Scenario Builder and Watershed Model Plan for the MPA

DRAFT 2014 07 10

In preparation for the 2017 Mid-Point Assessment, the CBP Partnership has expressed priorities for the Phase 6 watershed model development which are detailed in documents under the 'Projects and Resources' tab on the Water Quality GIT page. Initial priorities were set in the October 2012 water quality GIT meeting. These priorities have been updated and refined by recommendations from subsequent workshops and CBP meetings. The MPA master schedule lists these priorities in a table format. Additional documents on the web page are specific work plans to accomplish these tasks.

Out of necessity, phase 6 development is occurring along multiple parallel paths. These must eventually meet in a draft phase 6 watershed model and scenario builder that will be ready for full partnership review beginning January 1 2016. These parallel paths encompass all of the CBP priorities.

This document summarizes the priorities and identifies lead researchers for each effort. The descriptions here are brief with links to more detailed workplans.

Land use

CBP Oversight: Land Use Workgroup
Lead: Jenny Tribo and Karl Berger
CBPO Contact: Peter Claggett
Priorities:

- Improve Spatial, temporal, and categorical representation of land uses: LUWG
- Review and refine modeled assumptions about forest: FWG
- Representation of federal land boundaries: LUWG

Description:
The Land Use Workgroup (LUWG) is leading the development of the Phase 6 land use data, including both historical and future projections. The LUWG is working closely with source sector workgroups under the WQGIT and with state agencies and local governments to ensure that the land use information used in Phase 6 is accurate, current, and reflects the state of the science and management actions for water quality restoration.

Progress:
Through close coordination with the WQGIT workgroups, the LUWG has developed a master list of proposed new land uses for Phase 6. The CBP Land Data Team and state agencies are actively developing, refining, and evaluating mapping protocols for each proposed land use. To map these new land uses, the LUWG distributed a request for local land use and land cover to state resource agencies. Tetra Tech is currently soliciting additional information from county and municipal governments. To date, data have been received from over 40 counties. Because the categories and resolution of land use/land cover data varies across jurisdictions, the LUWG is beginning the process to reconcile and cross-walk these data to the proposed Phase 6 classes.

Federal Land Boundaries

Mapping of federal property boundaries is important for accurately assigning responsibility for nutrient and sediment load reductions. The CBP GIS Team has worked with the CBP Federal Facilities Team to assemble a federal property boundary database. The GIS Team has also developed a web-based tool for federal facility managers to review and revise boundary and land use information.

Next Steps:
Need to know the list of land uses by Oct 2014 with draft acreage by Feb 2015
Expected Completion Date:
Oct 1, 2015

Fertilizer and manure application

CBP Oversight: WQGIT / AgWG
Lead: Curtis Dell
CBPO Contact: Matt Johnston
Priorities:

- Model Data Processing: AgWG
- modeling baseline-input data and assumptions
- Improve Spatial, temporal, and categorical representation of land uses: LUWG

Description:
The Ag Modeling Subcommittee (AMS) of the Ag Workgroup is working on updates to fertilizer and manure application as part up the update for scenario builder. Matt Johnston is the coordinator for this group.

Progress:
The AMS has prioritized the list of potential updates to scenario builder based on their impact on modeled nutrient and sediment loads and is discussing land use definitions. The AMS is making progress on determining data sources for nutrient and sediment loads.
Next Steps:
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Expected Completion Date:
Oct 1, 2015

BMP effectiveness

CBP Oversight: WQGIT
Lead: Jenn Volk, James Davis-Martin, Brian Benham
CBPO Contact: Lucinda Power
Priorities:

- establishment and update of BMP definitions and efficiencies: AgWG

Description:
The WQGIT is evaluating new BMPs, and improving their definitions and associated effectiveness values through the partnership approved BMP protocol process.

- WQGIT BMP Review Protocol

Progress:

The panels have been very active and continues to deliver BMP recommendations to the partnership. A consortium of universities under the leadership of Virginia Tech has received funding to help coordinate BMP expert panels as a supplement to the CBP process. In addition, Tetra Tech is available to provide technical and logistical support as well.

