Modeling Workgroup Update to the WQGIT

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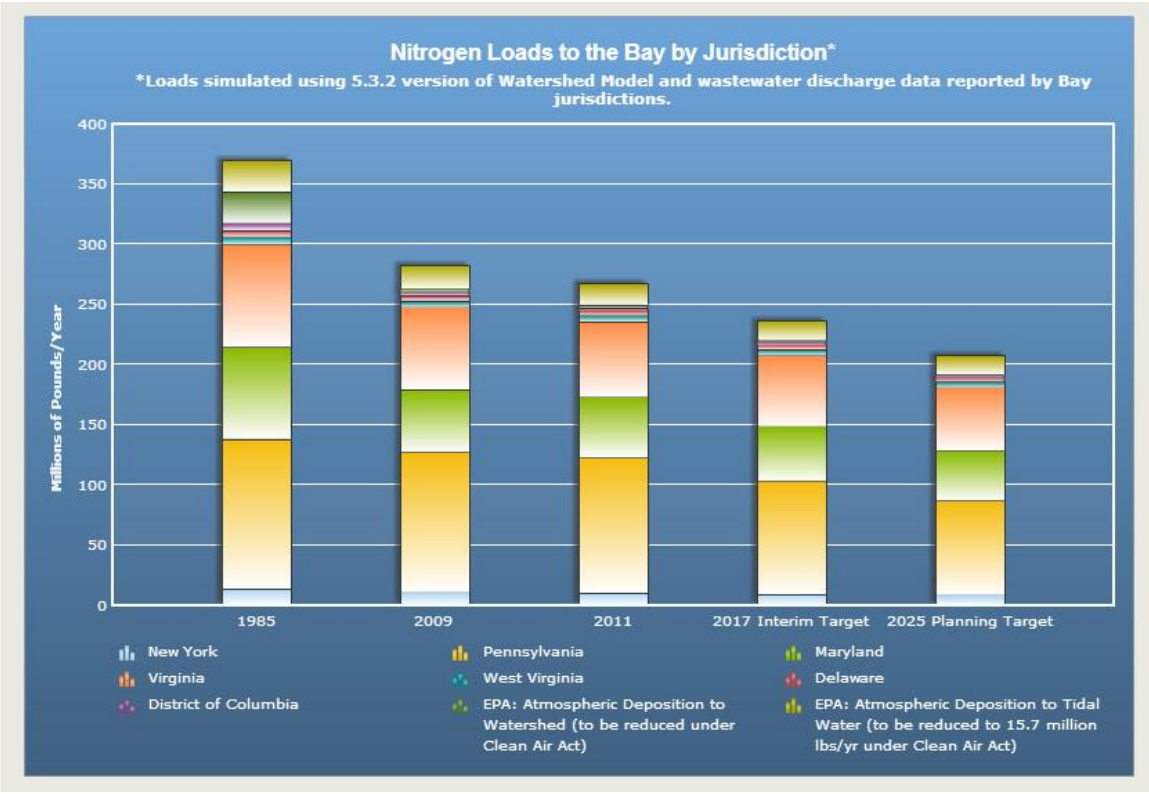
Key Points

- Modeling workgroup is committed to delivering a Phase 6 model by the end of this calendar year
- The Phase 6 model build upon the historic modeling within the Bay partnership and brings in new science where warranted
- 2016 is the year of review. There are many "dependencies" that impact the completion schedule so we need to map out the review process now, recognize the dependencies and ensure timelines are followed

History of Bay Partnership Watershed Model Development



Year	1983	1990	1994	1997	2003	2010	2011	2017
Phase	0	1	2	4.1	4.3	5.3	5.3.2	6
Segments	30	63	63	89	94	1956	2365	1976
Simulation Years	2	4	4	8	8	22	22	~30
land uses	5	7	9	9	9	24	30	~40
Purpose	Split NPS/PS	Refine NPS	1992 "40%" agreement	Confirmation of 40% goals	Re-allocation in 2003	TMDL	Phase 2 WIP development	Phase 3 WIP development

