Key CBP Model Updates, Enhancements, and Functionalities Added Over the Years

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Chesapeake Bay Program

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Introduction:

- CBP has had a successful three decades of watershed, airshed, and estuarine modeling.
- Throughout the progression of CBP models from the 1980s to the present there has been an attendant development of finer simulation scales, more simulation detail, and longer simulation periods.

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Key CBP Bay Model Products: 1987

The first allocation, or reduction in nutrients, in the Chesapeake Bay was directed by the 1987 Chesapeake Bay Agreement (Chesapeake Executive Council, 1987), which called for “at least a 40% reduction in the overall nutrient loads entering the mainstem of the Chesapeake Bay.” Key research in Chesapeake Bay eutrophication (Gillelan et al., 1983; Kemp et al., 1992, 2004, 2005; Boynton et al., 1995; Madden and Kemp, 1996; Boynton and Kemp, 2008) and a three-month summer steady-state Bay Model provided backing for the management directive of the 1987 Chesapeake Bay Agreement and its 1992 Amendments for reducing watershed nutrient loads.

Key CBP Bay Model Products: 1992

The generalized, nonspecific 40% reduction goal of the 1987 Chesapeake Bay Agreement was quantified in 1992 with the first major river basin-jurisdiction allocations of nitrogen and phosphorus (Perciasepe, 1992). Basin jurisdictions are formed by the intersection of the eight major basins of the Susquehanna, Potomac, James, Patuxent, Rappahannock, and York Rivers, the Western Shore tributaries, and the Eastern Shore tributaries. Airshed, forest, and all loads from Delaware, New York, and West Virginia were deemed to be uncontrollable. A three-year watershed and Bay model along with the first airshed model of nitrogen were applied.

Key CBP Bay Model Products: 1997

In 1997, the specificity of the basin-jurisdiction nutrient allocations was tightened by removing interim allocation loads for the Rappahannock, York, and James River basins and replacing them with specific basin-jurisdiction nutrient allocations (Butt et al., 2000). The interim nutrient allocations were initially done for these three tributaries because the lower Virginia tributaries had less influence on hypoxia than the tributaries north of, and including, the Potomac due to their closer proximity to the ocean mouth of the Chesapeake and the relatively lower residence times of waters and associated nutrient loads from these tributaries (Shen and Wang, 2007). Accordingly, the allocations given to the lower tributary basins of the Rappahannock, York, and James Rivers were based on an assessment of the water quality and living resource needs in those tidal tributaries based on submerged aquatic vegetation (SAV) restoration goals, an assessment of target chlorophyll *a* levels in the James, and dissolved oxygen (DO) habitat requirements in the lower Rappahannock and York River estuaries (Butt et al., 2000; Cerco et al., 2002; USEPA, 2003).

Key CBP Bay Model Products: 2000

The next milestone was the Chesapeake 2000 Agreement, a landmark agreement that included commitments for the adoption of living resource-based water quality standards, determining sediment load reductions that would be protective of SAV and other living resources, improving air deposition accounting in the Chesapeake watershed and tidal Bay and encouraging tighter partnerships with the headwater jurisdictions of Delaware, New York, and West Virginia (Chesapeake Executive Council, 2000). The 2003 allocations associated with the Chesapeake 2000 Agreement reflected the expanded partnership. The 2003 allocations were based on DO, chlorophyll a, and water clarity criteria that were protective of Chesapeake living resources and included all six Chesapeake Bay watershed states of New York, Pennsylvania, West Virginia, Maryland, Delaware, and Virginia and the District of Columbia. For the first time, the 2003 allocations included an allocation for sediment loads along with refined allocations for nitrogen and phosphorus loads.

Key CBP Bay Model Products: 2000 (*cont.*)

With a more inclusive and accurate accounting for nutrient loads than that of the 1992 allocation, the relative amount of nutrient load reductions, as compared to the estimated1985 benchmark of loads (Shenk and Linker, 2013), was a 48% reduction in total nitrogen (TN) and a 53% reduction in total phosphorus (TP) (USEPA, 2003). Also included in the 2003 allocation was a 29% reduction in total suspended sediment loads delivered to the Bay.

Despite the extensive restoration efforts of the Chesapeake 2000 Agreement and associated 2003 allocations, the 2010 TMDL was prompted by insufficient progress and continued poor water quality in the Chesapeake Bay and its tidal tributaries.

Key CBP Bay Model Products: 2010 TMDL

The historic 2010 TMDL was required under the federal Clean Water Act in response to consent decrees in Virginia and the District of Columbia from the late 1990s. By 2007, an assessment of nutrient loads found that estimated nutrient and sediment load reductions by 2010 would be insufficient to avoid a Chesapeake TMDL, and work began in 2008 to ensure completion of the TMDL allocation by 2010 (USEPA, 2008a). An additional feature of the 2010 allocation is the first allocation of atmospheric deposition of nitrogen loads in a TMDL (Linker et al., 2013). Also, allocations to federal lands and facilities in the Chesapeake Bay watershed, lands which cover 6.2% of the watershed area, were applied for the first time. For example, the District of Columbia has 7.4% of its impervious area and 6.3% of its pervious area in federal lands, which are now included in the accounting of the Chesapeake TMDL allocation. Exchanges of target load among basins and between nitrogen and phosphorus were established.

CBP Bay Model Products: 2017 MPA

The 2017 Midpoint Assessment (MPA) and associated target adjustments were made for growth, Conowingo infill (December 2017), and climate change (December 2020). The MPA also established the objective of examining 2035 climate change risk to the Chesapeake watershed and tidal Bay in 2025.

In Closing:

- CBP has had a successful three decades of watershed, airshed, and estuarine modeling.
- Throughout the progression of CBP models there have been the development of finer simulation scales, more simulation detail, and longer simulation periods.
- Awards associated with CBP Modeling: American Society of Civil Engineers Wesley W. Horner Award, 2005; Smithsonian Award in Environmental Information Technology, 1995 and 1996; EPA Gold Medal Awards 2004, 2010, 2014, and 2019; EPA Scientific Achievement Awards 1996, 1999, 2003, and 2009; EPA Bronze Medal Awards1993, 1998, 2005, and 2015; Chesapeake Bay Executive Council Award, 1992.

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