Completed panel reports are listed on ChesapeakeStat.
A separate web page for BMP panel reports is being prepared.

Next Steps:
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Expected Completion Date:
Oct 1, 2015

BMP implementation accounting

CBP Oversight: WQGIT
Lead: Jenn Volk, James Davis-Martin
CBPO Contact: Jeff Sweeney
Priorities:

Revisit watershed model calibration methods: MWG
Assess and explain water-quality trends: STAR

Description:
The effectiveness of CBP partnership watershed modeling in guiding decisions is dependent on accurate accounting of BMP implementation. This includes state and federal records as well as the systems that are used to collect the data

Progress:
There are several related efforts on BMP implementation

Historical BMPs – Jeff Sweeney - WTWG
Jeff is working with the partnership on the updating of the historical BMP database

NEIEN updates – Jeff Sweeney – WTWG
Jeff is supervising the changes to NEIEN based on input from the partnership

Non-Cost-Shared Data –Peter Claggett– AgWG
Peter is working on getting NRCS implementation data into a form that can be used publicly by the CBP.

Next Steps:
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Expected Completion Date:
Oct 1, 2015

Land Use Loading Rates

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Tetra Tech, Gary Shenk
Priorities:

Improve Spatial, temporal, and categorical representation of land uses: LUWG

Revisit watershed model calibration methods: MWG
Improve modeling accuracy of land use characteristics land uses: USWG

Description:

Land use loading targets will be based on multiple lines of evidence. Different types of modeling and monitored information will be incorporated from many sources. The MWG will oversee the process, but will welcome input from the WQGIT and its workgroups, particularly for relationships between different sub-classes within a large class. TetraTech will oversee the process as follows:

1. Set overall loading ratios between different broad land use types using large scale analyses.
2. Develop relationships between land use sub-classifications using literature and modeling
3. Apply relationships developed through other tracks
    a. Sensitivity to inputs
    b. Regional delivery differentiation
    c. Small scale effects
4. Final adjustments through Calibration to water quality data

Progress:

Broad Scale Analysis – USGS

The USGS will be using the Sparrow model with the CBP land use classifications to determine the overall ratio of loading rate between different large land use classifications in the Chesapeake Bay Watershed.

Literature reviews - TetraTech

TetraTech has already completed a literature review of urban land uses and will be conducting one on agricultural land uses. Several literature reviews already exist, which should be incorporated as well.

Peculiarities of Pervious Workshop – STAC

STAC will be delivering a workshop report that will have recommendations for urban land classifications and loading rates.

Expected Completion Date:

Oct 1, 2015

Watershed Model Development and Code Versioning

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Gopal Bhatt, Gary Shenk
Priorities:

(High) Revise Modeling Structure: MWG
Cross-cutting priority as necessary for all changes to the modeling structure

Description:

Make incremental changes to the watershed model code as data or processes from other parallel paths become available. A new calibration will be performed for each version to see the resulting incremental changes in model results.

Progress:

1. Phase 5.3.2
2. NLDAS rainfall data set rather than the XYZ data set. Available past 2005
    a. Made changes to the calibration routine to make the winter and summer bias better behaved
3. Land Sediment Calibration

    a. Modified the calibration method to go to a four-parameter optimization versus 2-parameter
4. PQUAL-only simulation
5. PQUAL with draft sensitivities (7/2014)

Next Steps:
PQUAL run with draft sensitivities
Expected Completion Date:
Oct 1, 2015

Scenario Builder Development and Code Versioning

CBP Oversight: WQGIT
Lead: Jenn Volk and James Davis-Martin
CBPO Contact: Jeff Sweeney
Priorities:
Model Data Processing: AgWG
modeling baseline-input data and assumptions
Cross-cutting priority as necessary for all changes to the modeling structure
Description:
Incorporate decisions from the CBP partnership. Test the effects of assumptions during development of recommendations. Re-structure scenario builder code to incorporate recommendations
Progress:
Restructured code to make future changes more easily implemented
Next Steps:
Move to cloud architecture
Expected Completion Date:
Oct 1, 2015

Calibration Methodology

CBP Oversight: Modeling Workgroup
Lead: Lee Currey, Dave Montali, and Ross Mandel
CBPO Contact: Gopal Bhatt, Gary Shenk
Priorities:
Revisit watershed model calibration methods: MWG
Description:
Work to improve the calibration process, particularly in the area of PQUAL calibration and regional factors.
Progress:

Improvements in hydrology and land sediment processes – Gopal

Incremental changes have been made to the calibration procedures that produce better seasonal balance with the new rainfall data set in use for phase 6.