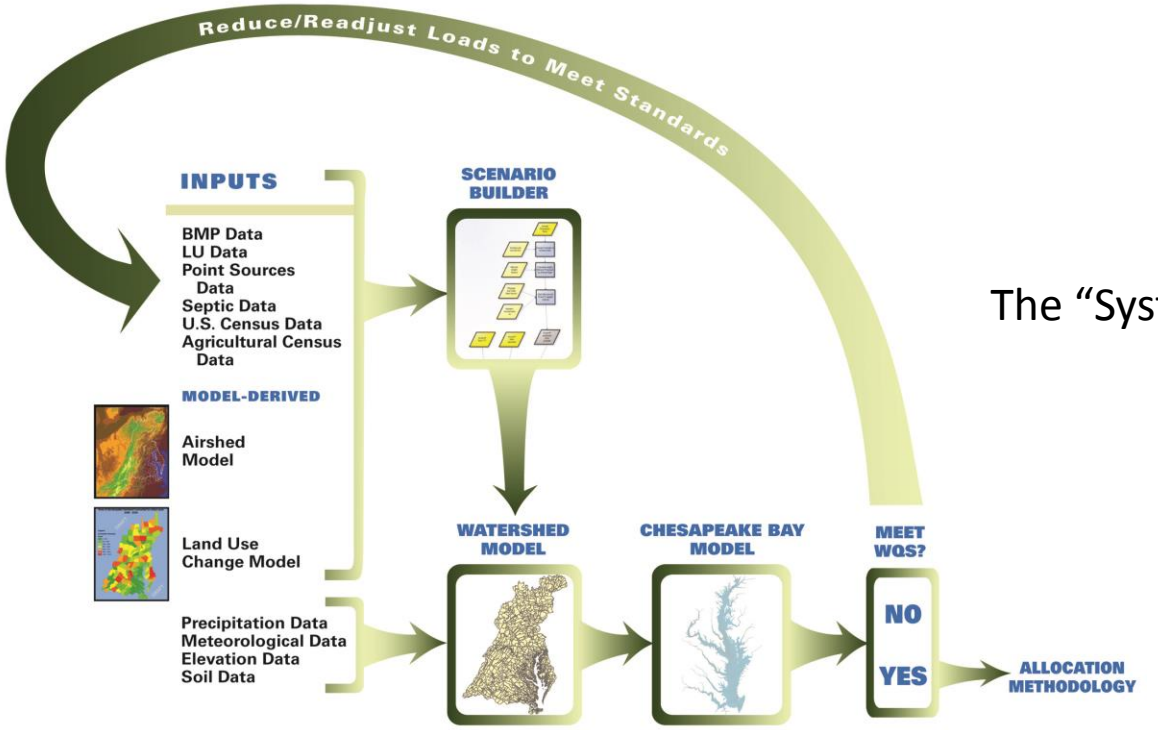
Completing the Phase 6 Model

- **The development and application of Phase 6 is driven by the feedback of WQGIT members, recommendations from STAC and recent advancements and understanding of nutrient/sediment monitoring, research and modeling.**
- **It is a partnership model. Because of this, the finalization of Phase 6 has peer and stakeholder reviews and also many dependencies that must be factored into the next year and a half.**

Phase 6 Review Process

- **Guidance for comparing model versions**
- **Review materials**
- **Stakeholder review**
  - **Modeling Workgroup**
  - **WQGIT, Management Board and PSC**
- **Peer review**
  - **Independent outside review**
  - **STAC – watershed model and water quality sediment transport model**
- **Dependencies that impact review**

Comparing Versions of Models



The "System" of Models

A note on comparing Phase 6 to Phase 5. In comparing this version of the model to previous versions of the modeling tools, history has shown that a common question is to understand the level of effort required to meet water quality goals. It must be communicated that these models are a suite of models and ultimately must be applied as a complete system to answer this question.

