

1 Section 1: Overview

1.1 Notes on the Beta 2 documentation

The April 19, 2016 version of the Phase 6 Beta 2 Watershed Model documentation is an updated draft of the documentation of a development version of the Phase 6 Watershed Model. The Chesapeake Bay Program’s Phase 6 Watershed Model is a participatory creation of the CBP Partnership. The broad partnership participation in Phase 6 development has grown to include many workgroups. In that the decisions of these workgroups determine the methods used, the Phase 6 documentation also belongs to the partnership.

The purpose of making the draft documentation available to the partnership at this early stage is to provide the partnership with a written record of the results of the many partnership decisions that have been made in the Management Board, the Modeling Workgroup, the Water Quality Goal Implementation Team, and the WQGIT’s many workgroups. The reader should be aware that there may be errors and omissions. With the partnership’s participation the documentation will be edited, corrected, and made more complete in subsequent Beta versions and the final Phase 6 version.

1.2 Context

The Chesapeake Bay Program (CBP) Partnership is revising the watershed model used to assist in Partnership decisions. The version known as Phase 6.0 will be released in early 2017 to be used in the 2017 Midpoint Assessment for the Chesapeake Bay TMDL. The documentation was first released in early 2016 and will be continually updated until final release in early 2017.

This continues a long history of improvements to the tools used to simulate the Chesapeake Watershed. Major releases of the watershed model are shown in Table 1-1 below. For a more detailed description of the history see the Chapter 1 of the Phase 5.3 Watershed Model documentation USEPA 2010a-01 and Linker, et al. 2002.

Table 1-1: Watershed Model Versions

Phase	Year	Purpose
0	1983	Split point source and nonpoint source
1	1990	Refine nonpoint source simulation
2	1994	40% reduction agreement
4.1 ¹	1997	Confirmation of 40% goals
4.3	2003	Allocation to avoid a Total Maximum Daily Load
5.3	2010	Total Maximum Daily Load and Phase I Watershed Implementation Plans
5.3.2	2011	Phase II Watershed Implementation Plans
6.0	2017	Midpoint Assessment and Phase III Watershed Implementation Plans

1.2.1 Total Maximum Daily Load (TMDL)

The 2010 Chesapeake Bay TMDL sets limits on nitrogen, phosphorus and sediment pollution necessary to meet water quality standards in the Bay and its tidal rivers. It is the largest and most comprehensive TMDL that the EPA has established to date. The phase 5.3 Watershed Model was used extensively

¹ The Phase 3 watershed model was a development-only version to add additional detail to the crop and forest simulation.

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throughout the TMDL process to deliver loads to the estuarine model and as part of the allocations process. Initial load allocations by State and major basin were calculated according to a set of rules that was based in large part on Watershed Model predictions of effectiveness delivery of loads and the ability of each region to reduce those loads based on land use and other physical characteristics.

For more information on the TMDL and the watershed model use in the TMDL, refer to [the TMDL documentation \(USEPA 2010c\)](#), particularly [Section 4](#) for the modeling of the inputs, [Section 5](#) for the modeling of the physical setting, and [Section 6](#) for the specifics on how they were used to set the TMDL.

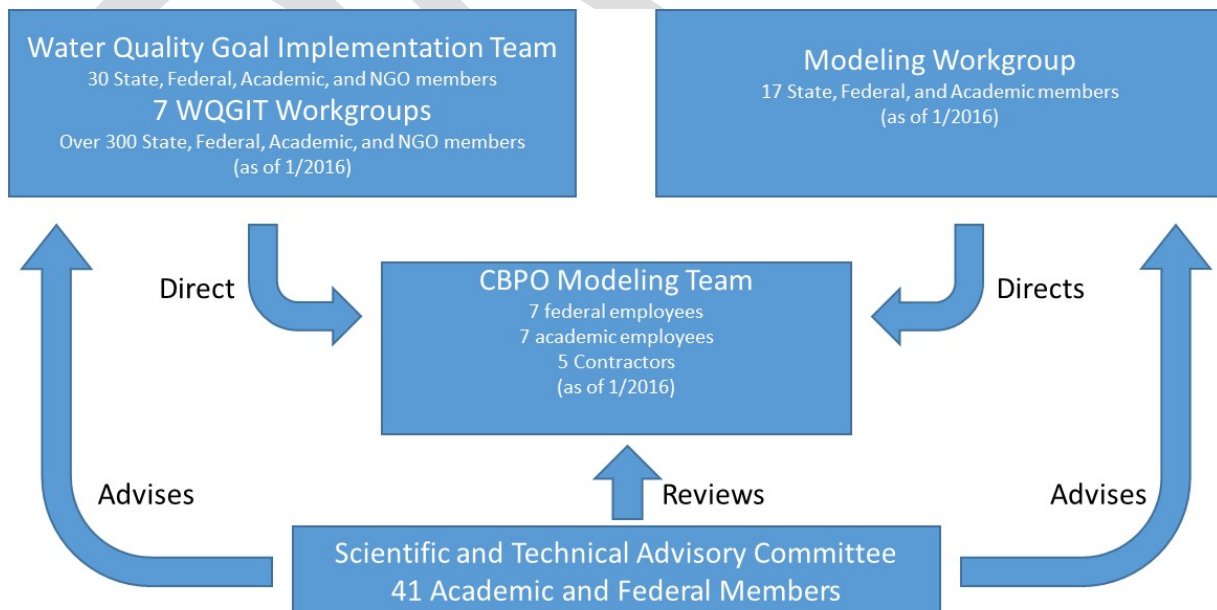
[Watershed Implementation Plans](#) (WIPs) are plans for how the Bay jurisdictions, in partnership with federal and local governments, will achieve the Chesapeake Bay TMDL allocations and planning targets. Phase I WIPs were developed in 2010 to inform the TMDL allocations. Phase II WIPs were developed in 2012 to meet nitrogen, phosphorus, and sediment planning targets based on updated information in the Phase 5.3.2 watershed model.

