluctant to enter into a recalibration of the WQSTM which may be required if settling velocities would need modification. However, issues may be present which could be explained as there is a great deal of fine sediment that never settles out, which may also be tied to WSM inputs.

Chester River Shallow Water Multiple Models – Richard Tian, UMCES
Attachment K

- Richard presented findings from his Chester River shallow water modeling efforts, using an application of the unstructured grid model FVCOM, and reviewed initial calibration efforts as well.
- Chlorophyll values are unlikely to grow at depth in the Chester, an improved settling function may be necessary.

- Low salinity bias from CH3D biases values all the way up the Chester River, but the SCHISM boundary condition performs a bit better. Still, Richard's use of CH3D does outperform other models' predictions of salinity

Phase 6 Septic System Loads – Vic D'Amato, Tetra Tech
Attachment L

- Vic reviewed the process of establishing and utilizing expert panel guidance for septic system loads and attenuation in Phase 6.
- Vic also presented a brief overview of STUMOD, a model that is being used to better determine attenuation rates and outline differences evident with different soil media.
- Further work is currently waiting for additional SPARROW model results to determine whether the STUMOD based approach to zone 1 would improve the statistical metrics for SPARROW; this would then indicate that insight is gained by using a spatially variable approach. Furthermore, the approach can provide insights into processes occurring in zones 2-4, where empirical data are lacking.

Progress in Simulating Lag Times with rSAS – Ciaran Harman, JHU
Attachment M

- Ciaran presented an overview of rSAS and its implications for inclusion in the Phase 6 watershed model.
- The parameterization is completed through the USGS MODFLOW modeling, best estimates of values, and statistical regionalization modeling.
- No specific assumptions are made for denitrification, rather the assumption is that the target we have based on models that implicit simulation of denitrification, take those into account.
- A monthly or annual time series of recharge loadings of nitrogen provided to Ciaran could help to better develop the initial condition. At the moment, it is assumed that all storage that is older than a certain age has the same concentration.
- Further work could focus on refining the sensitivity of outflows to recharge rates.

Analysis of Lag Times in the Potomac Watershed – Ward Sanford, USGS
Attachment N

- Ward presented findings from MODFLOW, representing porosities of different soil types measured by tracer transport through the subsurface in the Upper Potomac River Basin.
- The fit used by Ciaran for gamma distributions of travel time distributions was optimized to the first 25 years of the period under study.
- Ward's work will be used in the Phase 6 Beta 1 model, and more of Ciaran's work will be implemented in the Beta 2 model. Gopal's implementation of UNEC will be incorporated into Beta 1 building off of Ward's evaluations presented here.

Assessment of Bank and Flood Plain Nutrient and Sediment Loads – Greg Noe and Peter Claggett, USGS
Attachment O

- Greg outlined the framework by which the transport processes of sediment loads through streams and rivers are understood, as well as the methods by which measurements are made.
- Dynamic floodplain activities and processes are not only important for sediment fate and transport in the watershed, but phosphorus and, to a lesser extent, nitrogen as well.
- These efforts will utilize CBP expertise to develop a Chesapeake Channel Floodplain geomorphic GIS which will help create tools capable of extrapolating flux measurements outlined to the entire Bay watershed.
- Mean or median rates could possibly be applied to the Phase 6 Beta 1 model to begin to incorporate floodplain processes.

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