Review Materials

- **Draft Model reports available in January 2016**
- **Calibration Metrics**
  - ***Quality of calibration***
  - ***Think about what summary information will be needed***
  - ***What have we used before?***
- **April 2016 - Key Scenarios to be used for review**
  - ***Calibration 1985-2014***
  - ***All Forest***
  - ***1985***
  - ***2009***
  - ***2014***
  - ***WIP Phase II***
  - ***No Action (2010)***

Modeling WG Review

- **The expectation is that consensus will be reached on key model development decision points by workgroup members by the end of CY 2015**
- **The 2016 review process will be:**
  - **1) Internal review by WG members**
  - **2) Seeking consensus that model can be applied by jurisdictions in Phase III WIP development**
  - **3) Developing STAC peer review questions,**

STAC Peer Review and Workshops

- **What is the difference?**
  - **Peer Review – Independent review on approach applied…**
  - **Workshop – bring together a diverse group of experts to review and advise on…**
- **STAC Schedule**
  - **Feb 2016: Phase 6 watershed model peer review**
  - **Jan/Feb 2016: Uncertainty Approach workshop**
  - **Jan/Feb 2016: Climate Change Approach workshop**
  - **April 2016: Conowingo Modeling Approach workshop**
  - **June 2016: Water Quality Sediment Transport model peer review**

Stakeholder Review

- **WQGIT Review**
  - **Schedule briefings throughout the year with the plan of reaching agreement to present to MB and the PSC toward the end of CY 2016 (See draft schedule)**
  - **After each STAC review and workshop report out to Modeling WG and WQGIT**
- **Management Board and PSC**
  - **As requested**

Major 2016 Model development dependencies that need to be considered in the review process and final schedule

- **Dependencies**
  - **Modeling WG**
    - **STAC Workshops and Peer Reviews: 2016**
    - **Conowingo monitoring data: 2015 -16**
    - **Wetlands**
    - **Atmospheric deposition**
  - **WQGIT**
    - **Landuse: Sept 2016**
    - **Historic BMP information**
    - **BMP efficiencies - Are there any major practices that are being finalized through the review period?**
    - **Poultry Litter Subcommittee - Manure application and mass balance**
    - **BMP verification**

- **Actions**
  - **We need dates to be verified by lead**
  - **These dependencies must be factored into the schedule and we must be specific in communicating the impacts they may have through the review process**
  - **Contingencies will be applied where necessary for the modeling WG to meet the schedule**

Planning for 2017

- **Scenarios as assigned for WQGIT decision making**
- **Additional climate scenarios**
- **Geographic Isolation Scenarios**
- **Uncertainty analysis**
- **Factors affecting trends**

Status Update on Phase 6

Review of PSC Charge

Summary of PSC high level midpoint assessment priorities

- **Incorporate better model input data from local partners, particularly for current, historic and future land uses and their associated pollution loading rates**
- **Revisit model calibration methods and assumptions so modeling results better align with monitoring data**
- **Includes accounting for decreased trapping capacity behind dams, though this is not just a modeling issue**
- **Make CBP models more transparent, easier to understand, and better decision-support tools**
- **Ultimately, enhance decision support and assessment tools to enable successful engagement of local partners**

Bottom Line for Meeting 2025 Goal

- **Partnership needs to be able to engage local partners in order to get practices on the ground**
- **Current suite of modeling tools is pushing partners away**
- **Changes to modeling inputs and assumptions will allow us to work with key partners**
- **Healthy step in adaptive management process**

What has changed and Why?