1.2.2 Midpoint Assessment

The goal of the WIP process is for all pollution control measures needed to fully restore the Bay and its tidal rivers to be in place by 2025. EPA expects practices in place by 2017 to meet 60 percent of the necessary reductions. The Chesapeake Bay Program (CBP) partnership is reviewing the latest science, data, modeling, and decision support tools used to estimate progress in nutrient reduction effort. Phase III WIPs will be developed by jurisdictions based on a [midpoint assessment](#) of progress and new information provided by the Phase 6 Watershed Model and a related update of the estuarine Water Quality and Sediment Transport Model. Phase III WIPs will provide information on actions the Bay jurisdictions intend to implement between 2018 and 2025 to meet the Bay restoration goals.

1.2.3 Governance

The phase 6 watershed model was developed with extensive partnership input and direction. The figure below illustrates the modeling governance structure with in the CBP. These groups are part of the larger



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CBP [organizational chart](#).

Figure 1-1: CBP Modeling Governance Structure

The Modeling Team is a cross-disciplinary group at the Chesapeake Bay Program Office (CBPO) working on development, analysis, research, calibration, and operation of the CBP modeling suite including the Land Cover Model, Scenario Builder, Watershed Model, and Estuarine Water Quality and Sediment Transport Model. The team takes direction from decisions of the CBP Partnership, particularly the [Modeling Workgroup \(MWG\)](#), the [Water Quality Goal Implementation Team \(WQGIT\)](#), and the Workgroups of the WQGIT. The independent Scientific and Technical Advisory Committee (STAC) advises the partnership through recommendations from workshops and reviews, and through direct communication. The MWG and WQGIT also receive considerable input from stakeholders and other interested parties that participate in regular meetings. The MWG reports to the [Scientific and Technical Analysis and Reporting \(STAR\)](#) group. The WQGIT reports to the Management Board and the Principals' Staff Committee.

The WQGIT directs the modeling team on issues related to how the models are used to inform policy. The WQGIT has seven workgroups that are directly involved in direction of Scenario Builder and the Watershed Model efforts, generally in the areas of model inputs and the extent of BMP implementation. Additionally, panels determining the effectiveness of BMPs report to the WQGIT and its workgroups. The [current list of panels](#) is available on the CBP website. The Agriculture, Forestry, Urban Stormwater, and Wastewater Treatment Workgroups direct the CBPO Modeling Team on issues related to inputs for their respective areas of interest. Some of these groups have formed subgroups to facilitate discussion. For example, many agricultural simulation decisions are first made in the [Agricultural Modeling Subcommittee](#). The Land Use Workgroup oversees the CBPO Modeling Team in developing the land use dataset for modeling and other purposes. The Watershed Technical Workgroup works on cross sector BMP issues and facilitates BMP integration into the Watershed Model.

The MWG directs the modeling team on issues related to scientific integrity, modeling of the physical environment, model calibration, and issues that cross sectors such as average sector land use loading rates. The modeling workgroup adopted the following core values on 1/20/16.

- Integration - Integration of most recent science and knowledge in air, watershed, and coastal waters to support ecosystem modeling for restoration decision making
- Innovation - Embracing creativity and encouraging improvement in the development and support of transparent and robust modeling tools.
- Independence – Making modeling decisions on the basis of best available evidence and using the most appropriate methods to produce, run, and interpret models, independent of policy considerations.
- Inclusiveness - Commitment to an open and transparent process and the engagement of relevant partners, that results in strengthening the Partnership's decision making tools.

Table 1-4 near the end of this section shows the relationship between the workgroups, major parts of the watershed model, and the documentation.

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1.2.4 Motivations for Change

Given the role of the Phase 5 watershed model in the TMDL and Phase I and II WIPs the CBP partnership and many additional stakeholders have brought additional scrutiny to the model development process. As a result, many changes have been suggested to enhance the ability of the Watershed Model to be used as the primary accounting tool for designing implementation plans and tracking progress in BMP implementation.