Complete:
Presented at MWG MM/YYYY

PQUAL calibration methods – Ross and Gopal

Calibration method exists from previous phases of the WSM. Possible improvements include using baseflow-separated in-stream observations to set seasonal variations in concentration, and basing seasonal variability on application and uptake schedules.

Next Steps:
Investigate concentrations relative to monitoring data
Develop Method of relating input timing to output concentration
Expected Completion Date:
Oct 1, 2015

River calibration method – Ross

Modifications to the calibration routines to take flow into account rather than matching the CFD
Next Steps:
Coding of trial calibration methods
Expected Completion Date:
Oct 1, 2015

Regional Factors – Ross

Working on methods to reduce or eliminate regional factors by using *a priori* data in setting land use target loading rates. The USGS Sparrow team is running targeted analyses that may be used in this effort.

Next Steps:
Investigation of sparrow output
Expected Completion Date:
Oct 1, 2015

Sensitivities to inputs

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Guido Yactayo
Priorities:

Revise Modeling Structure: MWG

Description:
The major structural change to phase 6 is the incorporation of multiple model estimates for sensitivity to nutrient inputs. Rather than relying on a single model estimate of load response to changes in inputs of atmospheric deposition, fertilizer, and manure, the phase 6 model will use evidence from multiple sources, including HSPF and other mechanistic models, sparrow and other statistical methods, and literature.
Progress:
Draft documentation is available on the source will be described with relative merits weighed.

Next Steps:
Continue to bring new information to each modeling quarterly review and update the documentation
Expected Completion Date:
Oct 1, 2015

Land Use Loading Rates

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Tetra Tech, Gary Shenk
Priorities:

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7. Apply relationships developed through other tracks
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    b. Regional delivery differentiation
    c. Small scale effects
8. Final adjustments through Calibration to water quality data

Progress:

Broad Scale Analysis – USGS

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Expected Completion Date:
Oct 1, 2015

Fine-scale Processes

CBP Oversight: Land Use Workgroup and Modeling Workgroup
Lead: Jenny Tribo and Karl Berger
CBPO Contact: Peter Claggett
Priorities:

Revisit watershed model calibration methods: MWG
Improve Spatial, temporal, and categorical representation of land uses: LUWG

Description:

Increasingly, research is showing that sources and transport mechanisms of nutrients and sediment have high variability at fine spatial scales. The scale of the watershed model segmentation is coarse relative

to hillslope and small-order stream processes. Efforts are underway to describe fine-scale effect in ways that can be applied at the scale of the CBP partnership's watershed model.

Progress:

Progress is occurring along several parallel tracks. Implementation of the findings of these efforts in the Phase 6 watershed model is likely to improve the model, however not all areas of active research may be available in time for incorporation.

Small-stream delivery – Center for Watershed Protection

Streams contribute to the loading from the watershed as both a source and a sink. Generally at the size of a CBP segment, the stream network acts as a net sink. The CBP partnership has expressed interest in modifying the current method of attributing the entire delivered sediment load to land-based sources. The CWP will make recommendations for considering both land and in-stream sources with the in-stream sink terms applying to both sources.

Small-Scale processes – Land Data Team

The CBP Land Data Team, led by Peter Claggett, are investigating methods to map and evaluate the nutrient and sediment effects of impervious surface connectivity, urban stream corridors, riparian forests, riverine wetlands, and urban tree canopy. Incorporating stream corridors (channel, banks, and floodplains) as sources and sinks for nutrients and sediments has potential for addressing the issue of impervious surface connectivity. Research conducted by Matt Baker (UMBC) and Don Weller (SERC) is under review to parameterize the nutrient effects of riparian forests. Researchers at West Virginia University, operating under a grant from USGS, are investigating options for mapping floodplains and parameterizing their sediment deposition potential. The US Forest Services' iTree Hydro program is being evaluated for parameterizing the hydrologic effects of urban tree canopy. If these factors can be adequately described, they may be utilized to differentiate loading effects between land uses within a segment, or from segment to segment.