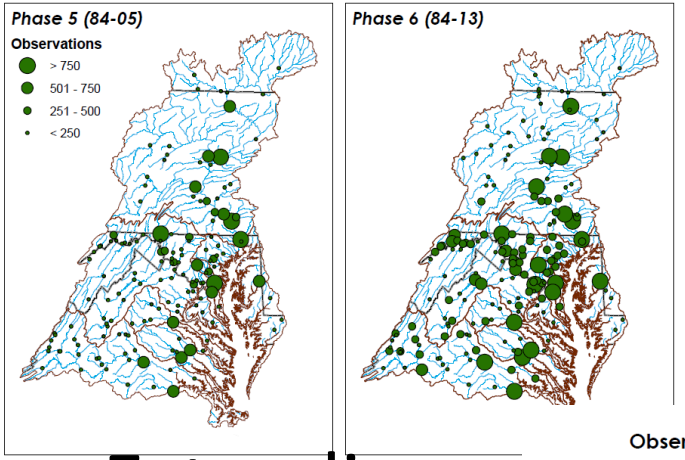
- **Phase 5 to Phase 6**
  - **Phase 6 is an evolution of Phase 5. It builds upon the strengths of existing models and provides improvements directed by the most recent data and scientific understanding. To this end, it is important to recognize what has remained unchanged, what the improvements are and why they have occurred.**
- **What:**
  - **Many of the fundamental modeling processes have remained the same but have been improved with better, and more recent, input information. In some cases the modeling processes have changed, such as the simulation of phosphorus transport or have been simplified to make them more transparent.**
- **Why**
  - **The improvements are to provide increased confidence in Bay restoration decision making. This is accomplished through including the most recent monitoring information, increasing the transparency of the modeling tools, improved resolution of transport processes (mechanistic and geographic) and by leveraging the strength of multiple models within the Bay watershed.**

The Initial Steps

- Keep the segmentation the same
- Extend the models to reflect recent years
  - Inputs
    - Atmospheric deposition
    - Rainfall
    - Solar radiation
    - Air temperature
    - Wind
  - Outputs
    - More calibration stations

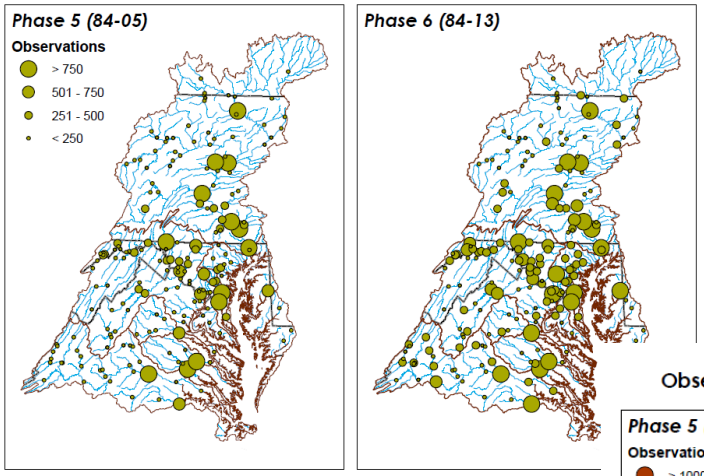
Extending the Watershed Model Time Series

Observed Total Nitrogen - Number of Observations

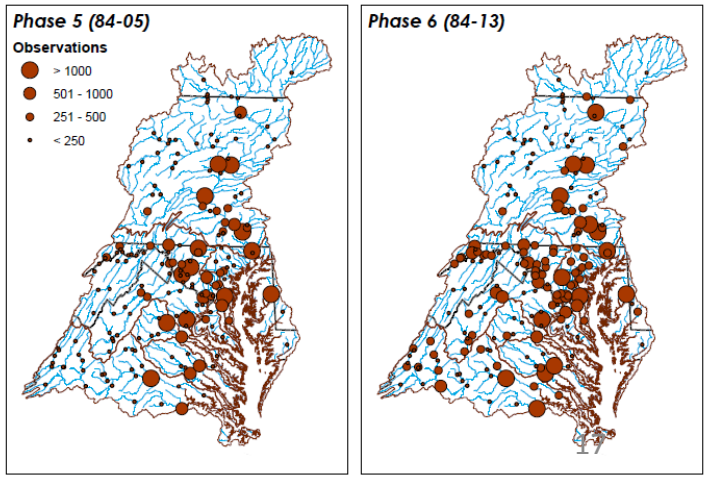


Parameter	Number of Records in Phase 5.3.2 (1984 to 2005)	Number of Records in Phase 6 (1984 to 2013)	% Change
TOTN	30,197	54,926	82%
TOTP	48,946	62,505	28%
TSSX	68,893	70,799	3%
FLOW	2,141,306	3,415,525	60%