1.2.4.1 STAC

The Scientific and Technical Advisory Committee has conducted a number of workshops and reviews that were influential in the priorities set by the CBP Partnership. In addition to comprehensive reviews of the CBP Phase 5 Watershed Model carried out in [2005](#) (STAC, 2005) and [2008](#) (STAC, 2008), and the Land Use and Land Cover Model in [2010](#), (STAC, 2010) STAC produced a more targeted review of phosphorus dynamics in [2014](#) that influenced the development of watershed input and processing simulation. The workshop report on multiple models in [2014](#) and the [factsheet](#) accompanying the report were pivotal in the development of the model structure described in section 0 below and in the partnership acceptance of that new structure. The [2013](#) workshop report on lag times motivated the explicit inclusion of lag times in the CBP watershed model for the first time. Finally, a [2012](#) report on natural landscape features initiated a focus on understanding the spatial distribution of factors affecting the watershed delivery of nutrients described in sections 7 and 8 of this documentation.

1.2.4.2 CBP Input

The WQGIT met in October of 2012 to discuss priorities for the 2017 midpoint assessment. A major focus of that meeting was the generation of modeling priorities. The [initial](#) list was reworked a number of times by the partnership for better organization and as additional opportunities presented themselves. The Modeling workgroup, the Management Board, and the Principles' Staff Committee have all contributed to the list of refinements. Stakeholder meetings were also carried out. Primary among these was the 'Building a Better Bay Model' workshop planned by the Agricultural Workgroup and co-sponsored by the USDA-NIFA and Mid-Atlantic Water Program held in May of 2013. The midpoint assessment webpage has a [list](#) that includes modeling priorities which is kept current. From the standpoint of the CBPO modeling team, these can be grouped in to the following major areas, which are dealt with in this documentation as indicated in Table 1-2 below.

Table 1-2: CBP Priorities

BMP Effectiveness	6.3
BMP Implementation Accounting	6.5
Fertilizer and Manure Applications	3.2
Land Use Types and Acreage	5
Land Use Loading Rates	2
Climate Change	11
Modeling Tools Code Development	1.4
Calibration Methodology	10
Sensitivities to Inputs	4
Fine Scale Processes	7 and 9
Atmospheric Deposition Data	3.3
Lag Times	10.5

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Better Representation of Reservoirs	10.6
Time Series Data	10.2

1.2.4.3 Major Themes

Taken together, a few major themes arise from the advice of the groups previously mentioned in section 1.2.4. These themes are multiple lines of evidence, understandability, and improved data sources.

STAC and others have urged the CBP to use a *multiple modeling approach* on numerous occasions. The benefits of this approach are discussed in STAC’s report from the [Multiple Models Workshop](#). The CBP has used multiple models and multiple lines of evidence wherever possible in the. While the Phase 5 model was a Hydrologic Simulation Program – Fortran (HSPF) model that began to incorporate information from other models, the Phase 6 Watershed Model is built on the structure of Phase 5.3.2, but is primarily built outside of HSPF and depends on multiple models, including HSPF, SPARROW, APEX, and APLE.

Table 1-3: Models Incorporated in the Phase 6 Watershed Model

Model	Use in P6
P532	Global land simulation targets Global sector targets Sensitivity of nitrogen export to changes in nitrogen loading rates
SPARROW	Global sector targets Sensitivity of nitrogen export to changes in nitrogen loading rates Land-to-water delivery factors Stream-to-river delivery factors
CEAP/APEX	Global sector targets Sensitivity of nitrogen export to changes in nitrogen loading rates
APLE	Sensitivity of phosphorus export to changes in phosphorus loading rates
RUSLE 2	Distribution of Land Sediment Erosion
rSAS	Lag time
UNEC	Lag time
Modflow	Lag Time
Regression Models	Stream sediment mass balances

Understandability is the second major theme of Phase 6 development. In Phase 5, the final land use nutrient loading rates and delivery factors were determined through a complex calibration process of a detailed mechanistic simulation in HSPF. This process, while fully documented, was not necessarily clear to local stakeholders. Greater understandability is implemented in P6 by separating out the accounting functions of the model from the model’s role in providing the time series of loads to drive the WQGSTM. The time averaged accounting model is the simple product of a number of factors as described below in section 1.5. This simplicity of calculation and the full description of the derivation of the factors provides greater transparency.

The third major theme is *better data*. The CBP partnership will be incorporating many new and improved data sets from climatic variables to land use to nutrient inputs as described in the sections to follow. These improved data sets have been a major focus for the WQGIT and its workgroups between the release of the phase 5.3.2 model in 2011 and the current time.

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1.2.5 Schedule

1/4/2016 - The first public version – Phase 6 Beta 1 was released in the form of nutrient loads by land use and calibration plots

2/1/2016 Draft Documentation Released

4/19/2016 – Phase 6 Beta 2 release

Beta releases will continue approximately every three months if enough changes have been made to warrant a new release until the final phase 6 model is released in early 2017.

