U.S. Senate Committee on Environment and Public Works

Subcommittee on Water and Wildlife

Finding Cooperative Solutions to Environmental Concerns with the Conowingo Dam to Improve the Health of the Chesapeake Bay

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Testimony of
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Chairman Cardin and members of the subcommittee, I appreciate the opportunity to present these perspectives on solutions to the risks posed by the progressive infilling with sediments of the Conowingo Reservoir in the context of the restoration of the Chesapeake Bay. I am Donald Boesch, a Professor in and President of the University of Maryland Center for Environmental Science, the region's leading research and educational institution focusing on the Chesapeake Bay and its watershed. I have been engaged in research or in management of significant research enterprises focusing on the Chesapeake Bay and its watershed for 32 years. I have long experience providing scientific advice to four Maryland governors, a host of state and federal agencies, the National Academy of Sciences, and organizations engaged in large-scale ecosystem restoration in other parts of the world, such as the Baltic Sea.

Based on the available evidence and analyses I would conclude that the infilling of the Conowingo Reservoir has created an additional burden of nutrient and sediment pollution to the Chesapeake Bay that requires mitigation. However, this burden does not render ineffective or significantly compromise the Watershed Implementation Plans that, if fully implemented, would achieve the Chesapeake Bay Program's restoration goals. I believe my perspectives to be widely shared by the scientific community engaged in research and analysis on the subject, although by the very nature of science we will continue to debate the specifics and work toward even better understanding.

In my testimony, I will briefly explain the scientific bases for my perspective and point to how science can improve the framework of effective and efficient management to achieve Chesapeake Bay restoration goals.

As the other panelists at this hearing have described, the Lower Susquehanna River Watershed Assessment Study has—based on monitoring and modeling conducted by the U.S. Geological Survey, the U.S. Corps of Engineers, the Environmental Protection Agency and state and academic scientists—refined our view of the status of the Conowingo Reservoir as a trap for sediments and nutrients transported from the Susquehanna Watershed to the Chesapeake Bay. Since the construction of the dam, the reservoir has retained some portion of these materials. As the reservoir gradually infilled with sediments, reducing the volume of water in the reservoir and allowing sediments that had been deposited behind the dam to be resuspended and flushed out by floods, it had been predicted that sometime around 2025 the reservoir would reach equilibrium, when sediment load entering the reservoir would equal that leaving. Research has now shown that the proportion of sediments and nutrients, particularly those forms of nutrients associated with particulate material, that enter the reservoir transported downstream has been increasing, particularly in response to storm events[1]. The scour threshold has been reduced from 427,000 cubic feet per second in 1996 to 330,000 cubic feet per second in 2011. Models of these phenomena suggest that the reservoir has already reached a dynamic equilibrium in which there are periods during which exports from the reservoir would exceed imports during scouring floods, followed by periods in which the deepened reservoir would effectively trap nutrients and sediments.

At this point, then, the essential question is how does this overall diminished trapping effectiveness affect water quality downstream in the Chesapeake Bay and our ability to achieve water-quality restoration goals. After all, the Susquehanna is no average river, contributing 47% of the fresh water, 41% of the nitrogen, 25% of the phosphorus and 27% of the sediment entering the Bay from land or air. However, the answer to this essential question is not simple because it requires understanding not only of the characteristics of sediments and nutrients released from the reservoir, but also knowledge of the ultimate fate of the material and its impacts.

Does the sediment settle out mostly in the upper Bay or does it extend well down the Bay? Satellite images following Tropical Storm Lee in 2011 show turbid water extending down into Virginia waters. But is it the bullet or just smoke from the barrel? Recent research has indicated that the vast majority of this sediment remained in the upper Bay[2]. To what degree are the particle-associated phosphorus and nitrogen that have been on the rise available to the plants and microbes that use these nutrients to produce the organic matter that clouds the water and depletes dissolved oxygen? And, how is this affected by the salinity of the estuarine waters and other environmental conditions, particularly the oxygen availability in waters overlying the deposited sediments? This is a particularly important question for phosphorus, as monitoring data show phosphorus loads have not been declining where the Susquehanna discharges to the Bay. Phosphorus is strongly associated with particulate matter. If those particles are deposited on the bottom in the low-salinity and well-oxygenated waters of the upper Bay the phosphorus would largely not be bioavailable. But, if they were deposited in the more brackish and oxygen-limited waters of the middle Bay the phosphorus might be.

Our best current understanding of these processes is incorporated in the Chesapeake Bay Program's Water Quality and Sediment Transport Model (WQSTM). Multiple runs of this model have been conducted by the EPA and Army Corps of Engineers to estimate

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[1] Hirsh, R.M. 2012. *Flux of Nitrogen, Phosphorus and Suspended Sediment from the Susquehanna River Basin to the Chesapeake Bay during Tropical Storm Lee, September 2011, as an Indicator of the Effects of Reservoir Sedimentation on Water Quality*. Scientific Investigations Report 2012-5185. U.S. Geological Survey, Reston, Virginia; Zhang, Q., D.C. Brady and W.P. Ball. 2013. Long-term seasonal trends of nitrogen, phosphorus, and suspended sediment load from the non-tidal Susquehanna River Basin to Chesapeake Bay. *Science of the Total Environment* 452-453: 208-221.