Next Steps:

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Expected Completion Date:

Oct 1, 2015

Lag Time – Gopal Bhatt

CBP Oversight: Modeling Workgroup

Lead: Lee Currey and Dave Montali

CBPO Contact: Gopal Bhatt and Gary Shenk

Priorities:

Revisit watershed model calibration methods: MWG

Description:

Groundwater lag times may be simulated for calibration through a simple Continuously Stirred Tank Reactor model. To parameterize this model, the lag time will have to be estimated from outside sources for all areas of the watershed. More sophisticated models may be generated through collaboration with academic partners. STAC has asked the CBP to include this capability on multiple occasions, notably:

Incorporating Lag-Times Into the Chesapeake Bay Program
Understanding "Lag Times" Affecting the Improvement of Water Quality in the Chesapeake Bay

Chesapeake Bay Watershed Model Phase Five Review

Progress:
None to date

Next Steps:
Coding of groundwater module
Expected Completion Date:
Oct 1, 2015

Atmospheric Data

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Lewis Linker and Gopal Bhatt
Priorities:

Revisit watershed model calibration methods: MWG
Shallow Water Simulation and Conowingo Refinement

Description:
The Phase 5 precipitation, meteorology, and atmospheric deposition data covered the period 1984-2005. In order to take advantage of the intensive shallow water estuarine data, new watershed stations, and recent Conowingo data with, the watershed simulation will need to be extended.
Progress:

Precipitation and meteorology

Gopal Bhatt has shown that the NLDAS-2 data set calibrates the WSM hydrology as well as the previous USGS XYZ data set. NLDAS-2 is preferred because of longer term availability. An automated download method has been created so that these data can be updated each year.

Atmospheric Deposition – Lewis Linker

The CBPO will look for a reanalysis of rainfall, NADP, CASTNET and other data sources. It is likely that this will be done externally.

Next Steps:
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Expected Completion Date:
Jan 1, 2015

Climate Change

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Lewis Linker, Climate Change Coordinator (to be hired)
Priorities:

Influence of climate Change on WQS and TMDL

Description:
The partnership has agreed to address climate change during the 2017 MPA. The motivation is expressed in the 2014 Bay Agreement, 2011 and 2008 STAC workshops, 2010 TMDL, and the 2009-2010 executive order and accompanying strategy. In order to effectively evaluate the influence of climate in the MPA, climate change must be included within the partnership's suite of models.

Progress:
The CBP will be hiring a climate change coordinator to head the climate change workgroup under STAR. Climate change is already being addressed in the modeling through several collaborative efforts already underway.

Critical Source Area – NSF/WSC project – JHU, VaTech,UMCES, etc

A large NSF grant on the effects of climate change has been awarded to a team of researchers from regional universities led by Bill Ball at Johns Hopkins. Part of the work plan is to work with the watershed model to incorporate variable source area and lag time effects into the simulation. This is a very promising avenue for improvement, but may be coming in too late to be incorporated into phase 6

Next Steps:
…
Expected Completion Date:
Oct 1, 2015

Conowingo and other Reservoirs

CBP Oversight: Modeling Workgroup
Lead: Lee Currey and Dave Montali
CBPO Contact: Lewis Linker
Priorities:
Conowingo reservoir and greater representation of reservoirs
Description:
There are three primary objectives:

1. Develop and assess options for addressing increased amounts of sediment and nutrients from the Lower Susquehanna Reservoirs
2. Better characterize trapping of sediment in reservoirs
3. Develop an approach to simulate effect of impoundments in the Bay watershed.

Progress:
The Conowingo reservoir is being studied through the Lower Susquehanna River Watershed Assessment, led by the Corps of Engineers and MDE.

Next Steps:
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Expected Completion Date:
Oct 1, 2015