1.3 Physical Setting

The Chesapeake Bay’s 64,000-square-mile watershed includes parts of New York, Pennsylvania, West Virginia, Delaware, Maryland, Virginia, and the entire District of Columbia (Figure 1-3). Throughout the Chesapeake Bay watershed there are more than 100,000 streams and rivers tributaries that eventually flow into the Bay (USEPA 2003a). Runoff and groundwater from the watershed flow into an estuary with a surface area of 4,500 square miles, resulting in a land-to-water surface-area ratio of 14 to 1. That ratio is a key factor in explaining the significant influence that the watershed has on Chesapeake Bay water quality. The nine major basins of the Chesapeake Bay watershed are the Susquehanna, Potomac, Patuxent, Rappahannock, York, and James rivers and the Maryland Western Shore, Maryland Eastern Shore, and the Virginia Eastern Shore.



Figure 1-3: States within the Chesapeake Bay watershed

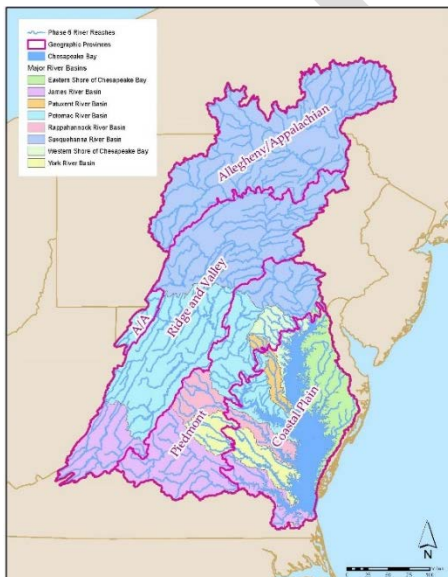


Figure 1-2: Geologic Provinces within the Chesapeake Bay Watershed

The Chesapeake Bay watershed is almost entirely within the Appalachian, Ridge and Valley, Piedmont, and Atlantic Coastal Plain geologic provinces (Figure 1-2). The Atlantic Coastal Plain is a flat, lowland area with a maximum elevation of about 300 feet. The Coastal Plain extends from the edge of the continental shelf, east to a fall line that ranges from 15 to 90 miles west of the Chesapeake Bay. The fall line forms the boundary between the Piedmont Plateau and the Coastal Plain. Waterfalls and rapids clearly mark the line, which is marked by the Bay watershed cities of Baltimore, Washington, D.C., Fredericksburg, and Richmond. Those cities developed along the fall line taking advantage of both the potential water power generated by the falls and tidewater shipping. The confluence of geography and history placed the largest population centers in the watershed, including Baltimore, Washington, D.C., and Richmond, directly on the Chesapeake tidewater. The Eastern Shore of the Chesapeake

Bay is entirely within the Coastal Plain.

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The Piedmont Plateau extends from the fall line in the east to the Ridge and Valley province in the west. The Patuxent, Rappahannock, and York River basins span the Piedmont and Coastal Plain (

). The Susquehanna, Potomac, and James rivers span the Ridge and Valley region through a series of water gaps with some rivers, such as the Shenandoah, lying entirely within the Ridge and Valley province.

The Appalachian province covers the western and northern part of the watershed. Water from this province flows to the Chesapeake Bay through the upper reaches of the Susquehanna, Potomac, and James rivers. The Susquehanna is the largest river, followed by the Potomac and James rivers. The watershed is about 2/3 wooded, 1/4 agriculture, and about 1/10 developed. According to the [CBP population indicator](#) 17.9 million people lived in the Chesapeake Bay watershed in 2014 and the population is estimated to increase to over 21 million by 2040. The major river basins of the Chesapeake Bay Watershed are shown in Figure 1-2.

1.4 Segmentation

Segmentation is similar to segmentation in the [Phase 5 Watershed Model](#) (USEPA 2010a-05). Key data inputs, such as crop types and associated nutrient application rates, are most readily calculated only at the county-level scale which do not generally follow watershed boundaries. To best represent the appropriate processes land and river simulations are performed on separate spatial delineations. A land segment is defined as an area in which all land in a given land use is simulated as being homogenous. That is, each land segment contains a single instance of each type of land use. A river segment is defined as the land draining to the river reach contained in the river segment. In areas of the coastal plain where there are no simulated river reaches, river segments are defined as the land draining directly to a Chesapeake Bay Water Quality Segment (Martucci et al. 2006).

1.4.1 Land Segments

Phase 6 land segments are primarily counties, but some counties were subdivided in allow for significant differences in rainfall. The Phase 5.3 watershed model used in the 2010 TMDL had a similar approach. The Phase 5.3.2 Watershed Model used in the Phase II WIPs had land segmentation split between federal and non-federal areas as well.