Observed Total Phosphorus - Number of Observations



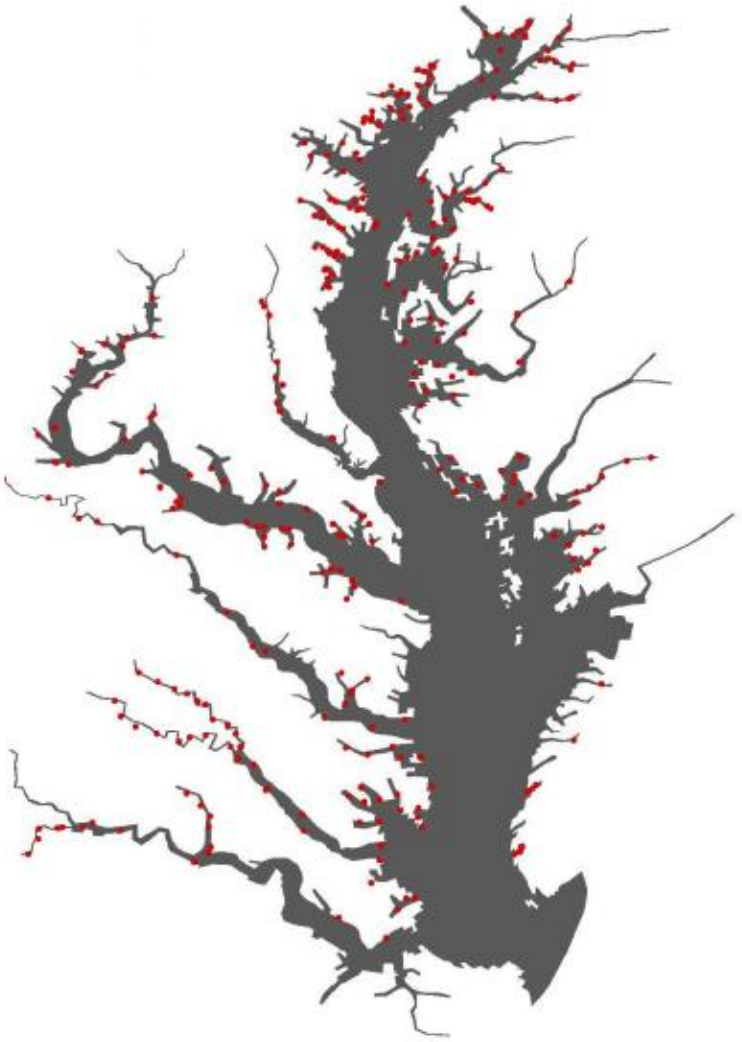
Observed Total Suspended Sediment - Number of Observations



Parameter	Number of Calibrated River Segments in Phase 5.3.2	Number of Calibrated River Segments in Phase 6	% Change
TOTN	152	181	19%
TOTP	191	196	3%
TSSX	182	187	3%
FLOW	287	287	

Extending the WQSTM

- Extending the time series allows the shallow water data to be used
- Adds about 84,000 observations
- Performance of model evaluated for 1991 - 2000 and now also 2002 - 2011