[2] Palinkas, C.M., J.P. Halka, L.P. Sanford and P. Cheng. 2013. Sediment deposition from tropical storms in the upper Chesapeake Bay: Field observations and model simulations. *Continental Shelf Research* doi.org/10.1016/j.csr.2013.09.012

the consequences of the decreased sediment and nutrient trapping efficiency of the Conowingo Reservoir and flood-associated releases on Bay water quality. This model is part of the state-of-the-art suite of models that have been used to estimate the load reductions needed to achieve improved water quality goals. The jurisdictions have developed Watershed Implementation Plans (WIPs) to achieve the Total Maximum Daily Load (TMDL) as determined by the models. Based on our best present understanding, if fully and effectively implemented, the WIPs would result in attainment of the water quality goals.

In a nutshell, what the model results indicate is that because of the increased nutrient loads resulting from the Conowingo Reservoir under its current state, full implementation of all existing WIPs would fail to meet water quality attainment only for dissolved oxygen in three mid-Bay segments and only after scour events. The model estimates that these three segments (in the mainstem Bay, lower Eastern Bay and lower Chester River) would fail to attain deep-channel dissolved oxygen standards by one percent in a January scour event; under a June scour event standard nonattainment would increase about three-fold[3]. More detailed analysis and determination of actions that could be taken to mitigate the impact of this additional nutrient loading should be included in the Chesapeake 2017 Mid-Point Assessment, and such an approach is envisioned under the revised Chesapeake Bay Agreement.

However, it is important to keep in mind that the nonattainment resulting from scour events is not a game-changer that overwhelms or otherwise renders the WIPs being implemented inoperable or ineffective. First, the most important implications concern nutrients not increased sediment loading as it appears that the vast majority of the increased sediment load is retained in the upper estuary. Second, the water quality model indicates that the increased loads have a relatively modest effect on dissolved oxygen in deeper waters near Kent Island, with little or no effects on water quality over vast portions of the estuary, including the larger tributary subestuaries, such as the Choptank and Patuxent rivers. Impaired conditions in the tributaries, including not only water quality but also harmful algal blooms and fish kills, are much more determined by reductions of nutrient pollution loads within their watersheds.

In essence, this new challenge is just one of many unanticipated factors that will confront the Chesapeake Bay restoration effort even after the water quality goals are fully achieved. Other changes, ranging from growth patterns to changes in agricultural practices due to economic forces to climate change, will undoubtedly cause curves in the road through which we must adaptively steer.

Consequently, the management models that are used to draw such conclusions must evolve over time as they incorporate these emerging conditions and advances in scientific understanding. There is no such thing as a perfect model. I like to quote the famous statistician George Box who said: "Essentially, all models are wrong, but some are

[3] Linker, L.C., C. Cerco, P. Wang, R. Tian, G. Yactayo and G. Shenk. 2014. *Estimated Influence on the Conowingo Reservoir Infill on Chesapeake Bay Water Quality*. EPA Chesapeake Bay Program Office, Annapolis, Maryland.

useful." The Chesapeake Bay Program suite of models are extremely useful in guiding our water quality restoration efforts. However, with regard to assessing the consequences of increased nutrient loads leaving the Susquehanna reservoir the models can be made more realistic through research, monitoring and more detailed modeling to better resolve the answers to those questions I posed earlier. More focused monitoring, particularly during and after reservoir scouring events, can better resolve the nutrient loads entering and leaving the reservoir and better characterize the forms of these nutrients. Experiments coupled with field observations can improve understanding of critical assumptions concerning sediment settling, resuspension and mixing and the release and regeneration of nutrients. Placing this knowledge in the context of tidal water flows and mixing via more facile models that can simulate flood and wind events would augment, inform and improve the Chesapeake Bay Program Water Quality Model. Thus, we have the rare opportunity to conduct truly innovative scientific investigations that would directly inform management decisions as they are considered in the Chesapeake 2017 Mid-Point Assessment.

As the other speakers at this hearing have addressed, there are other important issues surrounding the operation of the Conowingo Dam, including fish passage, habitat conditions above and below the dam, and upstream source control. I have focused on the consequences for water quality downstream in the estuary. Despite the revelation that the challenge of decreased retention of nutrient and sediments behind the dams on the lower Susquehanna River is not just something we should anticipate in the future but is with us today, there are many positive signs that the efforts to restore water quality in the Chesapeake Bay are working. Nutrient pollution from sewage treatment plants into both tidal waters and rivers and streams in the watershed are being dramatically reduced. Nitrogen concentrations and loads, once adjusted for variability in river flow, have declined at the mouth of the Susquehanna and most of the major rivers draining into the Bay. The unexpected resurgence of submerged aquatic vegetation on the Susquehanna Flats, not far downstream from Conowingo, provides testament to the resilience of organisms and ecosystems, once given a chance, to sustain themselves in the face of floods and other disturbances[4]. However, there is still much more to do in order to achieve our Chesapeake Bay restoration goals.

Fortunately, we have a highly capable and responsive scientific community in the Bay region to guide our efforts and verify the effectiveness of our actions. The Scientific and Technical Advisory Committee of the Chesapeake Bay Program is undertaking a peer-review of the Lower Susquehanna River Assessment. Moreover, I am confident that the scientific investigations that I have outlined would better resolve the uncertainties regarding the effects of reservoir scour events, lead to effective solutions, and provide critical support for the Chesapeake 2017 Mid-Point Assessment. Thank you for this opportunity to speak on behalf of Bay scientists.

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[4] Gurbisz, C. and M. Kemp. 2014. Unexpected resurgence of a large submersed plant bed in Chesapeake Bay: Analysis of time series data. *Limnology and Oceanography* 59: 482-494.