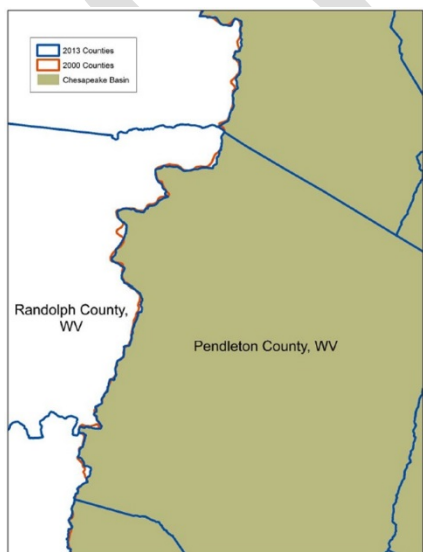


Figure 1-4: improved county boundaries

The following changes were made for Phase 6.

1. Federally-owned land segment divides were removed
2. County boundaries were updated with newer data
3. Divisions for rainfall were updated using PRISM data (Daly and others 2008).

County boundaries for Phase 6 use the 2013 TIGER file available from Census Bureau available at

<https://www.census.gov/geo/maps-data/data/tiger-line.html>.

There are numerous changes from the Census 2000 data used in Phase 5, with most of those changes being minor. The county

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boundaries now match the western Chesapeake basin boundary between VA and WV and within WV where they are coincident (Figure 1-4).

Counties were further subdivided by rainfall under certain circumstances. The 30 year long term normal data from the PRISM Climate Group (Daly and other 2008) were used at a resolution of 30 seconds, which is about 800 meters. A mean precipitation was calculated for each county and then the deviation from that county mean was calculated for each individual 30 second pixel. Pixels with rainfall 100mm or more below the county mean were designated as low. Pixels with rainfall 100mm or more above the county mean were designated as high. High and low pixels were aggregated into contiguous areas designated as high and low patches. A minimum patch of 72 square km size was enforced to remove patches that were too small to be adequately represented by the NLDAS-2 rainfall data set.

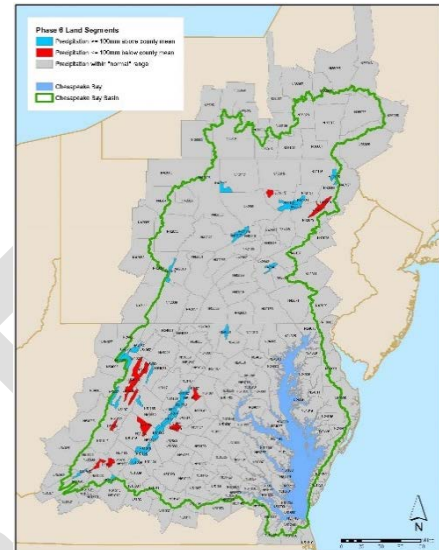


Figure 1-5: Finer segmentation of counties for rainfall differences

Figure 1-5 shows the final Phase 6 land segments with areas of high rainfall in blue and areas of low rainfall in red. Land segment names are formed by combining each county’s 5-digit FIPS code with a prefixed ‘N’ for normal rainfall, ‘L’ for low rainfall, or ‘H’ for high rainfall. The list of land segments is available in appendix 1.A.

1.4.2 River Segments

A river reach is section of a river or reservoir that is simulated as a single unit. A river segment is the land draining directly to each river reach. Each river with at least 100 cubic feet per second average flow is a separate reach and river segment. The confluence of two or more such rivers creates a new reach and river segment. Further divisions are made in the coastal plain such that each river segment drains to exactly one CBP Water Quality segment in the estuary. It is a requirement of the TMDL that the drainage to each designated use be well-defined. The Phase 6 river segments and major watersheds are shown in Figure 1-6.

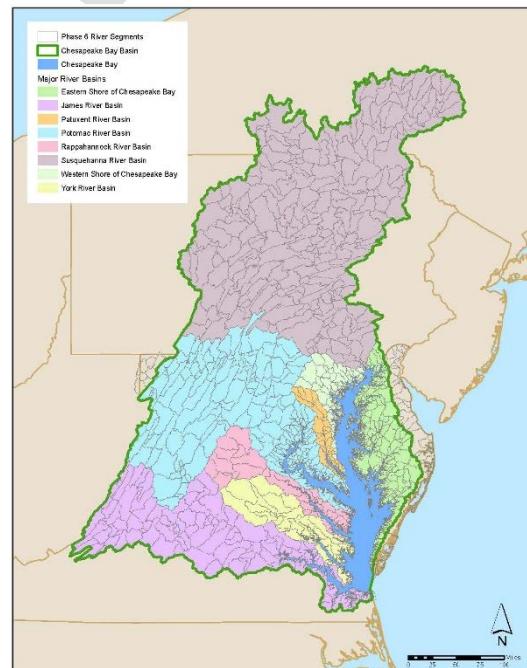


Figure 1-6: River segments and Major Watersheds

Phase 5.3.2 river segments were carried forward with a few major exceptions. It was decided by the Modeling Work Group that the Phase 6 river segments would incorporate a boundary of the Chesapeake Bay Basin derived from the USGS Watershed Boundary Dataset (WBD) Hydrologic Units (USDA-NRCS and others 2015). The new basin boundary was overlaid on the Phase 5.3.2

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RiverSegs. Areas outside of the new basin boundary were deleted and areas within the new boundary that were previously outside the basin were incorporated into the nearest existing river segment.

