Chesapeake Bay Program
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410 Severn Avenue Suite 112 | Annapolis, MD 21403 | 410-267-5700

March 9, 2015

Dr. Kirk Havens, Chair
CBP Scientific and Technical Advisory Committee
645 Contees Wharf Road
P.O. Box 28
Edgewater, Maryland 21037

Dear Dr. Havens:

Thank you for the opportunity to respond to the Scientific and Technical Advisory Committee's (STAC) report entitled, "STAC Review of Agricultural P-dynamics in the Chesapeake Bay Watershed Model." This workgroup report is well-aimed and well-timed to inform the Chesapeake Bay Program (CBP) partnership as we build the Phase 6 version of the Chesapeake Bay Program Watershed Model (CBWM) to be used to support collaborative decisions by the partners starting in 2017.

Most of the changes being made to the phosphorus (P) simulation in the CBWM for the 2017 Midpoint Assessment are a direct result of this report, other STAC activities as noted in the report, and the interaction between CBP Office staff STAC-affiliated scientists from Universities, USDA-ARS, and USGS necessary to produce these reports. We are addressing the specific recommendations as follows.

Modeling Recommendations Related to Soil P:

1. ***Account for soil P reservoirs as a source of P to runoff on a segment-by-segment basis.***
2. ***Track segment P balances to determine whether soil P reservoirs are increasing or decreasing.***
3. ***Describe the temporal dynamics of the effects of drawdown/build-up of soil P reservoirs on P losses in runoff.***

The CBP's Modeling Workgroup (MWG), Water Quality Goal Implementation Team (WQGIT), and the WQGIT's workgroups are generally addressing these three recommendations from STAC's phosphorus report, as well as many other priorities, through the restructuring of the CBWM. As described in the STAC report, the Phase 5 CBWM was dependent on Hydrologic Simulation Program – Fortran (HSPF) for the simulation of phosphorus dynamics. Following

recommendations in STAC's report on multiple models[1], the Phase 6 CBWM has a modular design that allows the use of the most appropriate model or suite of models for each major process. Discussions within the CBP workgroups and with the STAC report authors have led the CBP partners to investigate the Annual Phosphorus Loss Estimator (APLE) as an appropriate model for phosphorus losses that incorporates most of the factors identified by STAC. As of late 2014, the CBPO has recoded APLE into a more convenient format to run multiple large-scale simulations. The MWG will be evaluating APLE for use in the Phase 6 CBWM during 2015.

As identified in the STAC report, APLE requires accurate soil phosphorus level data. The CBP has made arrangements to acquire county-scale data sets from testing labs. This will allow the CBP to better simulate the phosphorus balances on the management scale of the Chesapeake Bay Total Maximum Daily Load (TMDL).

The STAC phosphorus report, combined with the previous STAC report on lag times[2], identifies the temporal response of phosphorus draw down as a critical issue. It is anticipated that APLE will adequately simulate this lag and allow the MWG to consider this lag in the calibration of the CBWM. This additional knowledge of lag times will be useful to the CBP's Explaining Trends in Water Quality Team as it investigates the physical processes driving observed changes in water quality. The WQGIT will determine how these descriptions of lag times will be used in running and evaluating scenarios and supporting collaborative management decision making by the larger partnership.

Modeling Recommendations Related to Management of P Inputs:

1. ***Account for different P application methods, including whether manure is left on the soil surface, incorporated by tillage or incorporated with low soil disturbance full-width applicators, or injected in bands.***
2. ***Apply manure at rates and times based on watershed or regional information.***
3. ***Improve representation of practices aimed at reducing P runoff potential by adjusting the timing of P applications.***
4. ***Account for P stratification that develops in soils in continuous no-till.***
5. ***Account for interaction between tillage and manure application on potential for P losses as particulate and dissolved P fractions in overland and sub-surface flow.***

The above management recommendations will not be modeled explicitly by a mechanistic simulation in the Phase 6 CBWM. The CBP partnership has determined that the most appropriate method to account for these and other conservation practices is to consider multiple models and multiple lines of evidence within an expert panel. The Manure Injection/Incorporation Panel has yet to be to be convened, but its creation has been approved by the Partnership by the WQGIT. The guiding documents are not available, but the Partnership's Nutrient Management Expert Panel has recommended that the Manure Injection/Incorporation

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[1] Weller, D. E., B. Benham, M. Friedrichs, R. Najjar, M. Paolisso, P. Pascual, G. Shenk, and K. Sellner. 2013. Multiple Models for Management in the Chesapeake Bay. STAC Publication Number 14-004, Edgewater, MD. 37 pages.

[2] STAC (Chesapeake Bay Program Scientific and Technical Advisory Committee). 2013. Incorporating Lag-Times Into The Chesapeake Bay Program. STAC Publ. #13-004, Edgewater, MD. 66 pp.

Panel develop recommendations related to phosphorus stratification, speciation, and loss related to manure spreading practices and tillage including continuous no-till, covering recommendations 1, 4, and 5 above.

The Nutrient Management Expert Panel extensively discussed recommendations 1 and 3 above on the timing and method of phosphorus application. Due to the Partnership's desire to focus on near term milestone goals and recommendations for the Phase 5.3.2 CBWM, these topics were left out of the Panel's draft final report. However, the Partnership will convene a Nutrient Management Expert Panel to make recommendations for the Phase 6 CBWM that considers these topics.