Extending the Watershed Model Hydrology

Land and River simulation method

- Phase 5 with new precipitation (met data) inputs

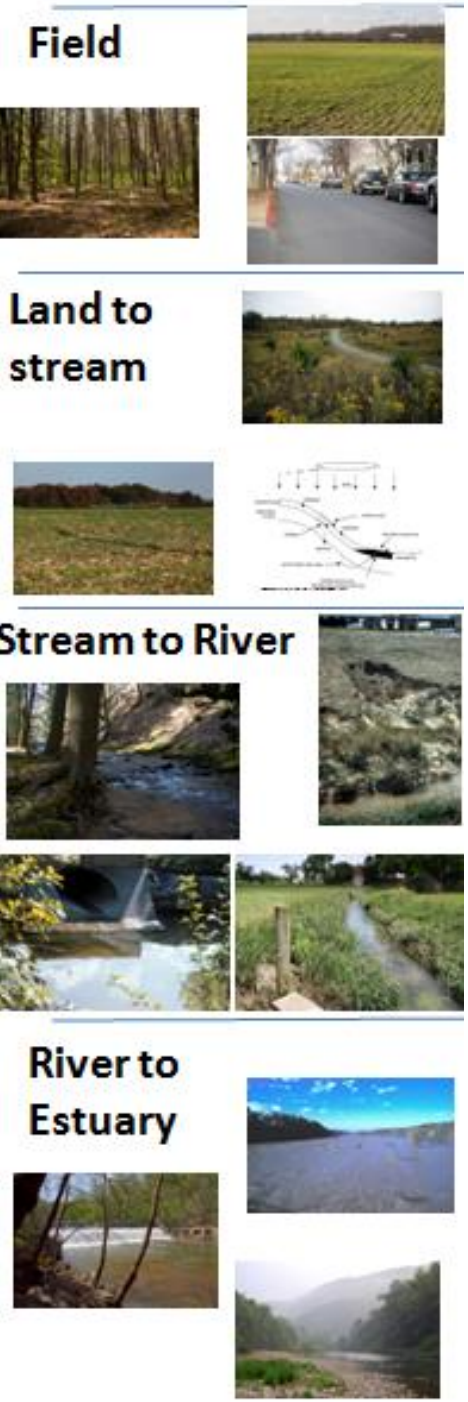
Calibration objectives

- Phase 5 with some refinements to calibration objectives

Decision points

- Reached consensus on new precipitation
- Modeling WG agreed that results were are as good or better than that of Phase 5

Phase 6



Multiple models

Estimated Average Load = **Sensitivity** * **Δ Inputs** + **BMPs** * **Land Delivery** * **Stream Delivery** * **River Delivery**

Multiple Lines of Evidence → Estimated Average Load

Scenario Builder → BMPs

Estimated with SPARROW
Estimated by Land Data team → Land Delivery

Estimated with SPARROW
Estimated by USGS / WVU / Land Data team → Stream Delivery

Simulated in HSPF
Calibrated with data, WRTDS, and SPARROW → River Delivery

A way to think about the revisions to the watershed model

- Lines of evidence driving the revision
- Land to river
  - Targets, sensitivity, BMPs, land and stream delivery
  - No more regional adjustment factors!
  - More transparent
- River to the Bay
  - Same as Phase 5
- Calibration
  - Objectives
  - River is calibrated to same data as Phase 5, but now more of it
- Decision points
  - What has been completed and what remains

Watershed Model Sediment

Lines of evidence driving change

- **Need for improved geographic accuracy to support Phase III WIP development**

Land to River

- **Sector target loading rates - *Global targets based on Phase 5 and local targets are Phase 5 or considering RUSLE2***
- **Sensitivity - converting inputs to outputs - *Phase 5***
- **Land to stream and stream to river delivery - *SCS Sediment Delivery Ratio being replaced with recently developed USGS method***
- **The effect of management practices on loads - *Phase 5***

River Simulation

- **Phase 5**
- **Improved reservoir characteristics**

Calibration objectives

- ***Phase 5***

Decision points

- **Reached consensus on land sediment methodology using RUSLE 2**
- **Need consensus on targets**
- **Need consensus on Sediment delivery ratio**

Watershed Model Nitrogen

Lines of evidence that are driving modeling changes

- Need for improved geographic representation to support Phase III WIP development
- Update atmospheric deposition with new CMAQ Bidirectional Ammonia Model