The areal extent of the Phase 6 river segment data layer is smaller than that of the Phase 5.3.2 river segments. Only river segments that are within the Chesapeake Bay Basin as well as the Virginia portion of the Delmarva Peninsula draining to the Atlantic, the rest of Delaware, and RiverSegs that are at least partly within western Maryland are included in Phase 6.

While most changes between Phase 5.3.2 and Phase 6 were minor, there were a few areas that had noticeable changes, particularly in southeastern VA. The two biggest changes in land area were the addition approximately 31 square miles of the Great Dismal Swamp and the removal of approximately 22 square miles of Virginia Beach, Virginia that drain to the Atlantic Ocean were removed from the model domain as it was determined that this drained. The list of river segments is available in appendix 1.A.

1.4.3 Land-River Segments

The intersection of land and river segment are known as land-river segments. These are the lowest geographic unit of output for the watershed model. The list of land-river segments is available in appendix 1.A.

1.5 Structure

The primary management decisions of the CBP are based on long-term flow-averaged output. The management questions typically asked of the models involve assessing the long-term loads from land uses and other sources, in different geographic and political boundaries, under various management scenarios. This information forms the basis of management decisions about where to implement BMPs and other control measures.

In previous versions of the watershed model, this output was accomplished by running an hourly simulation model over an extended period and summarizing the output into average annual loads. Phase 6 reverses this concept such that the primary model structure is based on long term loads. As discussed above in section 1.2.4, transparency – defined as understandability – was a high-level concern of the CBP partnership for Phase 6. The structure below is easily understood: to calculate the delivered loads for any land use in any segment a stakeholder simply has to know the 8 factors shown below in Figure 1-7. These factors are publicly available and calculated according to work being done in CBP workgroups so that all partners will have the ability to understand how their loads were derived and the ability to fully participate in the scientific process of deriving them. A time-variable version based on the results of the time-averaged model continues to be used to load the estuarine model, to estimate river delivery, and for scientific investigations such as lag time and climate change.

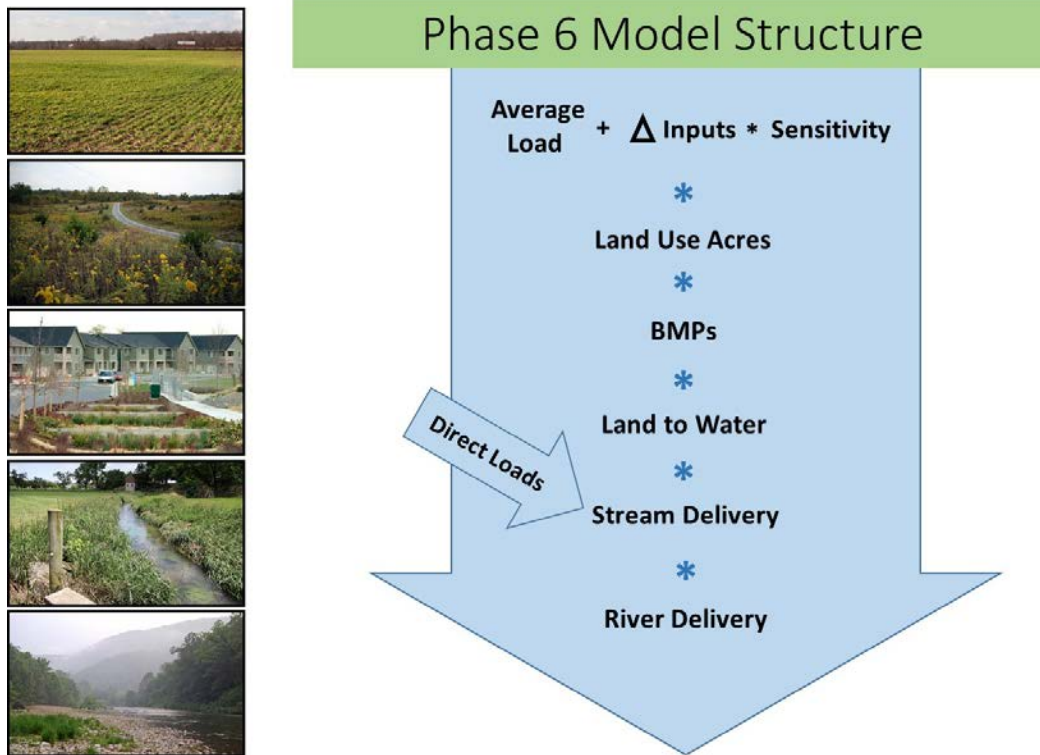


Figure 1-7: Phase 6 Watershed Model Structure

This structure also allows for deliberate use of multiple models and multiple line of evidence at each step. For example, in all previous phases of the watershed model the sensitivity for atmospheric deposition of nitrogen, defined as the change in export loads for a unit change in input loads, was determined through a run of the AGCHEM module in HSPF. The Phase 6 structure allows for the emergent properties of multiple models to be used in place of the single model as discussed in section 4. Similarly, multiple models are used as much as possible as they are available for each of the processes represented above.