The Agricultural Modeling Subcommittee (AMS) of the CBP Agriculture Workgroup (AgWG) is charged with developing the rules and data for application of manure, including the rates and times called for in recommendation 2 above. Discussions are currently underway within the AMS and the best available information will be used for the Phase 6 CBWM.

General Modeling Recommendations:
The following general recommendations from STAC are valuable guides for future modeling efforts. In some cases, these can be incorporated into the Phase 6 CBWM. Others will require a longer time frame to implement.

1. ***Identify the fraction of P losses associated with short versus long-term management strategies.***
   RESPONSE: Given the recommendations and the strategies to meet the recommendations laid out above, this will be a realizable goal. Most conservation practices discussed in Partnership's BMP expert panels will have a short term effect while the mass balance approach and the APLE simulation will allow for calculation of time lags in phosphorus soil drawdowns.
2. ***Model functions should be capable of scaling down to provide segment and field guidance on drivers of P.***
   RESPONSE: The Partnership's BMP expert panels' recommendations and large-scale modeling are necessarily general in nature. While these tools will provide guidance at the segment scale on the relative effectiveness of conservation practices in different regions, field-scale modeling for the Chesapeake Bay region will likely remain beyond our abilities for the near future although it should remain a long term goal.
3. ***Shift away from using model-generated values and proxy data for key input parameters.***
   RESPONSE: As noted above, the Partnership's Agricultural Modeling Subcommittee will be providing the data and methods on fertilizer and manure applications for the Phase 6 CBWM. The point of view expressed in this report is well represented in the AMS and regional data will likely be used where available.
4. ***Consider changing weather patterns associated with climate change.***
   RESPONSE: The MWG and WQGIT are committed to evaluating the effects of climate change as part of the Chesapeake Bay TMDL 2017 Midpoint Assessment.

It is expected that the hydrology and sediment simulation in HSPF, combined with the mechanistic simulation of phosphorus in APLE, will provide the CBP partners with estimates of phosphorus loading responses to climate change.

5. ***Better represent and report uncertainty in data sources and model output.***
   RESPONSE: As noted in the report, this is a recurrent request of STAC and is a long-standing goal of the MWG. The WQGIT requested an evaluation of uncertainty at its October 2014 meeting. Currently, the MWG anticipates working with uncertainty estimation in 2016 and 2017.
6. ***Differentiate between surface and sub-surface transport pathways of P loss and account for the role of drainage intensity.***
   RESPONSE: Subsurface transport of phosphorus, particularly in ditch and tile drain settings, is an area of active research. While currently there is not a mechanistic model available for these processes, the calibration of the Phase 6 CBWM will drive empirical estimates of these loadings.

Future Data Needs to Support Recommended Changes in Modeling Approach:
The CBP partnership appreciates receiving STAC's list of monitoring priorities. The timing of this list is fortuitous in that the three-stage Building And Sustaining Integrated Networks (BASIN) process is underway in the Integrated Monitoring Networks Work Group, under the oversight of the Partnership's Scientific, Technical, Assessment and Reporting (STAR) Team. It is understood that the list presented here is for assistance in setting future priorities by the CBP partners. Nonetheless, for the record please find updates below where the CBP partners have begun to collect these data sets.

1. ***Baseline soil P levels.***
   a. As noted above, work has already begun on gathering this important data set. Additional data access and a longer term record would improve the modeling.
2. ***Information on P application methods.***
3. ***Spatial and temporal data on manure application.***
4. ***Inorganic P application rates, including those associated with high-value row and horticulture crops.***
   a. As noted above, the AMS is working to produce the most accurate dataset for the Phase 6 CBWM for recommendations 2, 3, and 4. This work highlights the need for better data availability for manure and fertilizer applications related to the four Rs.
5. ***More systematic storm water sampling in predominantly agricultural watersheds for use in model calibration.***
   a. Since 2005, the CBP partnership's watershed water quality monitoring network has required storm samples at all primary monitoring locations, including many that drain watershed which are principally agricultural lands. These stations, now a decade or more into their improved datasets, are beginning to inform load and trend estimates used for model calibration. Additionally, the three USGS-USDA 'showcase' watersheds started in 2010, combining intensive conservation practices and monitoring, are beginning to show results.
6. ***Improved mapping of features that restrict water infiltration and promote "saturation excess" runoff.***

7. ***Improved mapping of drainage intensity as an indicator of hydrologic connectivity and P delivery potential.***
    a. The CBP partnership is now considering comprehensive, consistent basinwide LIDAR mapping that may provide useful elevation data for recommendations 6 and 7 if implemented. The MWG and CBPO Modeling teams are also working as collaborators on NSF-funded research that includes identifying and scaling up hydrologic landscape properties that affect the transport of phosphorus.

On behalf of the Management Board, I want to thank you for your thoughtful recommendations. Please extend our gratitude to the workgroup for the time and effort involved in the production of this report. We greatly appreciate the ongoing role of STAC in serving as an independent review body directly towards continually improving our overall management of the Chesapeake Bay and watershed restoration efforts.

Sincerely,

Nicholas A. DiPasquale, Chair
Management Board
Chesapeake Bay Program Partnership

ec: Management Board
Water Quality Goal Implementation Team