Land to river simulation

- Sector target loading rates - Global targets based upon multiple models which include Phase 5, CEAP, SPARROW and sector targets are from WQGIT sector workgroups, calibrated to RIM stations
- Sensitivity (Converting inputs to outputs) – Based on Phase 5 and Multiple models used for comparison P5, CEAP, SPARROW
- Transport factors (replaces regional factor) - Land and stream delivery based on SPARROW
- The effect of the management practices on loads - Phase 5
- Lag Time - included but can be turned off (USGS)

River simulation

- Phase 5

Calibration

- Same as Phase 5 but the improved geographic specificity is expected to reduce influence of a regional calibration factor
- River simulation objective the same

Decision points

- Reached consensus on nitrogen sensitivity
- Reached consensus on transport factors
- Working to reach consensus on targets
- Working to reach consensus on time series method (lag time)

Watershed Model Phosphorus

Lines of evidence that are driving modeling changes

- Phosphorus symposium
- New Insights Report
- STAC Phosphorus dynamics report
- Eastern Shore monitoring trends
- USGS WRTDS Phosphorus Trends

Land to river simulation

- Sector target loading rates - Global targets based upon multiple models, including Phase 5 and source sector WGs for new landuse categories and establishing within sector differences
- Sensitivity (Converting inputs to outputs) – APLE
- Transport factors (replaces regional factor) - Land and stream delivery based on SPARROW
- The effect of the management practices on loads - Phase 5
- Lag Time - ????

River simulation

- Phase 5

Calibration

- Same as Phase 5 but the improved geographic specificity is expected to reduce influence of a regional calibration factor
- River simulation objective the same

Decision points

- Need to reach consensus on targets, phosphorus sensitivity, time series model…
- This is our current focus

Water Quality Sediment Transport Model

Charge	*•Revise and update the water quality sediment transport model and refine the shallow water simulation for improved assessment of open water dissolved oxygen and SAV/clarity standards.* *•Improved diagenesis (organic decay) to better represent Conowingo scour, wetland and shoreline*
Segmentation	*•Same*
Inputs	*•New information from atmospheric deposition model and watershed model*
Hydrodynamics	*•Extended to at least 2011*
What has changed in the sediment simulation?	*•Refined sediment transport to better account for labile vs refractory nutrients. This is important to address impacts from Conowingo sediment scour and shoreline erosion.*
What has changed in the nutrient simulation?	*•Same processes but includes improved representation of labile vs refractory nutrient exchange from the sediment*
Calibration methods	*•Continue to review mainstem stations* *•Add focus to shallow water areas - "big data" approach used to inform calibration. Many shallow water sites incorporated by extending the model to simulate more recent years*

Summary

- Extending the models to more recent years allows for a more robust evaluation of model calibration performance
- Watershed
  - Phase 6 prototype up and running
  - Phase 6 builds upon Phase 5, provides revisions driven by MPA charge and incorporates the most recent science
  - Hydrology is complete, reaching closure on sediment and nitrogen, still more work needed with phosphorus
- WQSTM
  - Revision to sediment nutrient exchange to account for Conowingo infill and also benefits simulation of shoreline loads
  - Recalibration in progress

Thank You

…Extra slides follow

Modeling WG MPA Priorities

Airshed Model

- Update Airshed Model to new CMAQ Bidirectional Ammonia Model

Watershed Model

- Revise Watershed Model system structure
- Revisit Watershed Model calibration methods, including regional factors

Water Quality and Sediment Transport Model

- Refine and update the Water Quality and Sediment Transport Model (WQSTM)
- Refinement of shallow water simulation for improved assessment of open water DO and SAV/clarity standards

TMDL Charges

- Effects of Conowingo infill on Chesapeake Bay water quality standards
- Examine the influence of climate change (CC) on Chesapeake WQ standards and the 2010 Bay TMDL
- Review James River chlorophyll criteria and James River TMDL allocations
- Influence of oyster filter feeders on water quality, with increased aquaculture and sanctuary development

STAR Requests

- Support needs of water quality goal team and TMDL Mid-point assessment support
- Assess and Explain Water Quality Trends