The processes represented in Figure 1-7 correspond to separable scales and physical domains. Average Loads, also known as targets, are average loads per acre for each land use across the entire Chesapeake Bay watershed. Average loads are not true edge-of-field loads, but average for what would reach a small stream. Inputs are the applications to the landscape of atmospheric deposition, fertilizer, manure, and biosolids. Sensitivities are the change in export load to a small stream for each unit change in inputs. The top line in Figure 1-7 therefore represents the loads exported from a land use to a stream taking into account local applications, but not local watershed conditions. To get to a true edge-of-stream load, the next three steps are to multiply by the land use acres going to the stream, by the BMPs which act to decrease the loads, and Land to Water delivery factors. The Land to Water factors account for spatial differences in loads due to physical watershed characteristics. Since the initial loads are already at the edge-of-stream scale, the Land to Water factors do not add or subtract to the loads over the entire Chesapeake Bay watershed, but instead add spatial variance. Stream delivery factors account for streams that are lower than 100 cubic feet per second on average. River delivery factors are for larger rivers.

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In addition to the transparency and allowance of multiple models afforded by the phase 6 model, a particular advantage is that the Chesapeake Assessment Scenario Tool (CAST -- <http://casttool.org/>) will calculate precisely the same loads as the watershed model. CAST is used extensively by governments and stakeholders in the development of their WIPs and milestones. The increased accuracy of CAST in phase 6 will be a significant benefit to the partnership.

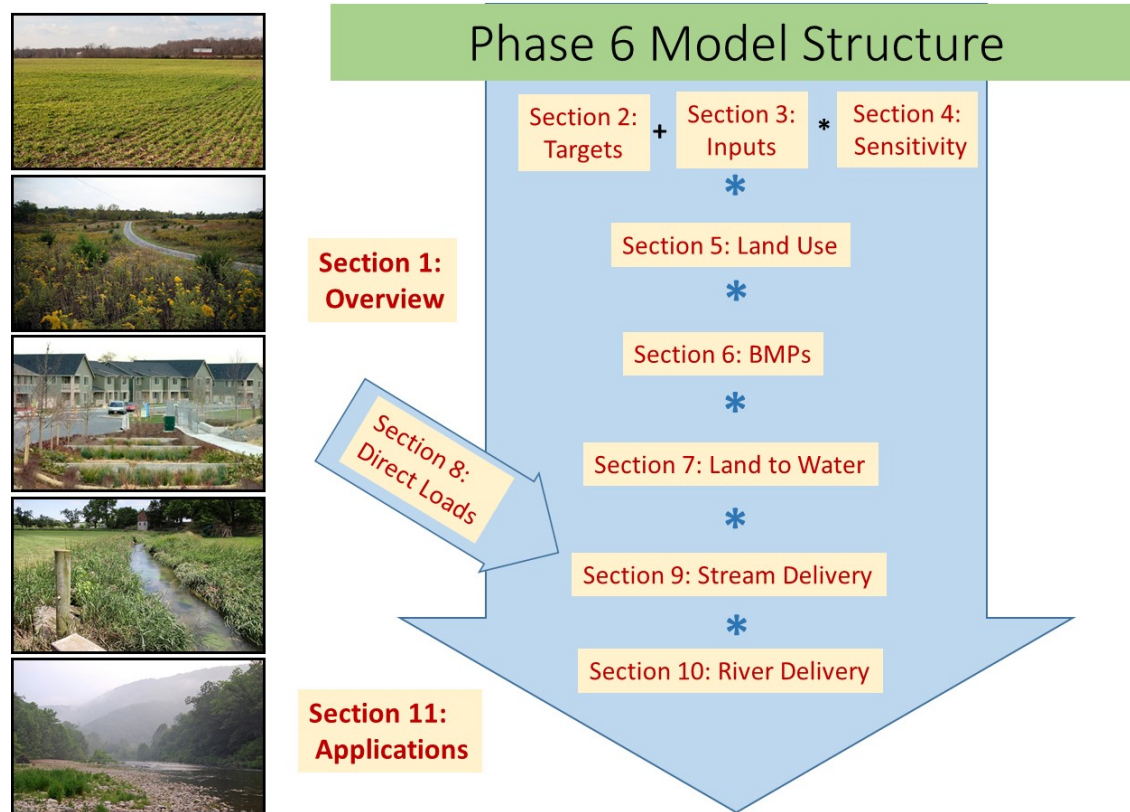


Figure 1-8 :Phase 6 Watershed model documentation structure

The structure of the documentation follows the structure of the model (Figure 1-8). Each major process is documented in a separate section with a final section for applications.

Table 1-4: Responsibility for Documentation and Decisions

Documentation Section	Workgroup with Primary Responsibility	Workgroup with Secondary Responsibility
Section 2: Targets	MWG	AgWG, USWG, FWG
Section 3: Inputs	WQGIT	AMS, AgWG, USWG, MWG
Section 4: Sensitivity	MWG	AgWG
Section 5: Land use	LUWG	USWG, AgWG, WQGIT
Section 6: BMPs	WQGIT	AgWG, USWG, FWG, MWG
Section 7: Land to Water	MWG	
Section 8: Direct Loads	WWWG	AgWG, MWG, PSG

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Documentation Section	Workgroup with Primary Responsibility	Workgroup with Secondary Responsibility
Section 9: Stream to River	MWG	
Section 10: River to Bay	MWG	
Section 11: Applications	WQGIT	

1.6 Overall Software Structure

The three different forms of the watershed model were discussed in Section 1.5. The static watershed model has a simple structure and is time-averaged. CAST is that same model, but applied to a specific geographic area and accessed through a web site. The temporal watershed model is constrained to arrive at the same long-term loads, but divides the load into hourly time steps for simulation. Since all three of these use the same logic to arrive at the long-term loads, it is beneficial for them all to use the same software to make the calculations. In addition to the efficiency benefits of having to program the logic once rather than three times, this structure ensures that all three are using the same version of rules and data and are constrained to calculate the same loads.

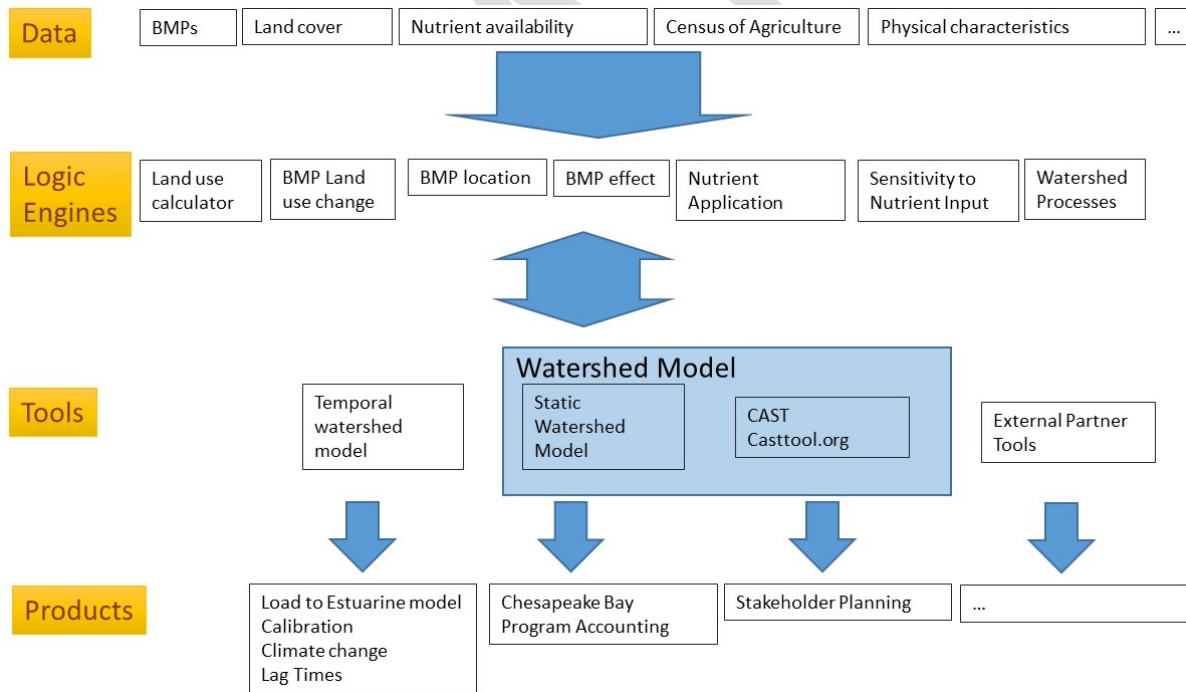


Figure 1-9: Phase 6 software structure

Figure 1-9 above describes the Phase 6 software structure. Data from the partnership and external sources are stored in databases at the CBPO. Logic engines common to all tools can be called to process the data. A user operating the tools selects the data sets to run and the tools are programmed to organize the process of calling the logic engines to make the calculations. Note that the 'Watershed Model' as understood by the CBP partnership incorporates both the Static Watershed Model to be used

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by the CBPO to run official Bay-wide scenarios, and CAST to be run by the partnership for WIPs, milestones, and other planning activities. The Temporal Watershed Model is only necessary for scenarios that will load the estuarine WQSTM, for calibration of the overall system, and for scientific investigation of processes such as climate change and lag times. The CBPO recognizes that other groups that are part of the CBP partnership may also want to develop tools that use the same logic. The logic engines will be available as web services that could be integrated tools in addition to the CBP watershed models and CAST.

DRAFT